United States Department of Agriculture

National Report on Sustainable Forests—2010

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Letter From the Chief

I am pleased to release the *National Report on Sustainable Forests—2010*. The report provides a comprehensive picture of current conditions and trends in our Nation's forests, its forest industries, and its forest communities. The Forest Service is committed to the sustainable management of forests through collaboration and foresight based on the firm foundation of good data. This report is designed to meet this end in the belief that better data lead to better dialogue and, thereby, better decisions.

One of the report's key findings is the fact that the United States is richly endowed with forests, 751 million acres to be exact. That area has remained remarkably stable over the last 50 years, and the amount of wood in these forests is increasing. At the same time, however, forests in the United States face a number of threats, ranging from fragmentation and loss of forest integrity due to development to an alarming increase in the area and severity of forest disturbances. The report finds, for example, that the incidence of insect-induced tree mortality has increased three-fold in the last decade. In the coming years, climate change could substantially increase the damages and uncertainties associated with these threats. Not coincidentally, forests have a major role to play in helping to mitigate climate change, a fact that is well documented in the report.

The economic and social environment surrounding forests is also changing rapidly. The data presented in the report indicate ongoing shifts in where and how we produce our wood products and the emergence of new markets for ecosystem services. The data also provide information on the broad array of tangible products and uses through which Americans obtain value from forests on a daily basis. These changes bring with them new opportunities for economic development in rural areas but also challenges for individuals and communities in areas facing job losses and production cutbacks. Realizing these opportunities and facing these challenges constitute an important part of sustainability.

In order to ensure the sustainability of America's forests in the long term, land managers need to work across jurisdictions and land-use types, viewing forested landscapes as an integrated whole, both ecologically and socially. This is the essence of an all-lands approach to resource management. The data and analysis found in this report are designed to contribute to this effort.

Thomas Tidwell

Acknowledgments

A team of experts is required to prepare a report of this scope and depth. The national report was prepared by a core team composed of Guy Robertson, Peter Gaulke, Ruth McWilliams, Sarah LaPlante, and Richard Guldin. Members of the team were current and former employees of the Forest Service, an agency of the U.S. Department of Agriculture (USDA).

Criterion team leaders each provided leadership to a team of indicator specialists in preparing the individual indicator reports and criteria summaries:

- Biological Diversity: Steve Shifley
- Productive Capacity: W. Brad Smith
- Forest Health: Frank Sapio
- Soil and Water: Mike Amacher
- Climate Change and Global Carbon Cycles: Chris Woodall
- Socioeconomic Benefits: Ken Skog
- Legal, Institutional, and Economic Framework: Steverson Moffat and Fred Cubbage

In addition to the work of the criterion team leaders, the following individuals (including some criterion team leaders) authored or coauthored one or more supporting technical documents for the indicators and the two-page summaries:

- Biological Diversity: Steve Shifley, Curtis H. Flather, Kurt Riitters, Carolyn Sieg, and W. Brad Smith
- Productive Capacity: Sonja Oswalt and W. Brad Smith
- Forest Health: Jeff Mai and Jim Ellenwood
- Soil and Water: Michael Amacher and Rick Swanson
- Climate Change and Global Carbon Cycles: Chris Woodall, Ken Skog, Jim Smith, and Charles H. Perry.
- Socioeconomic Benefits: Ken Skog, James Howard, Susan Alexander, Ken Cordell, Marla Emery, Evan Mercer, Shela Mou, Kristen Magis, and Maureen McDonough
- Legal, Institutional, and Economic Framework: Steverson Moffatt, Fred Cubbage, Kathleen McGinley, and W. Brad Smith

Although each indicator is condensed in the report, extensive technical supporting documentation was developed for most indicators. That detail is contained on the report Web site, and the contributions of the criterion team leaders and individual indicator authors and coauthors are recognized there.

The Roundtable on Sustainable Forests (RSF) provided support and encouragement throughout the process of planning and developing this report. Led by non-Federal cochairs Jim Finley (Penn State University) and Dick Brinker (Auburn University) and Federal cochairs Joel Holtrop and Jim Hubbard (Forest Service), the RSF provided critical feedback that helped to shape the content of this report. Particular thanks are due to Roundtable participants from the Communications and Outreach Working Group, led by Graham Cox (New York Audubon Society) and Eric Norland (USDA National Institute on Food and Agriculture) for the group's help in organizing and hosting the three public review workshops for the draft report. In addition, the contributions of the Meridian Institute, especially Sarah Walen and Shawn Walker, are recognized for facilitating RSF meetings and workshops. They and their colleagues have helped organize productive meetings and synthesize comments from the workshops, which were of immeasurable help.

Two members of the Forest Service International Programs staff and one from the U.S. Department of State made substantive contributions to the refinement of the Montreal Process criteria and indicators following the 2003 report: Sandra Cantler and Shelley Gardner (Forest Service) and Kathy Karr-Colque (State Department). Their interactions with experts from other countries helped us focus better on the key issues.

Midway through the 7-year process of developing this report, three stalwarts of U.S. reporting on sustainability criteria and indicators retired: Dr. Stephanie Caswell (State Department), Robert Hendricks (Forest Service), and Ruth McWilliams (Forest Service). They were pioneers in how reporting on criteria and indicators could be used to improve natural resource monitoring programs, policy analyses, policymaking, and national accountability for sustainable forest management. They taught us all a great deal, and the globe's temperate and boreal forests are in better condition today because of their dedicated efforts.

A great deal of work goes into the actual physical production of a document such as this. Sonja Beavers provided critical assistance in editing and layout. Without her help, this report would not have been possible.

Preface

This report is issued at a critical moment in time. The year 2011 is the International Year of the Forest—a time when people around the world are encouraged to pay special attention to the importance of forest ecosystems and the goods and ecological services they provide to sustain societies and economies. With the many threats facing forests today, this report highlights conditions and trends of forests in the United States.

This report is unique from three perspectives. First, it is the second U.S. national report; the first was released in 2003. Thus, the information in this report enables the reader to evaluate the progress recently made by U.S. forest land owners and managers toward reaching the goal of sustainable forests in this country.

Second, this report is the United States' contribution to the set of reports produced by the 12 countries that are members of the Montréal Process Working Group (MPWG) on the Conservation and Sustainable Management of Temperate and Boreal Forests. The MPWG is a voluntary, nonlegally binding group of countries that have agreed to use a common set of criteria and indicators for tracking each country's progress toward their shared vision of sustainable forests. Visit http://mpci.org for more information about the MPWG.

Third, this report is just one component of the reporting process that the United States is using to report on forest conditions and trends and the progress being made toward sustainability. Supporting this document are a number of more detailed subsidiary reports on the individual indicators that provide a great deal of additional information in more detail than could be included here. These supporting technical documents are available at http://www.fs.fed.us/research/sustainability.

In addition to this report, several companion reports focusing on related information are being prepared. The Roundtable on Sustainable Forests is developing an Action Plan based on the findings in this document. A group of experts on America's tropical forests is developing a companion report on the conditions and trends of tropical forests so a more complete picture of all the United States' forests is available. A Web site being developed will serve as a repository for much of the technical information upon which the individual indicators reports are based. Some States and counties are also preparing similar reports using criteria and indicators to report on the situation at those spatial scales. As a result of these efforts, a great deal more information is available today for policy analysts and policymakers at national, regional, State, and county levels than was available a decade ago. The 2003 report stimulated most of this additional reporting activity; this report is expected to add momentum to additional endeavors at multiple spatial scales.

During the public review and comment period on the draft report, a number of comments suggested that this report needed to be reorganized to separate the more data-rich indicator pages from the analysis of the data. Therefore, this final report is organized into two parts. Part I presents analyses and findings. Part II contains two-page reports for each of the 64 indicators of forest sustainability used in the Montréal Process along with summaries for each of the 7 general criteria under which these indicators are organized. We hope that this reformatting will improve the flow of presenting the analyses and findings, as reviewers desired, while still making it simple to find the information for individual criteria and indicators.

Executive Summary

Purpose

The United States is richly endowed with forests, and their care and conservation have been a national concern for more than a century. This report, the *National Report on Sustainable Forests—2010*, provides data and analysis aimed at addressing this concern by enhancing dialogue and decisions in pursuit of the goal of forest sustainability. The report relies on the Montréal Process Criteria and Indicators (MP C&I) for Forest Sustainability to organize and present data relevant to U.S. forests and their sustainability across ecological, social, and economic dimensions. It is linked to the forest sustainability reporting processes of the other countries participating in the Montréal Process, and it is also linked to domestic efforts at local and regional scales that use criteria and indicators to help ensure the sustainability of their forests.

A similar report, also using the MP C&I, was published in 2004, and the release of the current report marks another milestone in our continuing efforts to build the knowledge base needed to sustainably manage forested ecosystems in the United States.

Key findings

Are our forests sustainable? This complex question has no easy *yes* or *no* answers. On the whole, no evidence suggests that we are "using up" our forests. In fact, the total area of forests has been stable, and the volume of wood found on them increasing. But a number of issues cause significant concern; they range from regional forest fragmentation and loss to widespread increases in forest insect infestation and other disturbances. Potential changes in climate compound the risks and uncertainties associated with these issues. The following additional key findings have emerged from the information presented in the report:

- At 751 million acres, forest area in the United States remains stable.
- Fragmentation and loss of forest land are occurring in many regions and localities, owing mostly to human development.
- Levels of forest disturbance are rising, including a three-fold increase in insect-induced mortality relative to the previous report.
- The number and complexity of values and demands society places on forests are increasing.
- Wood products production is declining relative to growing consumption, with increasing imports filling the gap.
- Forest management activity is declining in many areas as forest products firms divest themselves of timber lands.
- Sustained capacity and willingness to manage forests sustainably are evidenced by a growing number of public-private collaborations on projects devoted to landscape-scale conservation.

Overarching Issues

The following three overarching issues emerged from the analysis of the data and from the extensive comments received from the public—issues that promise to be of crucial importance to forests and their management in the coming years.

1. **The loss of forest lands and working forests.** The gross statistics on forest area mask substantial fragmentation and outright losses in forest land at the regional level, particularly in areas adjacent to growing urban areas or where recreational development is prominent. Fragmentation and loss is further compounded by the sale of forest lands to firms and individuals whose primary focus is not active forest management for timber production, forest conservation, or other purposes. With the loss of an active management focus and the revenue streams that often accompany it, the survival of these forests and their associated ecosystem services is in question.
2. **Forests, climate change, and bioenergy.** Climate change presents profound challenges and opportunities for forests and forestry in the United States. We are already seeing altered patterns of forest disturbance associated with changes in temperature, precipitation, and insect activity. The resulting changes in the distribution of forest cover and species distribution will play out over the coming decades. At the same time, forests serve as a major carbon sink with the potential to further sequester large amounts of carbon from the atmosphere, and they may also serve as a major

source of carbon neutral, renewable energy in the future. To the extent that these potentials are realized, carbon sequestration and bioenergy production could radically alter the ecological and economic landscape of forest management in our country.

3. **Forest health and disturbance patterns.** The elevated levels of forest disturbance documented in this report promise to profoundly shape both our forest landscapes and the ways we manage them. In many areas, particularly the West, confronting the complex causes and effects of disturbance will remain a dominant, if not the dominant, consideration in forest management and policy for the foreseeable future.

The Path Forward

In response to the challenges and opportunities these issues present, the report makes a number of general policy recommendations. First and foremost is the need for robust and engaged dialogue about forests and forest sustainability at all levels of society. This need is in keeping with the core philosophy underlying the report: better data leads to better dialogue and, thereby, to better decisions. Another general recommendation is that solutions are often best accomplished at the landscape scale, spanning different types of land uses and involving collaboration among different stakeholders. This recommendation embodies an all-lands approach to forest conservation. Other recommendations include the following:

- Flexible, adaptive management techniques that work with natural processes need to be continually developed to meet the challenges posed by climate change and growing levels of forest disturbance.
- Innovative market mechanisms that account for and generate revenues from the various ecosystem services forests provide are sorely needed.
- Carbon sequestration and wood-based bioenergy should be vigorously pursued, but not at the cost of other aspects of forest sustainability.

Content and Structure of the Report

More than 30 Forest Service scientists, senior staff, and outside collaborators contributed to the production of this report. Through an extensive process of comment and review organized by the Roundtable on Sustainable Forests, the report incorporates the views of a broad range of individuals representing the community of interest surrounding forests and forest sustainability in our country today.

The report is divided into two main parts. Part I discusses the concepts underlying forest sustainability, summarizes major issues and conditions affecting U.S. forests, describes numerous sustainability efforts under way at local and regional levels, and identifies the implications of the report's findings for policy and action.

Part II contains the data reports addressing each of the 7 criteria and 64 indicators in the MP C&I. The data reports provide the data foundation for the analyses found in Part I and are, by themselves, important resources for specific data; general information; and references related to forest ecosystems, their current conditions, and their sustainability.

Contents

Part I.

Background, Context, and Summary Analyses

Chapter 1

Setting the Stage: The Context for Reporting on Sustainable Forests

Why We Care About Sustainable Forests

Forests perform many critical ecological roles. They are the lungs for the planet, cleaners of the air, catchers of rainfall and protectors of soils, filters for streams, and homes to countless species.

Beyond their ecological roles, forests are the foundation of societies, providing places to build communities, raise families, enjoy outdoor activities, and nourish the spirit. Forests are also the foundations of economies, creating job opportunities, supplying environmental services such as clean water, and providing awe-inspiring natural splendors for tourists and residents alike.

Through sustainable management, forests can contribute to the resilience of ecosystems, societies, and economies while also safeguarding biological diversity and providing a broad range of goods and services for present and future generations.

Just as in President Theodore Roosevelt's era, our current actions are shaping the future that our grandchildren will inherit. Although the pressures facing our Nation's natural resources have no doubt grown in number and complexity since the dawn of the 20th century, the fundamentals of sustaining forests for future generations have not changed much. The choices that people make determine the sustainability of forests.

> The Nation behaves well if it treats the natural resources as assets which it must turn over to the next generation increased, and not impaired, in value.
>
> *Theodore Roosevelt, 26th President of the United States*[1]

Today, people depend on forests as much as they ever have. The converse is also true—forests depend on people and their actions. What is different today from Roosevelt's time is the advent of global influences, such as climate change and air pollution and worldwide commerce, whose effects are felt everywhere. Mirroring the sentiments expressed by President Roosevelt in 1910, Tom Vilsack, the current Secretary of Agriculture, stated, "*A healthy and prosperous America relies on the health of our natural resources, and particularly our forests.*"[2] As a society, we should collectively take good care of all of our forests so they, in turn, can take good care of us.

Reporting on Sustainable Forests

The first *National Report on Sustainable Forests—2003* reported on the state of forests in the United States using a set of 7 criteria and 67 indicators developed by the Montréal Process Working Group.[3] This current report is the second in the series, and continues to track our Nation's progress.

It provides fresh, factual information along with some context to inform and inspire dialogue about sustainability and our Nation's forests. Improvements in inventory and monitoring programs have yielded fresh data, and recent research has led to the development of new models and analysis methods. Expanding and emerging partnerships are providing new and more relevant information.

This report is divided into two main parts. Part I contains background information, summary analyses, and policy suggestions. Part II is devoted to the presentation of factual information and analysis specific to each of the 7 criteria and 64 indicators of the Montréal Process Criteria and Indicators (MP C&I) for forest sustainability. In this fashion, we have separated the summary and interpretation portions of the report from the more factual and data-intensive portions.

[1] Roosevelt, T.R. 1910 (August 29). Speech before the Colorado Livestock Association. Denver, Colorado. 1910. Cited in Roosevelt (1910).

[2] See Vilsack (2009) for transcript of speech (http://www.usda.gov/2009/08/0382.xml).

[3] See USDA Forest Service (2004). Copies of the 2003 report are available electronically at http://www.fs.fed.us/research/sustain/.

Chapter 1 sets the stage and provides some context for the information provided in subsequent chapters. This includes a discussion of the core concept of sustainability and how it has been reflected in the MP C&I. The major driving forces currently underlying change in forested ecosystems are also indentified in this chapter along with the major challenges confronting forest managers in their quest for sustainability. The chapter concludes with a more detailed description of the content and structure of this report and the Forest Service's sustainability reporting effort as a whole.

The intensive public dialogue spawned by the release of the 2003 report has led to an evolution in our collective understanding of "forest sustainability." This evolution was reflected and reinforced by the extensive dialogue and review process surrounding the production of the current report. Throughout this time, appreciation of the broader portfolio of values derived from the Nation's forests has continued to grow. Because the sustainability concept has been refined and the list of values has expanded, we now turn to describing those changes to set the stage for what follows in this chapter.

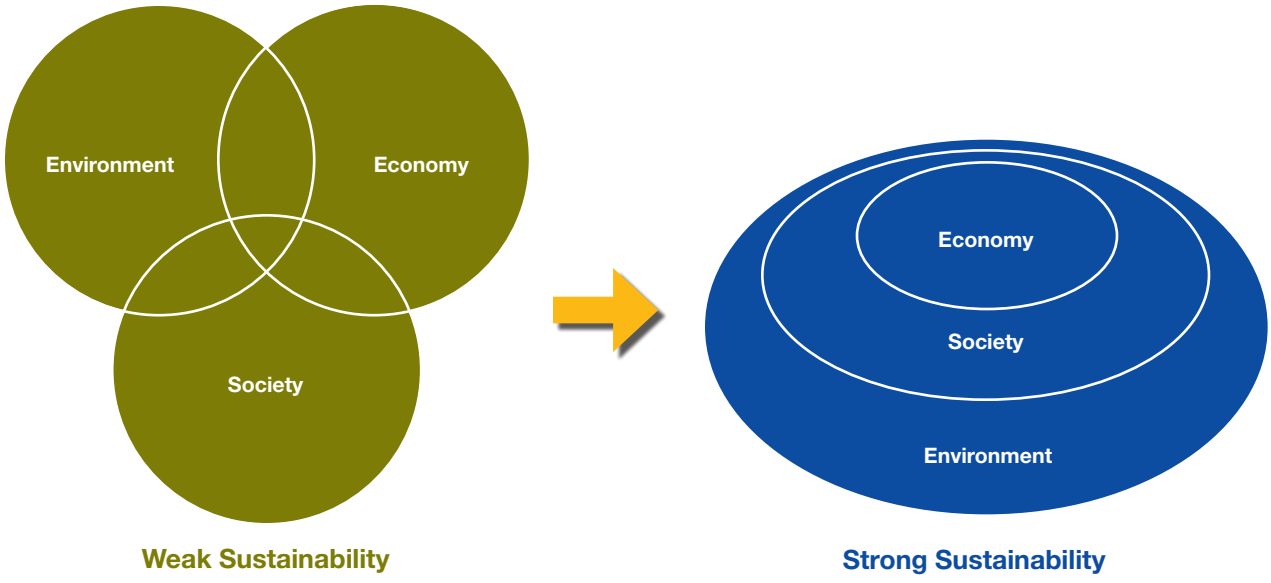
Defining and Modeling Sustainability

Since the publication of the 2003 report, the Federal Government has adopted a definition of the term "sustainable." As do most definitions of sustainability, this definition recognizes three arenas in which the effects of natural resource decisions are closely linked. These arenas—environment, society, and economy—are commonly referred to as "the triple bottom line." When influences and interactions between the threes spheres of the triple bottom line are properly accounted for, natural resource decisions have a better chance of achieving sustainability. To be truly sustainable, natural resource decisions should account for social, economic, and environmental considerations. Although we can think and talk about sustainability in different ways, the "triple bottom line" is being used increasingly as a shorthand way to describe an organization's commitment to sustainability.

The relationship between the environment, economy, and society was illustrated in the 2003 report with three intersecting circles (fig. 1). Earlier thinking about sustainability, (shown on the left side of figure 1 and referred to as Weak Sustainability) envisioned the environmental, social, and economic realms as intersecting, yet separate, parts of a system. More recently, thinking about the relationships between these three realms has evolved, and today, the depiction of sustainability shown on the right-hand side of figure I-1 (Strong Sustainability) is the one adopted by this report.

This updated model reflects the understanding that the environmental realm is the foundation of strong sustainability because the environment provides natural goods and services that cannot be obtained through any other means. Human society cannot exist without the environment, which provides the basic necessities of life: air, water, food, energy, and raw materials. The human economy depends on people and social interaction. The core concept of strong sustainability is that the benefits of nature are irreplaceable and that the entire economy

Figure I-1. Triple Bottom Line: interconnected and interdependent benefits.



Source: Maureen Hart—Sustainable Measures

is reliant on society, which in turn is entirely dependent on the environment. This emphasizes the interdependencies between our society, our economy, and the natural environment.

Today's most pressing forest issues (e.g., loss of ecosystem services, loss of working forests, fire danger and hazardous fuels, increasing demands for woody biomass to produce bioenergy, adapting forest management to potential climate changes, etc.) have strongly interconnected and interdependent economic, social, and environmental linkages. Decisions made regarding these issues will widely affect areas of the economy, society, and environment beyond those directly related to forests, which suggests that these pressing issues cannot be resolved solely within the forest sector or by actions taken solely within the boundaries of the forest. Solutions will require dialog among a broader set of interests, and it will require policy implementation in the economic and/or social spheres in order to improve conditions in the environmental sphere. This activity needs to occur not just within forests, but across landscapes that include towns, ranches, and farms as well. Developing implementable and sustainable solutions to these issues will require the involvement and support of a diverse group of interests, bridging not only different sectors but also spatial scales and generations.

Sustainability Across Landscapes and Through Time

In the early part of the 20th century, foresters viewed their work as managing "stands" of trees, commonly defined as (usually small) groupings of trees sharing some common feature, such as the same soil type or trees of the same species mixture or the same age. Forest managers attempted to plan sequences of stand-level activities to provide an even flow of goods and services over planning horizons stretching out two or three decades. They paid little attention to the pattern being created on the land by sequences of activities. During the latter half of the 20th century, it became clear that certain types of problems were not being addressed by segmented pattern-insensitive approaches to forest management. By the early 1990s, researchers had concluded that the effects of forest management needed to be evaluated over both a range of spatial scales beyond the stand level to include watersheds of various sizes, landscapes, and regions; and in light of ecologically relevant time scales (Brooks and Grant 1992). Although these conclusions were called "new perspectives" back then, today they are mainstream thinking.

Although landscapes and intergenerational timeframes are now widely accepted today as the appropriate spatial and temporal scales for thinking about sustainability, the concept of landscape is still too often limited to landscapes dominated by forests. Since the 2003 report was released, public dialogs have demonstrated that stands of trees are also quite important in landscapes that are dominated by agricultural and/or urban land uses. Indeed, the pattern of forest patches in landscapes dominated by other land uses may make those stands of trees even more important ecologically and socially than equivalent acreages of trees in forest-dominated landscapes. Those working toward sustainable solutions should take into consideration the conditions and relationships between the forest and nonforest parts of the environment, along with the social and economic spheres that depend on environmental conditions. Today, this is called an "all lands" approach to sustainability.

Montréal Process Criteria and Indicators as a Common Framework for Understanding Sustainable Forests

For society to understand the effects of complex problems on the environment and economy, and to become motivated to make choices that favor sustainability goals, a method is needed to communicate current forest conditions and important changes more clearly and explicitly to diverse interests. The Montréal Process Criteria and Indicators (MP C&I) provide a common framework to describe, monitor, assess, and report on forest trends at the national level and on the progress being made toward sustainable forest management. They also provide a common understanding within and across stakeholder communities of what is meant by sustainable forest management. An informed, aware, and engaged public is indispensable to promoting sustainable forest management, and these criteria and indicators help provide the informational foundation for this engagement.

The seven Montréal Process criteria reflect a holistic triple-bottom-line approach. No single criterion represents an adequate depiction of sustainability. No priority or order is implied in the order of the seven criteria, nor of their associated indicators.

The seven criteria represent a common set of values deemed the most important dimensions of the holistic set of values created by forests. In this way, the seven criteria help create a common language for discussing sustainability. The seven criteria create a platform for launching dialog to advance these shared values. Over time and through increasing use and scrutiny, this platform has proven to be solid. Since 2003, the seven criteria have not changed. In fact, other criteria and indicator development efforts (some of which are highlighted in chapter 3) have looked to the MP C&I, and its criteria in particular, for guidance.

The MP C&I have undergone extensive scrutiny during the past decade from members of the scientific and policy communities and from practitioners working at different spatial scales, ranging from the international to the local level. This scrutiny

is evident in Part II, which discusses in detail the rationale behind each of the seven criteria and how individual indicators have been revised. In Part II, readers can explore how the scientific body of knowledge has been structured around the MP C&I. This framework organizes the numerous data sources and scientific efforts under way that are attempting to measure the state of our Nation's forests. In doing so, it provides a hierarchical structure to the science of sustainability. Individual indicators provide insight into specific criteria, and the seven criteria, when looked at as a whole, provide a yardstick with which society can measure its progress toward sustainability goals.

Montréal Process Criteria For the Conservation and Sustainable Management of Temperate and Boreal Forests

1. Conservation of biological diversity.
2. Maintenance of productive capacity of forest ecosystems.
3. Maintenance of forest ecosystem health and vitality.
4. Conservation and maintenance of soil and water resources.
5. Maintenance of forest contribution to global carbon cycles.
6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies.
7. Legal, policy, and institutional framework.

Although many MP indicators are quantitative in nature, some are qualitative or descriptive. Some indicators can be readily measured (e.g., percent of forest cover), and others may require the collection of new or additional data, the establishment of systematic sampling, or even basic research (e.g., Indicator 6.44, "the importance of forests to people").

Excerpt From Quebec Declaration

Reaffirm our commitment to implementing the Montréal Process Criteria and Indicators as an important means of national monitoring, assessing and reporting.

Québec City, Canada
22 September 2003

When indicators are measured periodically over time, analysts can report on both current conditions and recent trends that are relevant to sustainable forest management. Monitoring and reporting over time provides information needed to evaluate the country's policies and progress toward sustainable forest management. This information is essential to making informed forest policy decisions.

As national-level assessment tools, the MP C&I provide a basis for reporting on all forests in the country, including public and private forests, and natural forests and plantation forests. Although they are not performance standards nor are they designed to assess sustainability at the management unit level, the MP C&I do provide a framework for developing policies, plans, and inventories at national, regional, and landscape scales, and they can serve as a model for monitoring and reporting on other natural resources, such as rangelands.

New Indicators Since 2003

After the initial round of 12 country reports were released from 2002 to 2004, the Montréal Process member countries conducted a review of the indicators used, exploring ways to refine and improve the relevance and definitions of selected indicators. Member countries have always expected that the indicators should be adaptable: that they would be tested and refined through use and discussion. In the several years after the initial round of reports, the MP C&I have evolved through workshops held by member countries. This report contains 64 indicators, not the 67 that were used in the 2003 report. Some of the former indicators were dropped, and some new indicators have been added. Several indicators have been refined through substantial rewording to improve clarity. Important exceptions are those indicators for Criterion 7. Revisions to Criterion 7 indicators were agreed on in November 2008, but that was too late to use them in this 2010 reporting cycle. A complete listing of indicator changes can be found in Part II.

Driving Forces and Contemporary Challenges Affecting Sustainable Forests

Today, many of the major pressures on forests are arising from outside the forest sector. Climate change, globalization of economic development and trade, rates of energy consumption, and population increases are all contemporary examples. These "driving forces" are resulting in profound effects to forested ecosystems and the social and economic systems associated with them. Coming with these effects are significant challenges for forest managers, policymakers at all levels, and the citizens of our country.

In this section, we briefly discuss and identify the major driving forces and contemporary challenges affecting U.S. forests today. This discussion will lay the foundation for the summarization and analysis of C&I information presented in chapter 2 and for the potential courses for action proposed in chapter 4.

Driving Forces Highlighted

A number of driving forces are largely responsible for the forest conditions and trends detailed in the data presented in Part II of this report. These forces, which are often beyond the control of individual land managers, result in both direct changes in forest conditions and indirect effects on economic and social conditions within communities where people live. They are also shaping the future of forest management. The resulting changes are at times subtle and, at other times, dramatic. Moreover, these driving forces not only affect forests but also affect all lands and land uses across landscapes. Ultimately, these forces affect social choices, policies, and management options across many different land uses and economic sectors—all of which eventually affect sustainability.

This report identifies seven major driving forces affecting forest sustainability:

1. Climate change.
2. Globalization.
3. Biomass energy demand.
4. Urbanization and related shifts in land use patterns.
5. Forest fragmentation and parcelization.
6. Loss of working forests.
7. Altered disturbance patterns.

These forces are not independent of one another. They often interact, leading to more complex situations, with one exacerbating another. We introduce them here without attempting to explain all the possible interactions.

Climate Change

Research and modeling indicate that changes in climate are leading to changes in temperature and precipitation patterns, which in turn are affecting the composition, location, health, and structure of forests. These changes are also affecting the composition and patterns of other land covers and land uses across a landscape.

Forests and other ecosystems—along with communities, cultures, and economies—will be impacted by, and adapt to, the effects of climate change. Evidence is emerging that adaptation is already under way. Whether policymakers and land managers can assist the adaptation process to reduce undesired effects remains to be seen. The policies implemented and adaptive management options chosen to combat climate changes are expected to affect society and the economy in myriad ways, none of which are completely understood today. Dealing with the risk and uncertainty that result from incomplete knowledge is an important dimension of our effort to foster resilient and sustainable forests.

Globalization

Nations, people, businesses, and natural resources are becoming increasingly interconnected globally, with actual and virtual movement of people, capital, technology, and goods across national borders and around the world. Globalization is changing economies and environmental conditions from local to international scales. In the forest products sector, wood and paper products grown and manufactured in the United States are already competing strenuously with products from other parts of the globe. Economic policies aimed at assuring fair trade in global markets may have direct and indirect effects on land uses and forest sustainability.

The emergence of forest and wood products certification programs in recent years has positively influenced forest sustainability around the globe, which is an example of how policymaking simultaneously influences economic markets, consumer choices, and forest management. But not all the effects of globalization are so positive.

In regard to forestry and wood products, the increasing trade associated with globalization has resulted in stiffer competition for U.S. producers and shifts in production between regions and to other nations. The job losses that go with these shifts, as well as the possibility that we are exporting environmental harm to other nations with more lax environmental standards, are important questions with both ethical and practical implications, but they are not explicitly addressed by the indicators used in this 2010 report. The indicators used in the 2015 national report[4] will hopefully do a better job of measuring and reporting on the trans-border effects accompanying globalization and shifting trade and production.

Biomass Energy Demand

Sustainable development requires sustainable energy supplies, particularly fuel for transportation and electricity for commercial and residential uses. Concerns about the long-term security and future prices of energy feedstocks have created demands for alternatives. Woody biomass is an alternative energy feedstock drawing considerable attention. In the future, the prospects for increasing our ability to use forest biomass to produce bioenergy and biofuels may result in increased pressures on forested landscapes.

[4] See *The Montréal Process Criteria and Indicators. 4th Edition* for the latest list of indicators at http://mpci.org.

In 2007, 4.3 percent of all the energy consumed in the United States came from renewable sources. Forest biomass provided more than one-half of that renewable energy, much of it through longstanding forest industry practices that recycle sawdust and other waste materials for energy used to run production processes. However, the drive for energy independence and reductions in carbon emissions from combustion of fossil fuels could radically change this situation in the near future, resulting in the emergence of new forest-based energy industries and increased competition among traditional and new forest products industries.

Researchers are carefully studying two pathways. The first is generating electricity and the second is converting wood into liquid transportation fuels. Generating electricity using wood is simpler because the technology is more mature. Converting woody biomass to transportation fuels, such as cellulosic ethanol, is more difficult because commercial-scale processes are not yet widely available.

Other potential changes in the energy sector are also possible. Two prime examples are the emergence of carbon credit trading markets and expansion of renewable energy use requirements. By increasing the price of fossil fuels or the demand for renewable energy, these changes could significantly increase the attractiveness of wood as a source of energy, which would have consequences for both forests and other land uses.

Urbanization and Shifting Land Use Patterns

More than 80 percent of the U.S. population now lives in metropolitan areas of 50,000 or more people. During the past five decades, urbanization has continuously encroached on forests adjacent to developed areas (Stein et al. 2007). Economic and social factors, such as discretionary income levels; decisions about where to live, shop, and work; and modes of transit, combine to affect local and regional land covers and land uses. As land shifts between forest, agriculture, and developed uses, and as development intensifies, the environmental services that the landscape provides also change.

Urbanization also drives change in the relationship between citizens and their forests, the values they hold for them and the ways they use them. For most of us, forests have become more distant and our dependence upon them less direct. The linkages between forests and the well-being of people are as important as they ever were, but they are less visible and less of a concern for most of us in our everyday lives. These changes, in turn, influence the political debate surrounding forests and their management.

Forest Fragmentation and Parcelization

U.S. forests are becoming increasingly fragmented, especially in areas close to our cities and where natural scenery or other amenities make an area attractive for vacation and retirement home development.[5] Fragmentation can reduce the supply of certain types of ecosystem services that are produced primarily by large, contiguous tracts of forest, services such as the provision of wildlife habitat essential for some species.

Parcelization refers to the decreasing average size of privately owned forest tracts, resulting from the increasing numbers of private forest landowners. At smaller parcel sizes, it becomes very difficult to actively manage the forest—at either the individual-owner scale or the landscape scale. As active management at both scales becomes more difficult, the supplies and quality of ecosystem services produced can decline and achieving sustainable forests and sustainable landscapes becomes more difficult. A complicating factor today, compared with 20 years earlier, is the fact that forest landowners today typically live farther away from the parcels they own, often in another State. Absentee landowners make it harder for State agencies and local nongovernmental organizations (NGOs) to foster new market mechanisms to determine the values associated with forest-based ecosystem services.

Loss of Working Forests

Land with trees provides society with numerous benefits every day. Ecosystem services are one type of benefit, as are wood and nonwood forest products. Examples of ecosystem services include providing filtration of rainwater, homes to pollinating insects, and scenic beauty. Society has traditionally considered many ecosystem services as free benefits from having forests. When forests are neglected, become fragmented, or are lost to other land uses, however, the amount of ecosystem services they provide often declines. Forests are working each day in support of society by providing these services, but the value of their contributions often goes unrecognized. In this sense, all forests are "working forests."

Shifts in land uses represent the most common cause of loss of working forests. When we create new residential and commercial developments from working forests, we change the types and amounts of environmental services the land can provide. Real estate development patterns also lead to forest fragmentation and are therefore a driving force in their own right. In the future, we expect real estate development to contribute significantly to the loss of working forests.

[5] Openings made in continuous forest cover, such as for vacation homes or wildlife food plots, are sometimes called "perforations" in tree cover and their impacts considered as part of the impacts of forest fragmentation.

Lack of active management is another factor contributing to the reduction in goods and services from working forests—and sometimes the loss of the forests themselves. In many areas, forests need regular management to stay healthy; unhealthy forests are rarely sustainable. Although short periods of benign neglect may not damage the long-term sustainability of some forests, driving forces like climate change will lead to quicker and harsher changes in the health of forests that are not actively managed. Consequently, those forests, and the services they provide, will be at greater risk.

Altered Disturbance Patterns

Some degree of disturbance is normal and natural in forests. Examples of common natural disturbances include storms, hurricanes, late frosts that damage flowering and seed production, mid-winter warm-ups that damage frost hardiness, lightning igniting wildfires, and pest outbreaks. Humans also cause disturbances in forests, some intentionally (e.g., converting forests to residential uses or prescribing fires as part of management plans) and some unintentionally (e.g., a campfire that escapes because it was not fully extinguished).

Part of the forest manager's job is managing the risks and uncertainties to forest health and ecosystem services that arise from disturbances. When a pattern of disturbances changes significantly across a landscape, more severely threatening forest health and productivity, forests need active management to help them adapt to the changing conditions and to sustain the flow of services and products expected from those working forests. Sometimes, forests need small, controlled disturbances to reduce the risks and uncertainties associated with larger, uncontrollable disturbances. For example, removing hazardous fuels and using light, prescribed fires can reduce the risk of losing ecosystem services and reduce the threat to homes from large wildfires. In many areas, simply allowing nature to take its course is not a viable option in the face of growing risks and uncertainties.

Several of the driving forces already introduced appear to be changing the pattern of disturbances considered normal during the past several decades. The following chapters will explain in more detail the combined effects of these driving forces on disturbance patterns.

Contemporary Challenges Facing Sustainable Forests

Besides the driving forces affecting the Nation's forests, attitudes and beliefs of Americans also affect how the country's public and private forests are conserved, used, managed, and protected. Some of these attitudes and beliefs reinforce the Nation's ability to achieve sustainable forests, although others seem to hinder sustainability. Sustainability is not only about what happens on the landscape to natural resources but also about what happens in the hearts and minds of citizens. Resource managers and landowners need to recognize the importance of values and beliefs, and they need to simultaneously work at managing the social dimensions as well as the ecological and economic dimensions of sustainable forests.

A Collective Conservation Ethic

During the 20th century, leaders in forest conservation identified a growing number of ways that forests benefit our society. At the beginning of the 20th century, the links between healthy forested watersheds and their beneficial effect on stream flows and water quality—key ecosystem services from working forests—were one of the main reasons why the national forests were created. In the middle of the 20th century, the values of forests for outdoor recreation and solitude were enshrined in public laws.

More recently, as urban areas have grown and energy for transportation, home heating, and cooking has shifted from burning wood to consuming electricity, oil, and natural gas, people have become increasingly disconnected from forests. Today, many people's primary interaction with forests and rural landscapes is driving past them on interstate highways. Further, with the advent of various new forms of entertainment, we and our children are spending less and less time outside engaged in physical activity in the woods.

Today, many conservationists are concerned that the general public is now so disconnected from forests and the numerous services and products they provide that public support for forest conservation and management is ebbing to dangerously low levels. To maintain our capacity and capability to manage forests, and more broadly, all the lands in rural landscapes, a new and collective conservation ethic is required. Not only would this ethic enhance the sustainability of forests, but it would also support pathways toward sustainability for rangelands, farms, and ranches; in short, it would build support for sustainable development principles that would benefit our growing national population. A shared conservation ethic could act as a cornerstone on which to anchor many different development decisions.

Landscape-Scale Conservation

In 2009, Secretary of Agriculture Tom Vilsack called for creating a "shared vision" for America's forests, one that recognized the importance of all lands: "*The threats facing our forests don't recognize property boundaries. So, in developing a shared vision around forests, we must also be willing to look across property boundaries. In other words, we must operate at a*

landscape-scale by taking an 'all-lands approach.'"[6] More and more, we are coming to realize that we need to consider entire landscapes, and not simply individual parcels of forest land, to achieve our social and economic goals at community, regional, and national levels.

As chapter 3 describes, success in achieving landscape-scale conservation is tied closely to our success in achieving constructive social interactions at that landscape scale. Examples highlighted in chapter 3 include activities that have been successful in various places and through various means to facilitate the transition from working forests into real landscape-scale conservation. These examples are our roadmap to affecting the way we view our natural assets and, more importantly, how we care for them.

Consumption Choices

Human consumption of goods and services from natural resources is the most profound way in which the social and economic arenas affect the environmental arena in the strong sustainability model (fig. 1). For this reason, a large number of indicators across all the criteria highlight the effects of various consumption choices.

Our choices about consuming natural resource goods and services are constrained by the current health and productivity of forests and landscapes, and they also have a major influence on the future health and productivity—the sustainability—of those same forests and landscapes. Consuming too much today may leave too little for the future.

Population growth is a major determinant in total consumption. Choices about desired standard of living and lifestyle—both of which are dependent on disposable income—determine per-capita consumption. When both of these factors are combined—increased consumption per-capita and increased overall population growth—stresses on sustainability can be magnified. Policymakers concerned with sustainability should track trends in per-capita consumption and use available population projections to evaluate future prospects for sustainability. The MP C&I have indicators of per-capita consumption, but leave population projections to others.

Decentralized Data Acquisition, Storage, and Reporting

A central premise of the Roundtable on Sustainable Forests is that forest policy decisions are more likely to receive support and achieve their desired outcomes when they are based on sound data and when broad-based public dialog has occurred during the policymaking process. The roundtable's mantra—better data leads to better dialog, which leads to better decisions—is founded on the quality and quantity of data available to describe current conditions and evaluate recent trends. If inventory and monitoring activities are well designed and funded, a solid basis for dialog can be created.

A major benefit from the first decade of development of the MP C&I is the fact that many countries created new inventory and monitoring programs or significantly improved existing programs in order to better meet the demands of the C&I. In the United States, strategic-level forest inventories have improved significantly over the past decade as a result, most notably in the case of the Forest Inventory and Analysis (FIA) program, which is administered within the Forest Service's Research & Development area with collaboration from partner organizations. Data from this source contributed substantially to the indicator reports found in Part II. Investments have also been made in inventories at finer spatial scales, but some of these have not paid similar dividends because much of this work is still too decentralized in its administration, with designs and measurements too inconsistent to permit effective landscape-scale, all-lands dialog and policymaking.

Summary of Driving Forces and Contemporary Challenges

Although they have been introduced here as discrete items, the combined effects of these driving forces and contemporary challenges on forests and on all lands across landscapes are inevitably the result of complex interrelationships. Their influence spans ecological, social, and economic dimensions and can be discerned throughout the indicators presented in Part II. Likewise, their ramifications can be seen in many of the most pressing issues facing forests and forest managers today.

In response to the many comments we received in the review process associated with the initial draft of this report, we have chosen three such overarching issues upon which to focus our analysis and policy suggestion in subsequent chapters of Part I of this report. They are—

1. The loss of forest lands and working forests.
2. The relationship between forests, climate change, and bioenergy development.
3. Changing forest health and disturbance patterns.

Obviously, we could have chosen other issues, but these three are widely recognized as core issues impacting forest sustainability today and promise to remain so well into the future, and they are broad enough to encompass the drivers and challenges identified above.

[6] See Vilsack (2009) for transcript of speech (http://www.usda.gov/2009/08/0382.xml).

The 2010 Reporting Cycle

The 2010 reporting cycle includes a number of products organized around the challenge of addressing forest sustainability in general and the requirements of the Montreal Process in particular. The *National Report on Sustainable Forests—2010* is the most visible of these products, but it is best viewed as a window on a much broader body of work. The genesis of this report began immediately after the release of the *National Report on Sustainable Forests—2003*. The team that prepared that report conducted a critique that identified lessons learned and potential areas ripe for improvement in the next report. Participants in the Roundtable on Sustainable Forests contributed a number of suggestions as plans were being laid and refined.

Overview of the National Report on Sustainable Forests—2010

Although this report has a national focus, external reviews and the critique of the 2003 reporting process pointed out that the national presentation masked regional differences and did not inform regional discussions. This report presents more information about conditions in subnational regions and how they differ—both between regions and over time. If data used for indicators show regional differences, then they are highlighted and often depicted visually in the 2010 report.

This report represents the work of some 40 individuals. The updated indicator reports found in Part II, in particular, reflect the work of more than 30 Forest Service scientists and collaborators from universities, other agencies, and organizations. This report is supported by the science in a number of associated reports and background documentation, all of which will be available electronically and some in hard copy. They include the following:

- National Report on Sustainable Forests—2010.
- Associated products:
  - Data reports for individual indicators.
  - Partner reports on specific topics.
  - A Web site with access to data and reports.

National Report on Sustainable Forests—2010

The National Report on Sustainable Forests—2010 is divided into two parts. The first part provides an introduction and sets the context for the report (chapter 1); summarizes key findings, significant conditions, and major trends that are evident in the data (chapter 2); reviews ongoing efforts to broaden and deepen the commitment to sustainable forests (chapter 3); and describes possible future actions (chapter 4). The second part provides a concise and consistent presentation of the current data and analysis specific to each of the 64 indicators. The indicator reports are brief—1 or 2 pages each—and serve as an overview and set of highlights drawn from the broader portfolio of work found in the supporting data reports, which will be published online.

Associated Products

Data Reports for Individual Indicators

Although the individual indicator reports have been limited to one or two pages in the national report, more indepth reports will be published and made available via the Forest Service sustainability Web site. These more detailed data reports will delve deeper into the data collected and analyses performed and provide pertinent metadata, sources, and reference materials.

Partner Reports

Several partners have collaborated in this 2010 reporting cycle by producing stand-alone, peer-reviewed reports. These partner reports cover related topics, including the state of sustainability of tropical forests in the United States, the sustainability of urban and agricultural forest resources, and more detailed considerations of certain indicators or syntheses between several indicators. These reports will be published in association with the 2010 national report as they become available. Together with the data reports, the partner reports support ongoing discussions of the various dimensions of forest sustainability; these dimensions cannot be easily addressed within the context of a single indicator brief.

Online Presence

Along with the 2010 national report, the Forest Service is preparing an online Web tool to deliver and display indicator data and associated analyses. The Forest Service anticipates feedback and weblog functions in the future, but these will not be included in the initial rollout.

In addition to the availability of information on the Forest Service Web site, more information regarding organizations using

the MP C&I to inform work at national and subnational levels is summarized and available via the Web site of the Roundtable on Sustainable Forests (http://www.sustainableforests.net).

Summary

This chapter sets the context for the rest of the report. It identifies the key changes in the philosophical approach to sustainability that have occurred—both globally and domestically—since the first national report was issued in 2003. It also provides an updated perspective on the major driving forces that the authors believe are affecting sustainability and determining the contemporary challenges faced by natural resource managers and policymakers. You may see things differently, and therefore you may draw different conclusions from the material presented in the remainder of Part I and Part II of this report. We hope that your perspectives and observations help to inform the public dialog that needs to occur concerning the future of U.S. forests. Better data should lead to better dialog, and better dialog should lead to better decisions.

Chapter 2

What the Data Tell Us

Are Our Forests Sustainable?

This is a complex question with no easy *yes*-or-*no* answers. On the whole, there is no evidence that we are "using up" our forests. In fact, the total area of forests has been stable, and the volume of wood found on them increasing. But there are a number of issues, ranging from regional forest fragmentation and loss to widespread increases in forest insect infestation and other disturbances, that are cause for significant concern. Potential changes in climate compound the risks and uncertainties associated with these issues.

Introduction

A fundamental goal of this report is to provide comprehensive, reliable, and consistent information that forestry professionals, policymakers, and the public at large can use to better assess forest sustainability. This goal represents the "better data" portion of the "better data-better dialog-better decisions" triad that underlies sustainability reporting. This chapter will undertake an initial foray into the dialog portion of the triad, providing a summary of those findings that emerge from the indicators that we think are most important to understanding the current conditions of our forests and their sustainability in the future.

The roughly 130 pages of indicator-specific information included in the second half of this report represent a wealth of data that can be used for a variety of purposes. Although each indicator brief provides some inkling of its broader implications for sustainability, much of the information the briefs present lacks the context needed to fully assess their collective meaning. As a result, the numerous charts and tables found in the data section of this report may strike many readers as a confusing "bag of numbers" requiring further analysis and interpretation before its implications for sustainability can be ascertained. Both in the broader public discussion surrounding this effort and in the specific comments we received on the initial draft of this edition, we were asked to provide this sort of analysis and state what all this information means in terms of forest sustainability. At the same time, we were repeatedly cautioned by other reviewers to remain as close to the facts as possible. Providing interpretation and analysis while remaining true to the facts is a fine line to walk, but it is in no way unique. In fact, scientists and analysts in all lines of inquiry walk this line daily.

We can approach this task in several ways. One approach is to provide explicit judgment calls for specific indicators, either through scores, up and down arrows, or similar techniques that present explicit determinations of sustainability on an indicator-by-indicator basis. Indeed, many people initially envisioned sustainability C&I as providing just such an explicit calculus.[7] The experience of those who have tried this approach, however, has shown that scoring individual indicators is no easy task, involving numerous and often contentious judgments about the desired trends or acceptable thresholds that describe sustainability for specific indicators. This challenge is compounded by the fact that the implications of specific indicators for sustainability often cannot be assessed in isolation from those of other indicators.

Therefore, we use a narrative approach to summarize the data found in the indicator briefs. This approach enables us to sift through and present the information in a more organic fashion, choosing those measures that we think are most important and drawing linkages to other indicators where needed. The next question is how this summary should be organized. The structure of the MP C&I gives us a logical starting place, and we provide a summary of significant findings by criteria as a frontpiece to the indicator briefs found in Part II. In this chapter, we begin with an overall summary of what we consider the key conclusions emerging from the indicator information, including several "red flags" demarking areas of particular concern.

[7] Work continues on the development of increasingly sophisticated quantified sustainability indexes, many of which make allowances for the challenges involved in this approach (see, e.g., Sing et al. 2009; Esty et al. 2005).

Next, we provide a "synthesis" of indicator information around three issues of particular importance to current policy debates: (1) loss of forest lands and working forests, (2) climate change and bioenergy, and (3) changing forest health and disturbance patterns. By addressing these issues, we hope to show how the database represented in the indicator briefs can be used to address pressing concerns and issues in a synthetic fashion. We follow with a discussion of regional differences, largely in response to the strong call for more regional and local information that accompanied the release of the 2003 edition of this report. We conclude with a discussion of data adequacy and potential strategies for future reporting on forest sustainability.

A Note on the Recent Recession

The recent sharp downturn in the global economy and the even sharper recession in the U.S. housing sector, in particular, have important implications for forest sustainability, at least in the short term. The most direct way the recession will affect forests is through reduced homebuilding activity, which results in reduced wood products production and related forest management activities, on the one hand, and reduced residential development, on the other. In the first case, decreasing timber harvests mean less immediate loss of forest cover but also potential reductions in our long-term ability to manage forests and the possibility that more land will be taken out of forestry in lieu of other uses. In the second case, declines in residential construction activity mean reductions in forest fragmentation in areas prone to development.

The indicators presented in this report, however, are generally designed to assess sustainability in the context of long-term trends, and they are either not sensitive or not timely enough to register changes resulting from short-term market fluctuations. Within the context of this report, the crucial question is whether the recession will result in a sustained secular shift in the demand for housing, thus affecting both rates of new residential construction and wood products prices and production over the long term. Should this occur, the recession's effects on forests and forest management would certainly be important, but it is too early to tell whether such a change is actually in the offing.

Summary of Key Findings

Key Findings in Brief

- Overall forest area is stable
- The integrity and biological diversity of our forests are increasingly threatened
- Elevated levels of forest disturbance are of particular concern
- Society's relationship with forests is changing
- Wood products production is declining relative to consumption
- Management intensity for timber production appears to be declining
- Institutional capacity to manage forests is difficult to quantify but appears to be stable

Overall Forest Area Is Stable (Indicators 1.01 and 1.02)

From the broadleaved forests of the East to the conifers of the West, the United States continues to benefit from a large and diverse inventory of forests distributed across the Nation. Total U.S. forest area, as defined for the purposes of this report, currently amounts to 751 million acres, or about one-third of the Nation's total land area. Since the beginning of the past century, the size of this inventory has been relatively stable, and the forests it represents remain largely intact. This stability is in spite of a nearly three-fold increase in population over the same period and is in marked contrast with many countries where widescale deforestation remains a pressing concern. It also is in contrast with our more distant past, where nearly 300 million acres of U.S. forest were lost between the advent of European settlement and the beginning of the 1900s.

The forest area's stability during the past century is the partial result of stable ownership patterns and land-use designations. For example, 14 percent of U.S. forests are currently protected under wilderness or similar status, and this number has changed little since the last report in 2003 (although the increased use of protection easements and similar instruments on private lands would indicate that the total amount of forest under some form of protection is increasing—see Indicator 6.27). A more important factor in maintaining overall forest area in America, however, is the fact that throughout the past century, losses of forest land in some areas (particularly those adjacent to growing urban areas) have been offset by gains in others (abandoned agricultural lands returning to forest, for example).

The Integrity and Biological Diversity of Our Forests Are Increasingly Threatened (Indicators 1.03, 1.04 and 1.05)

The relatively stability of U.S. forests is a positive development in terms of forest sustainability. This stability, however, does not necessarily indicate the quality of our forests and whether their condition has been improving or declining over time. In this regard, the indicator results are less promising. The gross statistics on forest areas cited previously mask considerable shifts in forest cover on a more local basis, meaning that many areas have experienced considerable losses in forest cover. Steady demand for residential and other development continues to fragment forest ecosystems both in urban areas and in more natural environments that are targets for vacation and retirement home development.

Despite notable reversals in the population declines of some forest animals (wolves in the intermountain West, for example), important components of the overall diversity of forest flora and fauna remain threatened. Seventy-seven forest-associated plants and animals that were present in our forests when our Nation was founded are now presumed to be extint. An additional 4,005 species, or 27 percent of the total number of forest-associated species, are at risk of extinction. Since 2003, changes in reporting practices and a substantial increase in data on many species make it very difficult to draw comparisons with data from the 2003 report, but indications are that the situation for certain groups (such as amphibians) has deteriorated slightly in recent years.

Elevated Levels of Forest Disturbance Are of Particular Concern (Criterion 3)

The data presented for the two indicators comprising Criterion 3 clearly show that the Nation's forests are subject to increasing levels of disturbance, such as insect infestation and fire. These disturbances result from processes we often cannot control and may not always fully understand. In particular, the incidence of insect-induced tree mortality has increased three-fold in the past decade. This fact is backed by substantial anecdotal experience and is undoubtedly the clearest red flag emerging from this report.

Society's Relationship With Forests Is Changing (Criterion 6)

As our society evolves, our relationship with the forest also evolves, as evidenced by many of the indicators in Criterion 6. We are recognizing new ways in which forests contribute to our society, while more traditional uses and outputs remain as important as ever. Much of this bodes well for forest sustainability. The growing awareness of ecosystem services, and the establishment of revenue streams associated with them, provides new emphasis on conservation and management along with new mechanisms and added resources to achieve them. The information on nonwood forest products proves that traditional gathering activities are not disappearing; in fact, they are more important than previously assumed and are attracting new participants. The diverse set of recreation activities portrayed in the indicators illustrates that forests provide direct benefits to many Americans on a regular basis. Although sustainability of U.S. forests in the past was largely characterized, although perhaps incorrectly, as a simple balancing act between nature and timber harvests, today it entails a much broader range of elements and objectives interacting in both competitive and complimentary ways.[8]

Wood Products Production Is Declining Relative to Consumption (Indicators 6.25, 6.28, and 6.32)

At the same time, commodity production of wood products remains an essential function served by the Nation's forests. The indicators on wood products production and trade indicate a slight decline in overall industry production in the past decade matched by an accompanying increase in imports. These changes are more pronounced at the regional scale. The indicators in Criteria 1 and 2 point to stable or increasing timber stocking throughout much of the Nation, and this supports the conclusion that declining production is not because of physical resource constraints. These developments are important not only for their potential effect on forest-dependent industries and communities but also for their potential effects on ecosystems in other countries. Moreover, the decline or disappearance of forestry operations in certain regions may influence forest management and land-use patterns in ways that are not always beneficial to forest ecosystems, particularly in areas subject to housing development pressure or where forest fuel loading and timber overstocking is an issue.

[8] The data presented in the Criterion 6 indicators do not currently reflect the potential alienation of urban populations from forests that was noted as a contemporary challenge in chapter 1. Criterion 6, and its indicators on recreational use in particular, will be an important measure for tracking this trend in the future.

Management Intensity for Timber Production Appears To Be Declining (Indicators 2.11 and 2.12)

Although growing timber stocks indicate that we will not be running out of wood anytime soon, mounting evidence indicates that the intensity of forest management for timber production is declining: firms are devoting less effort and investment to the creation and maintenance of production forests. This decline is clearly evident in the falling rates of plantation plantings. Forest management companies selling timber lands to real estate investment trusts and similar entities is cited as a major factor in this development, and these trends are exacerbated by low stumpage prices arising from a surfeit of available wood fiber and growing wood products imports. This situation has certainly not been improved by the recent recession. Although not immediately apparent in the gross statistics on growth and harvest, the potential effect of declining management intensity on our ability to supply our needs for timber in the coming decades bears watching.

Institutional Capacity To Manage Forests Is Difficult To Quantify But Appears To Be Relatively Stable (Criterion 7)

Our institutional capacity to effectively care for our forest ecosystems is an essential aspect of forest sustainability. Many of the indicators in Criterion 7 are difficult to quantify in a consistent and replicable fashion, but the information we do have shows that our government and academic institutions have stable capacity. In addition, the sustainability activities highlighted in chapter 3 of this report point to growing collaboration between multiple organizations and stakeholders with the aim of strengthening our understanding and informing our actions in relation to forest sustainability. Although impossible to measure in a quantitative sense, the sum total of these activities represents a substantial investment in our capacity to sustainably manage our forests.

Although capacity in government and academia appear to be stable, the economic infrastructure needed to engage in active forest management is deteriorating in some regions, notably the intermountain West. Likewise, the process of urbanization—indentified as a driving force in chapter 1—is resulting in a growing disconnect between people and their forests; kids are reportedly spending less time in the woods, and the number of traditional forestry degrees granted by post-secondary institutions is declining (although this is partially balanced by a rise in other environmental degrees that could support forest management). The extent to which these developments affect our institutional capacity to manage forests sustainably in the future remains to be seen, but it is certainly a concern.

Overarching Issues and Synthesis

Three Overarching Issues for Synthesis

1. Loss of forest lands and working forests
2. Forests, climate change, and bioenergy development
3. Changing forest health and disturbance patterns

The previous section used the information in the indicator reports to identify a number of key findings regarding current conditions and trends in our country's forests as they relate to sustainability. This approach is perhaps the most straightforward way to use the C&I, but this is certainly not the only way in which it can be used. Because it can organize a comprehensive set of information within an explicit hierarchical structure, the MP C&I functions well as a general reference for key statistics. These statistics can then be used individually or in combination to help understand specific topics, topics that may or may not be directly related to sustainability. The value of the MP C&I in this case lies not in its ability to paint a comprehensive picture so much as in its ability to quickly deliver the specific pieces of information that people need to address topics of their choosing.

In chapter 1, we identified three overarching issues of crucial importance to sustainable forest management now and in the future. In this section we use the information found in the various indicator briefs in Part II to address these issues synthetically. We begin with the issue of the loss of forests through fragmentation and land use conversion.

Loss of Forest Lands and Working Forests

The loss of forest land through fragmentation and outright conversion to other land uses is a major concern for the public, as evidenced by the many comments we received on the topic during the review of the initial draft of this report. The indicators in Criterion 1, particularly Indicator 1.01, which addresses the distribution of forest ecosystems by type and ownership class, and Indicator 1.03, which addresses forest fragmentation, are directly related to this issue. Indicator 1.01, however, shows that, at the national level, forest area has remained quite stable for the past century. This fact presents us with a paradox: loss of forest land is a major concern in professional discussions and policy debates, and yet the overall statistics for U.S. forest cover register no significant change.

This paradox is partially resolved when we realize that forest loss is experienced by most of us at the local level and not at the level measured by national statistics. In the words of foresters and geographers, the phenomenon is scale dependent (Willbanks 1999). We see forest loss when a patch of woods in our neighborhood is cut down to make way for a shopping center or when a forested hillside in the distance is progressively fragmented by new houses. The losses associated with these events, in the form of reduced ecosystem services, shrinking wildlife habitat, and diminished aesthetic values, are real and often permanent. The fact that they may be compensated in a statistical sense by gains in forest area, say, from forest colonization of abandoned agricultural land in some distant State, does not lessen their impact, particularly when the losses are concentrated in areas where intact forests and green space are in short supply. The implication here is that forest loss from land conversion is most important at the local, landscape, or regional scale, especially near major population centers.

Data on forest land affected by development, presented in Indicator 3.16, shows that affected lands have increased steadily over the past few decades, accounting for 13.3 percent of total forest land in 2000 and projected to reach 14.3 percent by 2020 (Theobald 2005). Most of this development has taken place in the "exurban" housing density category (1.7 to 40 acres per unit), and the effects here are likely more in the form of forest fragmentation than wholesale forest overstory loss. As a result, they are not identified as a loss of forest land under the definitions used in Indicator 1.01.

For a measure of forest fragmentation, we need to turn to Indicator 1.03. Here too, however, the measure is highly scale dependent. From the indicator, it is possible to identify large areas where contiguous forests dominate, and these are generally in areas without large concentrations of people or agricultural activity. Unfortunately, we have just begun to standardize our methods for measuring fragmentation, and it is currently impossible to get a clear picture of how it has progressed over recent years. We know, however, that it is occurring at a rapid pace in many localities, and this will be an important variable to watch in the future.

Changing forest ownership patterns, and the divestiture of large tracts of forest land by traditional forest management companies in particular, are another important aspect to consider when analyzing the loss of forest lands. It is in this context that the term "working forests," meaning forests producing an array of ecosystem goods and services (including timber), becomes applicable. A number of studies have shown that forest management for timber production can enhance biodiversity and other ecosystem services in certain settings (Gustafson et al. 2007; Miller et al. 2009). Moreover, where profitable, timber management and the revenues it generates can serve as a hedge against the conversion of forest land to other uses such as real estate development, although the extent to which it can actually do so in the face of rapid increases in land values close to urban areas will vary. Finally, the divestiture of forest lands by forest industry firms is often accompanied by a reduction in management activity because the new owners are more prone to view their land as real estate investments than as a source of wood for their mills (Clutter et al. 2005).

Many of these same issues face nonindustrial private forest landowners who must balance concerns such as their need for current income and desire to maximize their long-term investments for themselves and their children with their desire to be good stewards of the forests under their care (Stein et al. 2009). Because more than 60 percent of current nonindustrial private forest landowners are age 55 or older, life stages and succession planning play an important part here and point to increasing divestiture in the future (Butler 2008).

Discerning changes in forest ownership and their underlying causes is a complex task, and none of the indicators provide direct measures. Indicator 1.01 does contain information on forest ownership, but it is not the sole focus of the indicator; and the level of detail provided in this report is not sufficient to track forest land divestiture or parcelization. Experts who have contributed to this report are conducting further research so future reports should have better data. The indicators covering timber harvest, wood products production, and forest sector investment provide an indication of the broadscale shifts in forest sector activity, and these in turn provide some indication of where and to what extent forest land is being taken out of production forestry. The number of newly planted forest plantations, for example (Indicator 2.12), will be an important measure of our society's will to invest in timber production in the future.

In regard to forest loss, fragmentation, and changing ownership, the indicators in this report provide only the most general information. In fact, if we were not looking for evidence of loss specifically, it is unlikely that we would identify the problem from an analysis of the information included solely in this report, especially because Indicator 1.01, the core measure of forest area, shows no significant change in recent years. So how is the MP C&I useful in this context? First, it provides a starting point to discern what sorts of available data, if presented at finer spatial scales, could help in analysis. Second, it helps identify gaps or weaknesses in the major data sets that need to be filled. And third, it provides an overall context within which to understand the problem. Thus, we learn that loss of forests is largely a local or regional problem that is not immediately apparent at the national level; that fragmentation is perhaps more of a problem than the wholesale loss of forest cover; and that simple ownership categories, such as "public" and "private," mask important changes, especially in the private sector.

Forests, Climate Change, and Bioenergy

Climate affects forest in various and profound ways. Conversely, through processes such as carbon sequestration, transpiration, and the influence of vegetative cover on the reflective properties of the earth's surface (termed "albedo"), forests can affect climate both locally and globally. Accordingly, our consideration of the relationship between the MP C&I and climate change can be divided into two categories: the potential effects of the climate on forests, and the potential effect of forests on the climate.

The initial effect of climate change on forests will be primarily through changes in forest composition and productivity and through changes in forest disturbance regimes. In the case of the former, increases in atmospheric carbon, changes in temperature, availability of water, and the length of growing seasons will affect the relative health and productivity of different species in complex ways. For forests in some areas, the result may be a boost in growth, primarily as a result of increased availability of carbon dioxide—a process known as the CO_2 fertilization effect—although the actual degree to which this will occur is not yet certain (Gedalof and Berg 2010; Ram et al. 2001). In others areas, especially those receiving less precipitation, forests may suffer.

In the case of forest disturbance regimes, these factors will affect the range and intensity of biological disturbance agents (for example, insects and invasive species) and the prevalence of abiotic disturbance agents (primarily drought and fire, although storm damage may be quite important locally). These impacts may already be occurring. Recent studies have measured an increase in tree mortality owing to physiological stress related to drought and heat extremes, and climate change is noted as a potential cause (see Allen et al. 2010 for a global review of this work). The ability of the pine bark beetle to extend its range to more northern latitudes and higher elevations is a troubling example of this (Bentz et al. 2010).

Researchers are just beginning to understand the complex interactions between changing climate, forest composition, and productivity fluctuations at the landscape level. These results, combined with changing disturbance patterns and intensities, will change the type and pattern of forest cover across the landscape, and thus change the benefits we receive from forest ecosystems. Over the long term, these changes may be quite profound, requiring significant adjustments in forest management practices and policies.

Many of the indicators track the sorts of developments discussed in the previous paragraph. The indicators in Criteria 1 and 2, for example, measure different aspects of forest cover and productivity. The indicators in Criterion 3 characterize forest disturbance and will act as perhaps the primary leading indicators for detecting effects from climate change. In order to serve this function, however, we must view them in the context of the other indicators and information outside of the MP C&I. In this regard, the increases in insect infestations, drought, and fire registered in Indicators 3.15 and 3.16 may be the partial result of climate change, but we cannot say so with any degree of certainty.

Because of this uncertainty, we will need to adapt our actions and strategies as new information becomes available. In some areas, for example, we may need to favor different species in our management activities or shift our objectives to match changing realities on the ground. In either case, whether through intentional management or through processes over which we have little control, changes in climate could entail significant changes in the composition of forests and how they are used by the middle of this century. These changes, in turn, will manifest themselves in changes, some sooner and some later, throughout the indicators included in the MP C&I.

The indicators in Criterion 5 provide a direct measure of the influence of forests on national carbon accounts. These indicators clearly illustrate the role played by forests in mitigating carbon emissions through sequestration. The yearly accumulation of carbon on forests lands is estimated to offset 11 percent of total national carbon emissions, with accumulations in long-lived forest products providing another 1 to 2 percent. In addition, the fact that the total amount of carbon stored in forests is equivalent to 27 times our annual carbon emissions demonstrates the importance of forests in global carbon balances and the potential effect should substantial areas of forest be lost through natural (e.g., fire) or human causes (e.g., development).

Because forests provide a potential means for positively affecting climate change through forest management decisions, several of the indicators in Criteria 6 and 7 are also important here. For example, Indicator 6.27, which tracks payments for ecosystem services, shows a 20-fold increase in activity in the voluntary market for carbon offset credits from forestry operations. Similarly, Indicator 6.34 measures investment in forest management and wood products industries. The indicator notes that $230 million of Federal grants, in conjunction with private investments, have been allotted to promote wood-based biofuels—an energy source that has been designated by Congress as "carbon neutral."

The potential of forests to mitigate emissions and greenhouse gas concentrations also suggests that active, long-term afforestation programs on abandoned lands may be warranted, with funding at least partially provided by payments for the ecosystem service—namely carbon sequestration—they provide.

Moreover, forests in close proximity to heavy emission areas, such as in and around cities, can help alleviate air pollution and reduce temperature variation by providing shade in the summer and shelter from wind in the winter. Trees and forests in developed areas can also serve as a carbon sink.

Finally, many of the indicators in Criterion 7 measure our society's capacity to manage forests effectively in terms of both achieving carbon sequestration and responding to changing forest conditions resulting from climate change and other causes. Although it is difficult to discern a clear signal from the Criterion 7 indicators in this regard, continuing development of the indicators should improve this situation in the future. What is clear, however, is that a legal and institutional framework that underpins a supportive environment for investments in sustainable forest management, from both public and private sources and at the local, State, and national levels, is vital.

Bioenergy and biofuel production from forest biomass is another potential link between forests and climate**.** Bioenergy production represents a nascent forest products industry that has the potential to radically transform certain aspects of forest management, the wood products sector, and markets for both wood products and energy, with effects across the whole range of ecological, social, and economic dimensions covered in the MP C&I. Currently, most of the energy produced from wood comes from combustion, and the production of wood-based liquid biofuels and similar products is still in its infancy. Expansion in the production of these new products will depend on new technological innovations and developments in energy markets.

Indicator 5.24 shows that wood-based energy production currently represents 2 percent of total national energy production. Despite a near doubling of electricity generation in the past 20 years from the burning of wood, total wood-based energy production has been decreasing since the mid-1990s, due in most part to declines in the use of wood for heating—both in homes and as part of industrial processes. In the future, Indicator 5.24 will directly register changes in bioenergy and biofuels production, should they occur.

Converting wood to energy, and particularly burning wood to produce heat or electricity, does involve short-term emissions of carbon, a fact that is getting increasing attention (e.g., Manomet 2010). Carbon neutrality is attained over time as forests grow. Alternatively, carbon neutrality can result from producing energy from wood that would otherwise burn without producing usable energy, either through the process of disposal or through wildfires. This second form of neutrality is especially important when attempting to integrate bioenergy production with management activities designed to reduce forest stocking and fuel loading in the pursuit of ecosystem restoration.

Several other indicators are also related to this issue of energy production from wood. As noted in the previous section on climate change, Indicator 6.34 tracks investment in the forest sector, including bioenergy (although consistent long-term tracking will depend on U.S. Departments of Commerce and Energy statistical reporting practices). Investment will once again serve as a leading indicator. The indicators tracking wood products production and trade in Criterion 6 will provide additional information about activity in this area, but, this will again depend on consistent statistical reporting practices for various types of power (e.g., electricity generation versus liquid transportation fuels) and raw fuels and feedstocks (e.g., cellulosic ethanol versus starch ethanol, or woody biomass from forests versus agricultural residues). The information on forest area, stocking, and productivity found in Criterion 2 will provide important information on the long-term sustainability of bioenergy and biofuels production, particularly if they develop into major industries.

One of the key findings emerging from the indicators in Criterion 2 is that the sheer volume of wood being added to our forests each year through growth well exceeds the amount we are removing, and that total stocks of standing timber have been increasing rapidly in almost every region of the country as a result. Statistics comparing volume stocking and increment versus harvest removals are a classic measure of sustainability from strictly a timber standpoint. They indicate, in these gross terms at least, that substantial and growing resources are available for bioenergy production should it prove viable. Although, of course, a net surplus of available timber volume at the national level does not ensure large-scale bioenergy production will be sustainable for a given region or landscape. This sustainability will depend on local forest stocking and a host of other ecological and economic factors.

Changing Forest Health and Disturbance Patterns

We have identified elevated levels of forest disturbance as one of the key overall findings of the report, and they are treated in detail in the summary for Criterion 3 found in Part II of this report. The purpose of this section of the report is to emphasize the ways in which forest health and disturbance affect the other indicators and our pursuit of forest sustainability as a whole.

We should realize that disturbance patterns represent fundamental processes through which forests are formed and continue to evolve; they are not simply accidents that happen to forests as they go about their business of growing (Botkin 1979, Oliver and Larson 1996). All of our forests have, to some degree, been formed by disturbance processes, be they natural or human induced (e.g., periodic burning of the forest understory by

American Indians). So our forest management activities, which can be viewed as forms of disturbance in themselves, are continually interacting with a broader set of disturbance processes acting on the landscape, and the resulting forest is a product of this interaction. Consequently, forest disturbances have a profound effect on all aspects of forest ecosystems, ranging from species composition to the forest benefits and uses available to society.

Disturbance processes will also determine many of our forest management activities, particularly those directed to natural or seminatural forest stands. These processes are prime factors motivating the Forest Service's increasing focus on ecosystem restoration. This linkage between management activities and disturbance processes is especially relevant in landscapes prone to fire, but it also applies in other settings where forest health issues are identified and increased resilience is needed. Many of the most pressing issues currently facing our forests and their management stem from disturbance processes, such as insects and disease, catastrophic wildfire, invasive species, or human-induced impacts from development or, more indirectly, from climate change.

As a result, forest disturbance influences all of the indicators in the Montréal Process indicator set. In many cases, this influence will be indirect and difficult to immediately discern, but it will be present nonetheless. In other cases, such as the ecosystem indicators in Criteria 1 and 2 or the carbon accounts found in Criterion 5, the effect of disturbance may be more direct. At the national scale, however, it is still difficult to relate rising levels of disturbance to specific measures of forest stocking or species composition. A major question in the coming years will be the extent to which trends in disturbance, such as the three-fold increase in insect-induced tree mortality reported in Indicator 3.15, result in discernable effects to the biophysical indicators in Criteria 1, 2, 4, and 5, and thereby the social and economic indicators in Criterion 6.

Disturbance will continue to shape our management activities, demanding adaptive approaches in response to rapidly changing landscape conditions. Ideally, a shift to more adaptive management approaches would be registered in the indicators in Criterion 7, but it is not clear exactly how since no indicator in the current or proposed Criterion 7 indicator set addresses adaptive management (although, to be fair, it is difficult to imagine how such an indicator would be formulated). Moreover, since the impact of disturbance often extends across jurisdictional and ownership boundaries and across different land use types, managing for disturbance will increasingly require collaborative mechanisms involving multiple stakeholders organized around agreed upon landscape objectives. The National Fire Protection Association's Firewise Communities program is a case in point.[9]

Regional Differences

One of this report's goals is to provide improved coverage of regional and local variation in conditions and trends across all the indicators. Therefore, we have included a new heading addressing regional differences in each of the indicator briefs included in Part II. Given the breadth of indicators included in the MP C&I and the data available to treat them, however, providing regional detail is still a very challenging task. In particular, providing detailed regional analysis in each of the indicator briefs in Part II and the summary analyses in this section would significantly increase the length of what is already a long document.

Nevertheless, many of the indicators do have substantial regional detail underlying their analysis, even if it could not be included in the report. Certain data sets, notably the forest inventory data from the Forest Inventory and Analysis program (FIA) and the various socioeconomic data sets used to address Criterion 6, have a high degree of spatial resolution, often down to the State and even county levels. Some of this information is available in the supporting "data reports" associated with each indicator.[10]

In any case, we should remember that forested ecosystems and their associated socioeconomic conditions differ considerably between regions and localities in terms of both current conditions and trends. This situation is not surprising given the diversity of ecosystem types and socioeconomic conditions across our continent, but it is easy to overlook this fact when viewing statistics at the national level. Based in large part on the indicator data presented in Part II, we have identified some of the major differences between regions as they relate to forest sustainability. These differences include the following:

- The growing influence of disturbance processes in the West.
- The prominence of the South as the country's major timber supplier.
- The importance of public lands and environmental amenities in the West.
- Population and development pressures on forests in the East.

[9] See: http://www.firewise.org/.

[10] These reports will be posted in electronic form on the project's Web site (http://www.fs.fed.us/research/sustain/).

Growing Influence of Disturbance Processes in the West

The information presented on forest disturbance in Criterion 3 points to a marked increase in insect infestation and wildfires in the forests of the West. This increase is tied to a complex set of natural and human-induced dynamics involving fire suppression, increasing stand densities, aging of certain tree species, and warming temperatures. The result has been a dramatic increase in the area of forest affected by bark beetle infestations in the pine forests of the interior West and a general increase in forest fuel loadings and fire susceptibility throughout the West. Because of the resulting risk of widespread, catastrophic wildfire, along with the loss of life and property this can entail, forest health and fire prevention, which has been a longstanding concern in the region, has emerged as a major focus for forest policy and management at both the regional and national levels. This concern is compounded by the fact that many forested areas have experienced ongoing housing development resulting in more houses, and more lives, at risk.

Current efforts to address these issues range from insect control and broadscale forest thinning activities to the creation of defensible space around communities threatened by fire. The Forest Service and other management agencies are also using prescribed fire and controlled natural burns more frequently in ecosystems where fire has played an important role in the past, despite the attendant risk that the fire could escape control. The sheer size of the wildfire problem, combined with the fact that much of the most severely affected areas are under Federal management, means that Federal land management agencies (notably the Forest Service and Bureau of Land Management) will be struggling with disturbance processes and forest health issues for many years to come. This ongoing struggle will force land managers and local public officials to confront difficult questions regarding risk and responsibility in a landscape increasingly prone to major wildfires.

Prominence of the South as the Country's Major Timber Supplier

Since the 1970s, the Southern Region (essentially the Southeastern States and Texas) has consolidated its position as the Nation's major supplier of timber. Following harvest declines in the Northeast and Pacific Coast States, the South now produces more timber than the rest of the country combined. It also enjoys some of the highest tree growth rates in the country and is home to the largest acreage of high-productivity forest plantations. A divestiture of timber lands on the part of major forest management companies in the other regions has accompanied this shift (although this is also occurring to some degree in the South).

Although the increasing prominence of the South is hardly new, the fact that this trend has continued over the past decade indicates a long-term shift in management focus and production capacity away from regions that were considered major timber producers in the past and a growing concentration of activity, with concomitant economies of scale, in the South. This shift in regional focus also results in changes in the sorts of issues and concerns surrounding forest policy in regions experiencing reduced timber production. Debates that once focused on the relatively simple dichotomy between timber harvest and forest preservation are evolving into more complex considerations of competing management priorities, including real estate development, expanded recreational use, and the mitigation of fire risk, all in a landscape where traditional forest management activity is disappearing, at least at the scale existing in previous decades.

The South, however, is not immune to the forces affecting forestry and forest management elsewhere. Anecdotal evidence indicates that, in response to depressed timber prices and the divestiture of forest lands by timber management companies, planting and related management activities are decreasing. Furthermore, forests continue to grow and mature in other regions, adding timber value every year, so it would be premature to predict that the shift in the concentration of timber production to the South will continue unabated in the coming decades. Such a prediction would require a much more involved analysis than can be presented in this report.

Public Lands and Environmental Amenities in the West

Most Federal lands are located in the Western States. This fact is largely an accident of history, because the West was relatively un-owned and uninhabited (that is, uninhabited by people of European descent) when the national forests and other major Federal land holdings were first established. This concentration of Federal lands in Western States also reflects the fact that much of the region is either mountainous, arid, or both, and thus not amenable to economic development or large-scale settlement.

In any case, the concentration of public lands in the West has important ramifications for forest sustainability and management. First, the public land in the West contains many of the Nation's wildest areas. Some of these are explicitly recognized as wilderness areas or national parks, but others are simply lands that have not been developed over the years for one reason or another. Whether they enjoy explicit designation or not, these wild lands constitute a fundamental aspect of sustainability, both through their contribution to the various measures presented in this report, and more generally through their continued existence as places that exist and evolve in relative isolation from human activity and impact.

Another important aspect of Federal lands in the West is that decisions about how to manage them fall within the public domain, which means all citizens, even those living in distant regions, have a right to participate in decisionmaking processes and a stake in their outcomes. With this comes a responsibility to manage public lands in a wise and sustainable manner, including a consideration for the well-being of local residents who directly depend on these lands. This responsibility and scope for engagement simply does not exist in the case of private forest lands. As a result, many of our most contentious debates involving forest management and sustainability have been and will continue to be focused on public land management, and, thus, on forests in the West.

Population and Development Pressures on Forests in the East

With the exception of Ohio, all of the top 10 States with the highest population density are found on the East coast, mostly to the North. At the same time, this region exhibits a relatively high degree of forest cover. Although other States in the United States, notably California and Texas, have areas of high-population density, no region exhibits the same longstanding and cumulative degree of development pressure on forests as does the East coast. In the East, the negative impacts from development are more concentrated and the total value of green space and forest lands is more apparent because of their relative scarcity in an area with a large population. The situation is not entirely bad, however, because the combination of concentrated negative effects and recognized value is encouraging new forms of collaboration between citizens and government entities at the regional level to solve problems that are increasingly hard to ignore.

The continuing declines in water quality and estuary health in the Chesapeake Bay region, and efforts to address them, serve as an example. In that region, linkages between regional forest cover and the health of the watershed and estuary system have been explicitly recognized by local governing bodies, and initiatives have been launched at the county, State, and regional levels to preserve and expand forested green space (see chapter 3). In another example, New York City is addressing its need for clean water by paying private landowners in upstate New York to maintain their land in forest cover. The City of Philadelphia is considering using trees to enhance "green infrastructure" aimed at reducing storm-water run-off and increasing water quality. Although it is perhaps premature to say that the East Coast will lead the way in finding innovative solutions to forest sustainability in densely populated regions, it will certainly be a place to look for such solutions.

Data Availability and Adequacy

When compiling this report, we had to explicitly consider the types of data that we used, especially their quality and adequacy in addressing their respective indicators. Moreover, this report is only one step in a larger effort, and it is essential that we view our data gathering, reporting, and analysis activities as part of an ongoing process of sustainability reporting. Paying close attention to data quality and working to improve it are important parts of this process.

The MP C&I is a comprehensive framework requiring a broad range of data inputs spanning ecological, social, and economic dimensions. Producing the 2010 report involved an intensive search for available data that was undertaken by researchers with intimate knowledge of their respective fields. Consequently, the 2010 report represents, among other things, a compendium of data sources that address forest sustainability in the United States. The adequacy and sufficiency of these data to address the indicators is an essential question.

Indicator 7.58 displays our assessment of the adequacy of data for each of the indicators in terms of coverage, recency, and frequency of reporting. Because of their reliance on FIA data, the indicators in Criterion 1 that track forest characteristics enjoy excellent coverage, as do all of the indicators in Criterion 2. The coverage for the species and forest fragmentation indicators in Criterion 1 is either less complete or less current. The indicators on forest disturbance in Criterion 3 are supported by forest inventory and aerial survey data, which have not yet achieved complete national coverage but are improving over time. Criterion 4 draws on a number of different data sources, including point sampling of ecosystem characteristics and State-level reports about land-use designation and forest management practices. Data adequacy in Criterion 4 varies on an indicator-by-indicator basis, with soil condition enjoying the best coverage because of a recent expansion of FIA sampling to include soil characteristics. The carbon accounting information in Criterion 5 also relies on FIA data, but, in this case, forest inventory information has to be converted into estimates of aboveground and belowground carbon volumes, an additional step that requires a number of assumptions and analytical techniques.

Criterion 6 covers a broad range of social and economic conditions, and data coverage varies accordingly. In general, those indicators describing activity in the traditional wood products sector are well covered by standard reporting of production, trade, and employment statistics. Similar statistics are not available for nonwood forest products, and the indicators have relied heavily on Federal permitting data for information on

these products. The new indicators on community resiliency (Indicator 6.38) and the importance of forests to people (Indicator 6.44) are unique because we have used primary data collection through surveys designed specifically for each indicator to address them. Data for the recreation indicators in this criterion benefit from a now well-established program of visitor sampling on forest service lands and enjoy relatively complete national coverage.

Criterion 7 is particularly challenging in terms of both data collection and interpretation. For the 2010 report we have constructed an overarching framework for analyzing the various pieces of information we have describing policies and institutional arrangements (see explanation for Criterion 7 in Part II). Whether we will be able to move this in the future to a consistent and replicable reporting process is not clear, however, and much will depend on the new set of Criterion 7 indicators that have emerged from the Montréal Process.

Overall, data adequacy has improved somewhat relative to our assessment of adequacy in the 2003 report, but many challenges remain. Some of these challenges can be addressed by expanding ecosystem-sampling activities in areas such as forest disturbance, forest fauna, and forest stream conditions. For Criterion 6, better tracking of forest benefits and outputs outside of traditional forest products categories would constitute a substantial improvement. Whether current industrial reporting categories will allow for adequate measurement of bioenergy and biofuels production from forest biomass will largely determine our ability to track developments in the wood-based energy sector should they occur.

Implications for Future Reporting

The 2010 report marks the second iteration of our work in addressing the question of forest sustainability to fulfill our commitment to the Montréal Process. One of the things we have learned through this effort and similar efforts taking place across the United States and around the world is that sustainability reporting cannot be seen simply as a one-time effort after which everyone returns to their other responsibilities until the next report is due. Rather, reporting and accountability in sustainable forest management needs to be an ongoing process involving continuous improvement in data, analysis, interpretation, and communications guided by robust public participation and a thorough scientific review process.

While putting this report together, we identified a number of areas where additional depth and synthesis are needed, and we will address these areas with stand-alone partner reports. Ideally, these reports will be published on a continuous basis, with new reports commissioned as the need or interest arises. Collaborators and stakeholder groups, notably the Roundtable for Sustainable Forests, will serve as an essential resource in generating ideas, interest, and support for this work.

Chapter 3

Broadening and Deepening Our Commitment to Sustainability

Purpose of This Chapter

Broadening and deepening our commitment to sustainable forests is an ongoing journey that is unfolding in many ways and at many scales within the United States. This chapter uses examples of various forest sustainability efforts at different stages of development to demonstrate how the Montréal Process Criteria and Indicators (MP C&I) are being used as a practical framework for a variety of purposes including, but not limited to, monitoring, assessing, and reporting on the status of forests and other natural resources.

The examples highlighted, although not intended to be case studies, do offer insights into how early adopters of the MP C&I value having a common framework to help gather data, facilitate dialog, and/or make decisions. Experience reveals that the seven MP Criteria can be universally applied as a common language or framework for sustainable forest management. Use of the indicators, however, varies with "bottom up" adoption and implementation on the ground. The examples cited here, along with similar efforts, portray a diversity of approaches and provide numerous lessons-learned and how-to's for the application of criteria and indicators in the pursuit of sustainability.

All Lands Approach

We must work towards a shared vision—a vision that conserves our forests and the vital resources important to our survival while wisely respecting the need for a forest economy that creates jobs and vibrant rural communities. Importantly, this vision holds that the Forest Service must not be viewed as an agency concerned only with the fate of our national forests, but instead be acknowledged for its work in protecting and maintaining all American forests, including State and private lands. Our shared vision adopts an "all-lands approach…"

U.S. Department of Agriculture Secretary
Tom Vilsack
August 14, 2009

Through continued use, the MP C&I framework is helping expand the network of stakeholders concerned about U.S. forests and is helping connect forest-based actions across boundaries and geographic scales. The framework is also informing work within other natural resource sectors, leading to more integrated and collaborative efforts. The sorts of cross-sectoral and multiscale applications that many of these efforts exemplify are needed to track environmental progress and to achieve more comprehensive ecosystem and sustainable development goals across all lands.

Montréal Process Criteria and Indicators as a Framework

A framework is a supporting structure or system of ideas. The MP C&I were conceived as both a conceptual and an operational framework for the conservation and sustainable management of forests by outlining the key environmental, social, and economic parts of a complex task. In theory, as we better understand and integrate this set of interrelated parts, we should be able to achieve more sustainable outcomes.

The criteria broadly outline important forest categories or dimensions that reflect public values and scientific principles (e.g., the conservation of biological diversity). The indicators are value-neutral measures—quantitative and qualitative—of the criteria and define the status and trends for each. When considered together over time, the indicators will indicate whether or not the United States is moving toward or away from desired goals.

Using the MP C&I as a Framework in the United States

MP member countries, including the United States, have emphasized the importance of the MP C&I as a framework for the conservation and sustainable management of forests. With the experience gained from the production of the 2010 report, and from the many efforts occurring throughout the United

States and elsewhere, we are moving the use of this framework from hypothetical to operational. From their beginning in the international arena, the MP C&I have been extended to numerous local and regional applications. Because of their increased use, the MP C&I are no longer regarded in the United States as just an experiment or as useful only at the national scale.

The United States is a diverse country—ecologically, culturally, and economically; and this diversity is reflected in the approaches people are taking to ensure forest sustainability. The work of many individuals, representing a range of agencies, organizations and interests, is providing a better understanding of the relevance and utility of the MP C&I at multiple geographic and time scales.

Use of the MP C&I within the United States is still a work in progress. Three basic yet enduring questions continue to direct the nationwide conversation.

- Are forest conditions improving?
- Are we moving toward a more sustainable future?
- How do we collectively know?

The activities shared in this chapter reveal that the MP C&I are being used as a framework in many ways, all of which help broaden and deepen U.S. commitment to sustainable forest and natural resource management within more comprehensive sustainable development efforts.

Various Ways the MP C&I are Being Used as a Framework

Conceptualizing
Example: The National Association of State Foresters has used the MP C&I to characterize forest sustainability in its Principles and Guides for a Well-Managed Forest.

Visioning and Planning
Example: Baltimore County, MD, is using the MP C&I to envision desired future conditions, engage citizens in dialog, and set goals.

Implementing
Example: The State & Private Forestry Deputy Area of the Forest Service used the MP C&I to update the Forest Stewardship Program for family and other nonindustrial private forest landowners.

Monitoring, Assessing, and Reporting
Example: Several States, including Maryland and Oregon, are using the MP C&I as the basis for conducting assessments of forest conditions.

Informing and Communicating
Example: Twenty States in the Northeast and Midwest are using the MP C&I as a framework to organize and improve accessibility to data and as a set of base indicators.

Organizations referenced in the examples in the preceding text box are not the only ones using the MP C&I for the purpose listed. But they are notable—each is an early adopter and user of the MP C&I to help frame dialog and take actions within their respective spheres of influence. These and other examples also are summarized and available via the Web site of the Roundtable on Sustainable Forests (described in the next section).

Broadening the Dialog in the United States

When broadening the dialog about sustainable forests and sustainable forest management, we need to recognize that the responsibilities for U.S. forests are shared across a continuum of small to large ownerships within rural and urban areas. Public, private, and tribal landowners and managers share on-the-ground stewardship responsibilities. Policymakers and the general public, whether or not they own or manage forest land, also greatly affect the status and trends of forests in rural and urban areas when making decisions about land use, energy alternatives, and much more.

Broadening—Enlarging the Network

Broadening the dialog about sustainable forests means expanding the number and diversity of individuals and organizations involved. Being involved includes understanding the value of forests as forests, practicing sustainable forest management, and/or fostering sustainable outcomes that include trees, woodlands, and forests. It also can facilitate cooperation across administrative, ownership, and jurisdictional boundaries as well as cooperation across natural resource sectors—forests, rangelands, water, and more—to improve ecosystem health and achieve other mutually desired environmental, social, and economic benefits.

Forest issues are now part of an increasingly wide array of concerns confronting the United States that require connecting knowledge and actions across boundaries and across natural resource sectors. Addressing these concerns necessitates an active network of citizens who own, manage, and otherwise influence the conditions and trends occurring on the Nation's forests.

Increasing the Number and Diversity of Participating Forest Stakeholders

Sustainable forest management as understood today builds on decades of work—ranging from on-the-ground stewardship activities to international conversations about sustainable

forests and sustainable development. These discussions and activities often span multiple spatial scales, with local practitioners interacting with people working at the national and international levels. Efforts under way bring together people who are concerned about forests (communities of interest) and people who are concerned about the benefits of trees and forests in their particular places (communities of place).

Example—Roundtable on Sustainable Forests

Nationally, a multistakeholder group called the Roundtable on Sustainable Forests (RSF) is helping promote the MP C&I as a common framework.

Stakeholders met for the first time in September 1998, and the RSF was initially self-chartered in February 1999 "to serve as a forum to share information and perspectives that will enable better decisionmaking in the United States regarding sustainable forests." The initial focus of the RSF was "to implement and promote utilization of the Criteria and Indicators (C&I) contained in the Santiago Declaration of the Montréal Process as a means of measuring national progress towards achievement of this goal." Although the charter has since been revised, the RSF's work continues to be based on the MP C&I and the mantra "better data leads to better dialog, which leads to better decisions."

Participants in the RSF are now focusing on four themes identified in its work plan through 2011:

1. Reporting and monitoring progress toward sustainable forests.
2. Coordinating with related national data and indicator efforts.
3. Fostering sustainable forest management through the application of the MP C&I.
4. Engaging the broader community of forest stakeholders at multiple scales.

The RSF is an open, inclusive body with participants representing Federal land management agencies, Federal and national research organizations, government agencies at State and local levels, tribal entities, nongovernmental organizations (NGOs) including national associations and environmental NGOs, scientific societies, universities, and more.[11]

Many RSF participants also are working regionally and locally to encourage more place-based efforts aimed at fostering ecosystem-appropriate improvements and socially relevant outcomes. For instance, in the South, the RSF, through its meetings, workshops and stakeholder networks, stimulated a variety of forest sustainability efforts, including the development of a Western North Carolina Report Card (WNCRC—see box) organized around the seven MP Criteria.[12]

Cooperating Across Boundaries

Using the MP C&I as a framework to help improve data, dialog, and decisions requires cooperating across administrative, ownership, and jurisdictional boundaries. Working collaboratively involves including many organizations. At the same time, actions taken by government agencies can not only

Western North Carolina Report Card

The Western North Carolina Report Card on Forest Sustainability (WNCRCFS) is a cooperative effort between the Forest Service and the University of North Carolina at Asheville. The Report Card provides a current picture of economic, ecological, biological, and social information relevant to the subregion. By evaluating how forests are affected by natural and human causes, the collaborators hope to inform decisionmaking processes and policymaking in the area.

The subregion, which includes 18 counties in the mountains of western North Carolina, has long been recognized as a place of natural beauty marked by areas of ruggedness and isolation. It is a highly ranked destination for outdoor enthusiasts and a zone of ecological importance. The area includes the North Carolina section of the Blue Ridge Parkway, the most visited national park unit; the Great Smoky Mountains National Park (located in western North Carolina and Tennessee), the most visited national park; and the Pisgah and Nantahala National Forests, two of the most visited national forests in the system. Nine river basins split by the Eastern Continental Divide drain almost 7,500 square miles and provide high-quality water to several large metropolitan areas in the Southeastern United States.

Several issues threaten western North Carolina's forest ecosystems. These include, but are not limited to, loss of native species and natural communities; spread of invasive species; insect and disease infestations; air pollution; landslides: and the loss of contiguous forest land.

The WNCRCFS closely follows the framework of the Montréal Process Criteria and Indicators. All seven criteria are evaluated. All the MP Indicators were initially considered, but many were not suitable either because they were not well adapted to a subregional scale or no current data was available. Although the MP C&I uses 64 indicators, the WNCRCFS uses about 30.

[11] For more information about the RSF, see http://www.sustainableforests.net. The site includes meeting and workshop summaries, background information, and links to related efforts.

[12] See http://www.wncforestreportcard.org/ for the current Report Card and related project information.

influence work done on publicly owned and managed lands but can also be a catalyst in influencing work across ownership and jurisdictional boundaries. A noteworthy effort under way in the Northeast and Midwest is encouraging regional cooperation.

Example—Collaboration in the Northeast and Midwest

The Forest Service's State and Private Forestry Northeastern Area (NA) and the 20 State forestry agencies covering the area from Maine to Minnesota and from Missouri to Maryland are collaborating on forest sustainability. Together the NA and the NA Association of State Foresters (NAASF) developed the NA Forest Sustainability Indicators Information System, which was informed by the MP C&I, to understand and measure forest sustainability across the Northeast and Midwest. The system includes the following:

- Selection of 18 base indicators, with at least one indicator per MP criterion to track forest sustainability at regional and State scales.
- Online reports and data downloads to track trends in forest health and sustainability at State, multi-State, and regional scales.
- A sourcebook on C&I.
- Links to additional data and resources related to forest sustainability.

Other mutually supportive efforts are under way within the 20-State region, with the MP C&I and NA Forest Sustainability Indicators Information System informing multi-State and State-level efforts. In the Great Lakes basin, where forests cover 60 percent of land, every 2 years a binational conference is held by the Governments of the United States and Canada to report on the state of the Great Lakes under a 1987 water quality agreement. Since 2004, a working group of the State of the Lakes Ecosystem Conference (SOLEC) has been using the MP C&I as a starting point in its selection of forest indicators. Also in the Upper Great Lakes Region, the Great Lakes Forest Alliance, Inc., has worked with Michigan, Minnesota, and Wisconsin and the Canadian province of Ontario to focus on pressing issues threatening the region and to connect the issues-based work to assessment efforts informed by the MP C&I. State-level efforts such as the "New Hampshire Forest Resources Plan Revision Assessment Report," Maryland's Strategic Forest Assessment, and Wisconsin's Forest Sustainability Framework also are helping test and refine the MP C&I as a framework. These efforts complement national- and regional-scale assessment and reporting activities led by the Forest Service.

Northeastern Area (NA) Forest Sustainability Indicators Information System

The NA Forest Sustainability Indicators Information System is an online clearinghouse providing information on 18 base indicators for monitoring and assessment in the Northeast and Midwest.

A wealth of information is available, allowing users to do the following:

- Retrieve online data reports and additional resources for each indicator.
- Dynamically graph data at regional, State, multi-State, and other scales.
- View, print, and save graphs, maps, and data tables.
- Track trends over time.

More information about the system and related materials is available on the NA Web site (http://www.na.fs.fed.us/sustainability).

The NA Forest Sustainability Indicators Information System helps facilitate communication and data sharing among multiple efforts occurring within and across State borders; it also reveals differences in forest conditions within the region and cumulative changes across States and over time.

Each State used the work done by the NA Forest Sustainability Indicators Information System to prepare for and inform the development of Statewide Forest Resource Assessments and Strategies that were completed in 2010 in accordance with the Food, Conservation, and Energy Act of 2008. The NA and NAASF developed regional guidelines for the assessments process including a suggested framework that uses the MP Criteria for organizing the Assessments and draws on the data compiled for the NA and NAASF base set of 18 indicators. Most States in the Northeast and Midwest are referring to these regional guidelines and the C&I framework to determine what information to include in their statewide assessment.

Although it is too early to understand the lessons learned from the statewide assessment processes, some preliminary ideas are emerging. Delaware, Indiana, Iowa, Massachusetts, Minnesota, New Hampshire, and New York report that the use of the MP Criteria and the region's 18 base indicators allow for more comprehensive reports, help ensure scientific information is included, and provide a good tool for communicating with partners and the public. These preliminary benefits echo those reported in 2006 by New Hampshire in its "Forest Resources Plan Revision Assessment Report" (New Hampshire 2006).

Learning About Tribal Perspectives

Concepts of sustainability vary among forest owners, managers, and users. Although forest lands managed by or for tribal communities in the United States exist in many States, developing a collective voice on tribal views of forest sustainability has proven difficult. A number of efforts within the United States have been pursued in recent years to better understand tribal perspectives about forest sustainability and to learn how to use MP C&I to inform tribal efforts at sustainable forest management.

After the release of the *National Report on Sustainable Forests—2003,* the Intertribal Timber Council worked with the Evergreen Foundation, Forest Service, and other participants of the RSF to gather tribal perspectives. They shared these perspectives in a special Winter 2005 to 2006 issue of the *Evergreen* magazine on "Forestry in Indian Country: Models of Sustainability for our Nation's Forests?"[13]

Example—Cultural Resources on the Yakama Reservation Forest

Among the contributors to the special issue of *Evergreen* were the managers of the Yakama Reservation Forest, which totals 650,000 acres within the 1.4-million-acre Yakama Reservation in south-central Washington State. They pursued a multiyear project to more broadly understand cultural resources after reviewing the 2003 set of MP C&I. The managers believed the MP C&I defined cultural resources too narrowly within just two indicators of Criterion 6, and they wanted to develop quantitative and qualitative indicators for assessing the effectiveness of Yakama Nation land management policies and practices in sustaining cultural resources on their lands. The managers interviewed tribal elders, conducted field assessments, and used the results to improve forest management planning and develop a long-term strategy for improving forest health problems. The resulting forest plan protects cultural resources such as native plants that are traditionally used or otherwise valued by the tribe, artifacts, and sites of traditional significance.

Yakama forest managers' views about cultural resources and the use of related indicators have been shared domestically with others through meetings of the Intertribal Timber Council and the RSF. In 2007, the managers presented their views at the international Sharing Indigenous Wisdom Conference sponsored by the College of Menominee Nation located in Wisconsin.[14]

Incorporating Data About Urban and Agricultural Forest Resources in the United States

Concerted efforts by resource managers, urban planners, and affiliated stakeholder groups are under way to incorporate information about urban and agricultural forest resources into discussions about sustainability, including sustainable forest management. U.S. forests currently reflect a dynamic mix of land uses and land cover changes. There is a growing need for information to address problems at various scales and locations (for example, urban areas in which municipalities may be reaching legal limits set for water and air quality and facing potentially significant economic consequences).

Sustainable forest management discussions in the United States rely heavily on Federal data-gathering efforts. Neither the Forest Service (via the Forest Inventory and Analysis Program (FIA)) nor USDA Natural Resources Conservation Service (via the National Resources Inventory (NRI)) have been routinely and systematically collecting data on the status and trends of trees and forests in urban and agricultural settings. If urban and agricultural trees or forests do not meet FIA and NRI programmatic definitions, then they are not counted and therefore not included in national estimates.

For a variety of reasons, participating agencies and other forest stakeholders need to know more about forest resources in urban and agricultural settings. Therefore, in conjunction with the 2010 National Report, the Forest Service will publish a partner report focusing on urban and agricultural forest resources, and it will contain a strategy for incorporating the information in ongoing reporting activities.

Example—Sustainability Efforts in the Greater Kansas City Region

Traditionally, when communities like those in the greater Kansas City region invest in stormwater management infrastructure, they do so through grey engineering (e.g., storm drains and sewers). The Mid-America Regional Council (MARC) and USDA's National Agroforestry Center (NAC) are collaborating to put trees to work to address stormwater issues and to accomplish other environmental, social, and economic goals for the 2 million people in the region. By considering nature an integral component in planning and designing decisions, the 120 cities and 9 counties in the region are incorporating public and private open spaces; greenways; trails; and working farm, ranch, and corporate lands into a coherent

[13] For a copy of the special issue, see http://evergreenmagazine.com/magazine/issue/Winter_2005_2006.html.

[14] Presentations made by participants in the Yakama project are available on the conference Web site at http://www.sharingindigenouswisdom.org.

regional smart growth strategy. Moreover, by maximizing the "green infrastructure" potential in the region, MARC and NAC are seeking ways to ensure development occurs in an environmentally friendly fashion.

MARC and NAC pulled together an impressive array of resources to support its smart growth strategy. These include: a natural resources inventory; updated engineering design standards and planning guidelines for site design and stormwater management; development of model stream protection and management policies; creation of a regional Academy for Sustainable Communities, delivering leadership and professional development training; and a nearly completed regional sustainability indicator framework informed by the MP C&I framework. The U.S. Environmental Protection Agency, Forest Service, and area local governments are working together to support this smart growth strategy.[15]

Example—Great Plains Tree and Forest Invasives Initiative

The Great Plains Tree and Forest Invasives Initiative (GPI) is a multi-State cooperative effort involving the Forest Service and State forestry agencies in Kansas, Nebraska, North Dakota, and South Dakota that focuses on invasive pests (such as the emerald ash borer [*Agrilus planipennis*]) that may threaten tree resources in the northern plains. Participants seek to inventory tree resource using methods compatible with those of the FIA Program so they can integrate efforts and obtain a more holistic understanding of the resource.[16]

In 2008, the initial GPI inventory data collected from 400 rural plots across the four States indicate that an estimated 1.3 million acres with trees provide agroforestry benefits or functions not inventoried by the FIA Program. These 1.3 million acres of windbreaks, shelterbelts, riparian buffers, and other tree groupings across the rural landscape do not meet the FIA definition of forested land use (10 percent stocked, at least 1 acre in size, and at least 120 feet wide). Additional insights are being gleaned from data collected on 800 urban plots. The initial inventory results suggest many more acres of tree resources exist in the Great Plains than the 4.1 million acres of forest reported in the *Forest Resources of the United States, 2007* report which includes only lands that meet the FIA Program definition. Although not directly related to the MP C&I, the GPI embodies the idea that better data will lead to better dialog and thus better decisions. It also lays the groundwork for the eventual inclusion of agricultural and urban forest resources in a sustainability-reporting framework similar to the MP C&I.

Understanding Tropical Forests in the United States

The United States possesses a diverse collection of tropical forests, virtually all of which exist on islands in the Caribbean and Pacific. In the Caribbean, tropical forests are found on Puerto Rico and the U.S. Virgin Islands. In the Pacific, they are found on Hawaii, three U.S. territories (American Samoa, Commonwealth of the Northern Mariana Islands, and Guam), and three freely associated States (the Republic of the Marshall Islands, Federated States of Micronesia, and the Republic of Palau).

In 2000, Hawaii reviewed the MP C&I and released a first approximation report that attempts to measure its forest sustainability. The Hawaii Division of Forestry and Wildlife identified the status of collective knowledge about Hawaiian forests and highlighted what data was needed to facilitate Hawaii's progress toward sustainable forest management. Their report, entitled *State of Hawaii's Forests 2000*, provides information for decisionmakers at State and Federal levels.

The Forest Service International Institute of Tropical Forests, which is headquartered in Puerto Rico, has evaluated the MP C&I against indicators developed for tropical countries and determined that the MP C&I are suitable for use in the Caribbean. In addition, the Forest Service's Pacific Northwest Research Station completed a needs assessment for the Pacific Islands and implemented trial plots for the FIA Program; the Pacific Southwest Region worked with the Pacific Islands Imagery Consortium to complete a vegetation mapping and monitoring project for U.S.-affiliated islands; and the Pacific Southwest Station's Institute of Pacific Islands Forestry in Hawaii has worked with Forest Service and State counterparts to conduct related research and do outreach needed to restore, protect, and sustain forests of the Pacific.

These formative efforts provide the foundation for a companion project under way that will report on U.S. tropical forests using the MP C&I as the organizing framework. Researchers are collecting data and developing a summary as part of the 2010 reporting process. This work is complicated by the diversity of ecological, social, and economic conditions that prevail on the islands in question, and by the widely varying availability of data, but the need to understand these valuable and often unique ecosystems remains a major impetus for the effort.

[15] Information about project accomplishments and future plans is available on line at http://www.marc.org/Environment/Smart_Growth.htm.

[16] Information about the GPI is available on the Nebraska Forest Service Web site at http://www.fs.unl.edu/EAB.asp.

Engaging Across Natural Resource Sectors

The pathway to sustainability involves more integrated environmental and natural resource policies and actions. Recent successes using criteria and indicators are not limited to the forest sector. Organizations interested in sustainable natural resource management are drawing inspiration and lessons from the use of the MP C&I as a framework for understanding and measuring forest sustainability. Other national multistakeholder processes focusing on rangelands and water resources have identified related criteria and indicators.

Example—Sustainable Rangelands Roundtable

Since 2001, the Sustainable Rangelands Roundtable (SRR) has brought together representatives of agencies and organizations concerned about the Nation's 770 million acres of rangelands.

The SRR participants began their work by identifying important rangeland issues, and then they organized them into the following five criteria for rangeland sustainability:

- Conservation and maintenance of soil and water resources on rangelands.
- Conservation and maintenance of plant and animal resources on rangelands.
- Maintenance of productive capacity on rangelands.
- Maintenance and enhancement of economic and social benefits to current and future generations.
- Legal, institutional, and economic framework for rangeland conservation and sustainable management.

SRR participants then identified a set of 27 core indicators to initially assess the status and trends of factors affecting rangeland sustainability. Adopting and monitoring key indicators of U.S sustainable rangeland management remains the highest goal of the SRR and its stakeholders.

Three agencies participating in the SRR—the Forest Service, the Natural Resources Conservation Service, and the Bureau of Land Management—share responsibility for various aspects of rangeland inventory and assessment. They are pursuing a pilot project in eastern Oregon to demonstrate how they can work together to assess and report on rangeland conditions at the national level using a common set of core indicators.[17]

Example—Sustainable Water Resources Roundtable

The Advisory Committee on Water Information created the Sustainable Water Resources Roundtable (SWRR) in 2002 to promote the exchange of information among representatives of government, industry, and environmental, professional, public interest, and academic groups.

Rather than agreeing on a strict definition of sustainability, the SWRR adopted the Brundtland Commission's more general definition of sustainable development as a starting point for discussions about water sustainability. The SWRR now proposes a five-part framework for organizing water sustainability indicators:

- Water availability.
- Water quality.
- Human uses and health.
- Environmental health.
- Infrastructure and institutions.

The SWRR also developed a framework for tracking and understanding changes to the health of its fresh and coastal waters, surface and ground water, wetlands, and watersheds. Participants developed a methodology to understand the implications of long-term changes for ecosystems, communities, and industry.[18]

Informing Educators and Students Through Project Learning Tree

Project Learning Tree (PLT) and its partners around the country offer more than 2,000 professional development workshops for teachers each year. Now reaching some 30,000 educators, PLT uses the forest as a model, or "window on the world," to increase students' understanding of the environment. In addition to the workshops, the PLT produces suite curriculum guides, which include seven stand-alone modules for high school teachers on key topics. A prominent example is *Global Connections: Forests of the World*, which was published in 2008 by the American Forest Foundation and the World Forestry Center.

The *Global Connections* curriculum module provides secondary-level educators—both formal and nonformal—with an engaging series of nine project-based activities to help students gain

[17] Information about the SRR is available at http://sustainablerangelands.warnercnr.colostate.edu/.

[18] More information regarding the SWRR is available at http://acwi.gov/swrr/.

understanding of and appreciation for the diversity of world forest environments. The activities encourage students to investigate the environmental, social, and economic aspects of human interactions with, and dependence on, forests. Each activity provides students with an opportunity to apply scientific processes and higher order thinking skills in a variety of disciplines.

One activity focuses on students developing and evaluating their own criteria for defining and measuring forest sustainability and presents information about the history of the Montréal Process (MP) and about the MP Criteria and Indicators (C&I). Teams of students then create science-fair style displays for each criterion and discuss the environmental, social, and economic links between them. This activity has proven popular with teachers and students and has been used in both science and social studies courses.

Ten thousand copies of *Global Connections* are now in print and the module has been distributed at professional development workshops across the Nation during meetings of the National Science Teachers Association, North American Association for Environmental Education, State forestry and environmental educators, and the World Forestry Center's International Educators Institute. With the American Forest Foundation's support, regional training has continued, and 17 States have implemented plans to adopt *Global Connections* while working with Forest Service staff and other local partners to provide training and materials for teachers and natural resource professionals.[19]

Deepening the Dialog in the United States

Deepening the dialogue about sustainable forests involves agencies and other organizations understanding the power of the MP C&I as a common framework—and putting it to use across organizational boundaries and geographic scales to improve forest and landscape conditions. The MP C&I's comprehensive nature is one of its major strengths. It enables us to consider all aspects—social, economic and ecological—of the forest system in question. Together, these aspects provide context about the human systems as well as the ecological systems within which individual and collaborative actions are taken. The result is a web of relationships rather than neatly defined up-down hierarchies.

Deepening—Understanding Systems and Working Across Geographic Scales

Deepening the dialog about sustainable forests involves more completely understanding the workings of both nature-based ecosystems and human-centric institutional systems. And making improvements at broader landscape or spatial scales involves developing deeper understandings of the way natural and human systems are connected across geographic scales. It links the knowledge gained from using a common framework to develop data and other information to decisions made and actions taken individually and collaboratively at and across scales.

Across the country, various processes are under way for advancing and linking use of the MP C&I across geographic scales. One approach has been quite deliberate, with formal processes for encouraging linkages and providing mutual support while testing and using the MP C&I as a common framework. Another approach has been more laissez faire, with practitioners testing and using the MP C&I at various scales and letting the institutional linkages and associated actions across scales emerge.

Encouraging Linkages Across Geographic Scales

The MP C&I is advancing sustainable forestry in a more interconnected fashion by focusing our collective attention on a shared set of measures and objectives that people care about. Armed with a common vocabulary and database with which to describe forest sustainability, government employees, stakeholders, and the public at large can better share information between different efforts and locales, integrating their monitoring and reporting activities. The result is better communication and better decisionmaking.

By being more coordinated and directed to an explicit set of sustainability goals, management actions on the part of different individuals can add up to landscape-level improvements, crossing the continuum of rural and urban places and connecting to other sectors outside the forest community. For example, in the Northeast and Midwest, Forest Service and State forestry agencies are using the MP C&I as a basis for monitoring and tracking progress across a 20-State region; in Maryland, collaboration between local, regional, and Federal entities is leading to strategic efforts to improve watershed conditions at the State and local levels as well as within the broader Chesapeake Bay Watershed.

[19] More information about Global Connections and other PLT curriculum is available on line at http://www.plt.org.

Example—Collaboration in Maryland

Nested and networked efforts within Maryland draw support from each other and present opportunities to unify goals and actions. The efforts also create the potential to feed into larger landscape-level efforts, such as the Chesapeake Bay Watershed. In 2006, the Chesapeake Bay Executive Council, a group with representatives from adjacent States, regional associations, and the Federal Government, signed a directive committing all members to work to retain and expand forests in the Chesapeake Watershed (Chesapeake Executive Council, Directive 06-1, September 22, 2006). The directive explicitly recognizes that what happens on the land influences the health of the bay. Maryland's forests are an important part of the Chesapeake Watershed, and the State has been working to integrate State- and county-level forest management efforts to enhance water quality in Chesapeake Bay while meeting the many other goals associated with sustainable forest management.

Maryland's Strategic Actions

In Maryland, protecting and managing forests is challenging because of urban development, forest land fragmentation and parcelization, and other pressures. Forests that once covered more than 90 percent of Maryland's landscape now cover only 41 percent; the counties, landowners, and other jurisdictions share responsibility for the remaining area.

Maryland's Department of Natural Resources has used the MP C&I to do State-level assessments and to prioritize State investments. Its Strategic Forest Lands Assessment (SFLA), completed in 2003, provides geographic information system tools to strategically identify important forests and to support land management planning and land use decisions needed to protect forests and the State's natural lands, which are referred to as green infrastructure.

Use of the MP C&I to help organize State-level natural resource information for assessing forest conditions and identifying strategic forests has helped facilitate dialog across geographic scales, ownership boundaries, and program goals, supporting a complex mix of planning and management activities ranging from the site-level to county, to statewide, and to the Bay region as a whole. Maryland officials are using assessment data, indicators, and computer tools for county planning, watershed planning, landowner outreach, and much more. Maryland's use of the MP C&I also has assisted the United States in testing and refining them for use at the national level. State employees have found that applying the MP C&I at multiple scales encourages data coordination and the sharing of technology and "know how," and it facilitates the tracking of changes such as forest loss.[20]

Local Initiatives by Baltimore County, MD

Baltimore County, through its Forest Sustainability Program, is increasing the public's understanding about forest benefits, organizing information, setting goals, and taking action in collaboration with State and Federal agencies and others to assess forest health, protect forests, strategically reforest, and enhance landowner stewardship.

Through the Green Infrastructure training offered by The Conservation Fund and others, the Baltimore County Department of Environmental Protection and Resource Management became involved in a project to help communities use the MP C&I as a framework for sustainable forest management. The department documented the work in a case study, which is being used in the ongoing training program to help communities and their partners make natural resources and natural systems part of local and regional plans and community decisions.

Baltimore County's Natural Resource Manager used the MP C&I to engage stakeholders and develop a Forest Sustainability Strategy for the county in 2005, resulting in a report entitled *The State of Our Forests—2007*. Implementation is progressing with and through partners: criteria-level work is under way (for example, compiling data), the county is linking its strategy with other local initiatives through capital and operating programs, and the county is sharing its experiences with others in the State, region, and Nation through networks reaching forest stakeholders and local governments.

Locally, forest sustainability efforts are part of Baltimore County's Green Renaissance initiative, which focuses explicitly on forests and trees. The efforts also link to State-level strategies and programs for retaining and expanding forests to further Maryland's Green Infrastructure Assessment, the SFLA, and the Chesapeake Bay Program. In 2008, Baltimore County hosted a workshop that introduced forest sustainability and the MP C&I as a common framework to other local Governments in the State and region.[21]

Baltimore County's forest-related initiatives are gaining increased domestic and international recognition. Domestically, a number of methods have been used to share progress with forest stakeholders, through the RSF, and with local government planners and other officials, through the American Planning Association and the National Association of Local government Environ-

[20] More information about Maryland's efforts is available online at http://www.dnr.state.md.us/forests/planning/sfla/index.htm.

[21] Baltimore County's Forest Sustainability Strategy and 2007 report are available on line at http://www.baltimorecountymd.gov/agencies/environment/workgroup/programimplementation.html. The case study is on the Green Infrastructure Web site at http://www.greeninfrastructure.net.

mental Professionals. Internationally, a forthcoming report from the United Nations Food and Agriculture Organization (FAO) will include the Baltimore County story.

Letting Connections Across Scales Emerge

In the United States, many different entities share natural resource management responsibilities, and each has its own management objectives. In order to share information or tackle specific issues that require a more integrated approach spanning geographic or institutional boundaries, managers need to use a more unifying framework. The MP C&I are well suited for this role.

In the Western United States, for example, various organizations have used the MP C&I to inform their own work or advance their own efforts, and they are beginning to discuss linkages across geographic scales. The most prominent example is the State of Oregon, where opportunities for greater collaboration across geographic scales and organizational boundaries are emerging.

Example—Efforts Under Way in Oregon

In Oregon, as in other places, there exist polarizing political views regarding the appropriate balance of environmental, social, and economic benefits from the State's public and private forests. More than one-half of Oregon's forest land is federally managed. C&I processes could stimulate ideas about how to address problems in a more explicit and integrated manner and to collectively move trends in forest conditions in a direction more in line with public desires and political support.

Statewide Efforts Led by State Forestry Organizations

By adopting national and international sustainable forest management concepts, forest leaders in Oregon hope to reduce polarization and find common ground on forest policies. As a result, the State, via the Oregon Board of Forestry and the Oregon Department of Forestry, is using the MP Criteria as an integrated policy and technical framework. The State has used the MP Criteria to foster conversation about all forests in the State and to measure progress toward sustainability goals.

The *2003 Forestry Program for Oregon* is a strategic plan that sets out the Board's vision for all the State's public and private forests, and goals and objectives to guide the Board's decisions. The seven goals of the *Forestry Program for Oregon* are directly related to the MP. The Board has also endorsed 19 Oregon Indicators of Sustainable Forest Management. Although the indicators themselves remain neutral, Oregon has set forth desired trends or targets for each.

Oregon developed the *Forestry Program for Oregon* through a deliberative process that recognized that to be sustainable and successful, the State had to manage different forests for different purposes. The State was able to reach a wide audience through advisory committees, and its approach to consensus-building embraces the diversity of its population, rather than considering it a barrier.

Using the *Forestry Program for Oregon* and the Oregon Indicators as an information base, the State is collaborating with the Forest Service in the areas of National Forest System planning and monitoring, Statewide assessments required by State and Private Forestry law, and an Interagency Mapping and Analysis Project being led by the Pacific Northwest Research (PNW) Station. The research station and other cooperators seek to integrate forest indicators with other data to develop alternative future scenarios and management strategies to address them at multiple scales.

In these concrete ways, Oregon's Board of Forestry is creating a statewide dialog through the use of the MP C&I. An Oregon Indicators of Sustainable Forest Management Web site has been developed and is being expanded as new indicator data become available. The Oregon indicators also are being used in the State Forest Resource Assessment, which will be completed in 2010. The Board of Forestry is considering establishing an Oregon Roundtable on Sustainable Forests to further engage multiple stakeholders through collaborative efforts to advance understanding, assessment, and reporting of forest sustainability, and to encourage forest resource management that considers environmental, social, and economic factors in an integrated fashion.[22]

Example—Sustainability Efforts by the Mt. Hood National Forest

One of the State's Federal cooperators is the Mt. Hood National Forest, which is located in western Oregon adjacent to the Portland-Vancouver Metropolitan Area. The Mt. Hood National Forest serves as a scenic landmark and backyard to more than 2 million people who depend on it for a range of environmental, social, and economic benefits.

Since the 1990s, the Mt. Hood Forest Supervisor has been using a systems approach to advance sustainability. As the Federal commitment to sustainable natural resource management has increased, the Mt. Hood National Forest has participated in scientific, market, policy, and operations-based sustainability efforts, all of which were informed by the MP C&I.

[22] The *2003 Forestry Program for Oregon* and the associated *2007–2009 Oregon Forests Report* are available online at http://www.oregonforestry.gov.

Mt. Hood National Forest used a scientific approach to complete a Local Unit Criteria and Indicators Development (LUCID) project, and it used a market-based approach to participate in a national evaluation of forest management certification processes. From a policy perspective, the Mt. Hood National Forest is matching its annual Forest Plan Monitoring Report to the format of the *Forestry Program for Oregon*. In its day-to-day operations, the national forest is participating in agency efforts to change its levels and patterns of consumption.

Employees on the Mt. Hood National Forest believe that using a common set of criteria assists communications and facilitates coordination across boundaries and scales. They are using this approach to meet the requirements of the National Forest Management Act of 1976, which directs the Forest Service to use monitoring and assessment to evaluate the effects of land management, combining the consistency needed by the Forest Service with the flexibility needed to respond to local circumstances. The Oregon Department of Forestry views the incorporation of the *Forestry Program for Oregon* into the Mt. Hood National Forest's monitoring report as a very positive development and a model for other national forests.

Monitoring by the Mt. Hood National Forest

Each year, the Mt. Hood National Forest completes a monitoring report. In recent years, it facilitated the transition of the monitoring report to a systems-based framework to study many competing influences as one complete system in a sustainability context. The latest report for fiscal year 2008 is organized by the seven strategies in the 2003 Forestry Program for Oregon.

In the report, the Mt. Hood National Forest states, "…the question of sustainability has become a key consideration in most human endeavors…and the key question is not how much should we harvest or how much should we protect, but rather is the overall system sustainable."

National forest monitoring reports and related studies are available on the Mt. Hood National Forest Web site (http://www.fs.fed.us/r6/mthood/).

Integrating Efforts To Achieve Landscape-Scale Improvements

The health of forests and the ecosystem contributions of trees and forests to landscapes involve complex and dynamic natural and social relationships. Forest conditions are influenced by both nature-based ecosystem processes and human-centric institutional processes. Scientific information about forests and ecosystems in combination with discussions about societal values serves as a foundation for dialog about desired conditions. The Manomet Center for Conservation Sciences learned from indicator practitioners that indicator selection and use is primarily a social process to be informed and supported by data and science.[23]

Discreet actions undertaken at the local level have a better chance of adding up to larger landscape-scale improvements if managers work systematically and explicitly consider linkages to nearby actions by others. Making these landscape-level improvements is an adaptive process in which we learn by doing, checking outcomes against expectations, adjusting actions accordingly, and paying attention to what others are doing. In a recent report, Fedkiw and Rose contend that "management for sustainable forests is landscape management as distinguished from site-specific forest management," and it needs an enabling governance framework for identifying preferred outcomes (Fedkiw and Rose 2008). The MP C&I provides both a means of organizing a comprehensive set of information about the landscape, thus promoting a shared understanding of baseline conditions, *and* a framework for organizing public dialog in the identification of desired outcomes. By promoting consistency across different efforts and locations, it further enhances our ability to integrate our work across multiple spatial scales.

Understanding Ecosystem Conditions

Understanding what it takes to keep ecosystems healthy and what it takes to restore degraded ecosystems challenges forest managers, scientists, and others. The concept of strong sustainability, as advanced in chapter 1 of this report, holds that opportunities for making social and economic progress must be pursued within environmental realities. Therefore, understanding the state of the Nation's ecosystems, including but not limited to forests, is critical.

Example—State of the Nation's Ecosystems Project

The State of the Nation's Ecosystems project is a collaborative venture commissioned by the White House Office of Science and Technology Policy (OSTP) in 1997, later joined by the Council on Environmental Quality (CEQ) in 2002. The work is led by The Heinz Center for Science, Economics, and the Environment and is supported by corporate, foundation, and Federal funds. Working groups and multistakeholder technical committees design and report on sets of indicators measuring conditions and trends for six of the Nation's ecosystems: coasts

[23] The Manomet Center's report, which was sponsored by the National Commission on Science for Sustainable Forestry, is available at http://ncseonline.org/NCSSF/.

and oceans; farmlands; forests; fresh waters; grasslands and shrub lands; and urban and suburban landscapes. The Heinz Center has maintained a very focused and deliberate effort to obtain balanced representation from four social sectors: academia, industry, advocacy organizations, and public agencies.

The Heinz Center released the initial report from the project in 2002. It released a second version on June 17, 2008, titled *The State of the Nation's Ecosystems 2008: Measuring the Lands, Waters, and Living Resources of the United* States (H. John Heinz Center 2008). The 2008 report has more data and improved indicators, with a core set of 13 national indicators describing the overall condition and use of the Nation's ecosystems. A companion policy document to the 2008 report, *Environmental Information: Roadmap to the Future* (H. John Heinz Center 2008b), notes critical gaps in environmental information and highlights management challenges.[24]

Linking Institutional Commitments and Actions

The potential for creating more integrated efforts across geographic scales depends on our ability to find ways to link institutional commitments and actions. In the United States, many individuals and organizations are shaping forest sustainability, and over time they are finding ways to link their efforts and mutually support each other.

In previous sections of this chapter, we highlight the collaboration of the Forest Service and the 20 State forestry agencies in the Northeast and Midwest; we also note the strategic actions being led by Maryland and local initiatives enacted by Baltimore County, MD. These actions are institutionally linked to a number of other national and State-level activities described below and displayed in table 3-1.

Example—Principles and Guides for a Well-Managed Forest

The National Association of State Foresters (NASF) is a nonprofit organization representing the directors of all 50 State forestry agencies, the 8 U.S. territories, and the District of Columbia. The NASF has a long history of supporting greater use of the MP C&I and advocating support for nationwide forest inventory and monitoring efforts, the data from which underpin many of the biophysical indicators found in Criteria 1 through 5 of this report. In 1998, NASF and five other organizations encouraged the Council on Environmental Quality (CEQ) and the Office of Management and Budget (OMB) to support Federal actions and encourage Federal interagency coordination to more effectively implement the MP C&I.

It is not sufficient, however, to focus only on the actions of Federal agencies. More than two-thirds of the Nation's forests are privately owned by more than 10 million owners living in rural, suburban, and urban areas who make decisions every day about how to protect, manage, and use their trees and woodlands. Furthermore, approximately 45 percent of all forest land in the United States is under nonindustrial private ownership—mostly small-holders not actively managing their forests for timber or related outputs. To reach this diverse ownership base, NASF has taken actions in collaboration with others to support family and other nonindustrial forest landowners in their work.

Policy and Program Guidance

The NASF worked with the Forest Service Cooperative Forestry Staff to develop *Principles and Guides for a Well-Managed Forest*, published in 2003.[25] We can use these principles to assess the potential effectiveness and capacity of any system or program aimed at helping forest owners or

Table 3-1. Linking Institutional Commitments and Actions Informed by the Montréal Process Criteria and Indicators.

Scale	Activities	Lead Organization(s)
International	Montréal Process Criteria & Indicators (MP C&I)	Twelve MP countries, including the United States
National	Principles and Guides for a Well-Managed Forest; and A Stewardship Handbook—A Handbook for Planning, Managing and Protecting Your Woods, Your Investment and Your Environment	National Association of State Foresters (in collaboration with the Forest Service)
	Forest Stewardship Program Standards and Guidelines	Forest Service State & Private Forestry (Cooperative Forestry)
Multi-State Regional	Forest Sustainability Indicators System (including 18 base indicators)	Forest Service Northeastern Area State & Private Forestry (in collaboration with 20 State forestry agencies)
Statewide	Strategic Forest Lands Assessment	Maryland Department of Natural Resources
	Educational Assistance to Private Forest Landowners	Member universities of the Sustainable Forests Partnership (e.g., Pennsylvania)
Countywide	Forest Sustainability Strategy; and The State of Our Forests—2007	Baltimore County, MD

[24] More information is available online at http://www.heinzcenter.org.

[25] See http://www.stateforesters.org/node/201.

managers achieve a well-managed forest while attaining their objectives for their land. The seven principles outlined in the guidance were released in February 2003 and follow the seven MP Criteria.

The NASF then developed guidance for nonindustrial private landowners to help them manage their own forests based on the 2003 *Principles and Guides*. In February 2005, the organization released *A Stewardship Handbook—A Handbook for Planning, Managing and Protecting Your Woods, Your Investment and Your Environment.*

Subsequently, the Forest Service used the *Principles and Guides* to revise the national Forest Stewardship Program Standards and Guidelines to help private forest-owners develop plans for the sustainable management of their forests.[26]

Educational Assistance to Private Forest Landowners

Universities are also using the NASF handbook to help educate private landowners about the concepts and practices of sustainable forest management. Through the university-based Sustainable Forests Partnership, five academic institutions have worked with their respective State forestry agencies to translate the handbook into State-specific educational materials to supplement the handbook. The educational materials, developed by the following universities in collaboration with forest landowners and State forestry representatives, translate the MP C&I into local stewardship principles that landowners can use to clarify their ownership goals:

- Auburn University (in Alabama) worked with the Alabama Cooperative Extension System to create the *Alabama Stewardship Handbook* based on the MP C&I*,* a four-fold brochure on the stewardship principles, and an instructional article on how forest owners can market carbon credits.
- Oregon State University used a county-based approach to develop guidance and sources of information for private landowners and created supplements for the western and eastern parts of the State.
- Pennsylvania State University created a four-fold brochure describing State-level resources, and wrote a seven-part forest landowner newsletter.
- Cornell University (in New York) developed a six-part webinar series on the stewardship principles.
- Virginia Polytechnic Institute and State University developed field manuals and short courses for underrepresented populations and forest landowners.

These materials can all be found on the Sustainable Forest Partnership's Web site.

The universities are working with State forestry personnel, extension agents, and woodland owner associations to disseminate the materials. Although the State-specific materials address more local concerns and forest management dynamics such as invasive plants, fire prevention, and carbon sequestration, they can be duplicated and customized to match State needs. Project results and materials are also being shared at national extension education and natural resource conferences.

Increasing Institutional Capacity

National reporting on forest sustainability relies on extensive data collection and stakeholder participation, and it highlights the need for institutional capacity on the part of agencies and organizations to collaboratively and continuously monitor, assess, and report on forest conditions. This need does not end at the edge of the forest, however, and a number of efforts are working to increase our reporting capacity within larger natural resource and environmental arenas.

Example—National Environmental Status and Trends Indicator Project

As the Heinz Center and its partners have worked together on the state of the Nation's ecosystems project, discussions also have progressed about the institutional capacity of Federal agencies responsible for monitoring, assessing, and reporting on natural resources and the environment. Shortly after the initial *State of the Nation's Ecosystems* report was issued in 2002, the CEQ convened a number of meetings among Federal agencies about the capacity to report regularly on natural and environmental resources using a comprehensive set of indicators.

The CEQ-led dialog resulted in agency representatives developing options for assembling data and reporting regularly on resource conditions and trends. The options focused on using a small set of high-level environmental indicators that would be analogous to the sorts of major economic indicators regularly reported by the Department of Commerce and OMB (for Federal budgets).

In 2006, an interagency group worked with the National Academy of Public Administration to assess institutional

[26] The revised program direction, issued in September 2005, is available online at http://www.fs.fed.us/spf/coop/programs/, and the NASF handbook, reissued in 2009, at http://www.stateforesters.org/publication-type/reports.

options. The group's report was released in November 2007. It concluded that the United States needs a system of crosscutting environmental indicators as a strategic management tool (National Academy of Public Administration 2007). In response, the chairman of the CEQ, the director of the OSTP, and the deputy director of the OMB issued a joint policy memorandum on June 17, 2008, calling on the U.S. Departments of Agriculture, Commerce, Interior, and EPA to begin work on National Environmental Status and Trends (known as NEST) Indicators. A pilot project is under way focusing on developing indicators and associated data for water availability. Although it is just a beginning, the project holds the potential of instituting a stable, long-term reporting process for environmental conditions at the national level, a process that would have obvious linkages to the MP C&I and forest sustainability reporting.

Summary

This chapter highlights ways in which the MP C&I are being used at national and subnational scales. Although far from an exhaustive listing, the activities described here demonstrate the many different ways that governments, universities, forest owners, and other stakeholders are using the MP C&I at multiple scales for monitoring, assessing, and reporting on resource conditions and trends.

The examples also illustrate that the MP C&I serve as a useful framework for broadening and deepening the dialog among a growing network of forest stakeholders. The MP C&I are helping people better understand issues and better frame policy and management options, and they are providing an impetus for taking actions. In short, the MP C&I are proving to be socially relevant and valuable catalysts for dialog and decisionmaking.

Finally, we have seen that the MP C&I can help people connect what has happened to forests in the past with what their aspirations are for forests in the future, and they can link discussions about forests with discussions about other natural resource sectors and ecosystem concerns.

We have provided Web links in the text to many of the examples presented in this chapter. Additional online resources are listed following the literature references.

Web Addresses Given for Examples Highlighted in Chapter (in alphabetical order).

Resource	Web Address
Baltimore County, MD/Department of Environmental Protection and Resource Management	http://www.baltimorecountymd.gov/agencies/environment/workgroup/programimplementation.html
College of Menominee Nation/Sharing Indigenous Wisdom (including Yakama Nation project)	http://www.sharingindigenouswisdom.org
Maryland Department of Natural Resources/Strategic Forest Lands Assessment	http://www.dnr.state.me.us/forests/planning/sfla/index.htm
Mid-America Regional Council/Smart Growth strategy and related information	http://www.marc.org/Enviroment/Smart_Growth.htm
National Association of State Foresters/Principles and Guides of a Well-Managed Forest plus Stewardship Handbook	http://www.stateforesters.org/pulication-type/reports
Northern Area Forest Sustainability Indicators Information System (Forest Service)	http://www.na.fs.fed.us/sustainability/index.shtm
National Commission on Science for Sustainable Forestry/Considerations in the Selection and Use of Indicators for Sustaining Forests (report done by The Manomet Center for Conservation Sciences)	http://ncseonline.org/NCSSF/
Nebraska Forest Service/Great Plains Initiative	http://www.fs.unl.edu/EAB.asp
Oregon Department of Forestry/Board of Forestry	http://www.oregonforestry.gov
Pinchot Institute for Conservation/Stewardship and Landscape Coordination for Sustainable Forests (book)	http://www.pinchot.org
Project Learning Tree/Global Connections Curriculum	http://plt.org
Roundtable on Sustainable Forests	http://www.sustainableforests.net
Sustainable Forests Partnership/University project	http://sfp.cas.psu.edu/CI.html
Sustainable Rangelands Roundtable	http://sustainablerangelands.warnercnr.colostate.edu
Sustainable Water Resources Roundtable	http://acwi.gov/swrr/
The Conservation Fund/Green Infrastructure case study about Baltimore County and related information	http://greeninfrastructure.net
The Heinz Center for Science, Economics, and the Environment/State of the Nation's Ecosystems project	http://www.heinz.org
USDA Forest Service:	
Mount Hood National Forest	http://www.fs.fed.us/r6/mthood/
Northeastern Area State & Private Forestry	http://www.na.fs.fed.us/sustainability
State & Private Forestry/Forest Stewardship Program	http://www.fs.fed.us/spf/coop/programs

Chapter 4

Looking Ahead to the Future

Introduction

The preceding chapters and the indicator-specific briefs included in Part II of this report describe and analyze the current conditions and recent trends in the Nation's forests. The most general conclusion emerging from this information is that forest conditions—social, ecological or economic—are continuing to change in complex and interrelated ways. Direct human pressure on forest ecosystems is increasing in many areas, and this pressure is interacting with an evolving array of environmental processes, particularly those associated with forest disturbances. Economic and social pressures are also affecting forests, and climate change holds the potential to profoundly affect all these processes in ways that may be anticipated in general terms, but whose specific effects remain difficult to predict.

In the face of all the pressures, inaction does not seem to be a promising avenue to a solution. Actions, in the form of wise policy choices and on-the-ground activities, are needed to fully realize the great potential of America's forests. Better data—reporting current conditions and trends—is a useful first step to action. But if this generation is to leave America's forests in better condition for future generations, we should identify and implement specific ways to achieve desired social, economic, and ecological goals. Actions are needed that—

- Foster vibrant and diverse forested ecosystems.
- Create resilient forests that are better able to withstand disturbances and climate change.
- Retain forested ecosystems as vital components of the broader landscapes and regions.
- Perpetuate the flow of ecosystem services and products from forests that provide jobs to people and support both the economic vitality and social well being of local communities, States, regions, and the Nation.

These are not small tasks. To foster vibrant and diverse forested ecosystems, we must restore some forests. To create more resilient forests, we need to change some policies and management activities. To retain forested ecosystems as vital components of landscapes, we need to more fully recognize the contributions of tree cover in urban areas and in mixed use agricultural and suburban areas. To perpetuate flows of ecosystem services or simply ensure that nature and wild places can persist in a rapidly changing world, we need to change conservation and management practices. Meeting all these requirements is a tall order, requiring ideas and sustained effort from many different groups and individuals outside and inside government.

In this chapter, we suggest several approaches that could mobilize and catalyze concrete actions toward improving the sustainability of America's forests. We hope these approaches inspire you to bring your own ideas to the public dialog over the future of sustainable forests in America. Indeed, a diverse set of ideas is essential to foster the sort of dialog envisioned in this report. That dialog should focus not only on what the indicators show but also on what needs to be done. Dialog needs to build support for decisions and actions.

The Context for Dialog, Decisions, and Actions

Several fundamental assumptions have been made that help to set the context for sustainable forest management in the United States of America. These often go unmentioned, but it is important to explicitly acknowledge them to help establish and clarify the setting and the scope for dialog about the future of the Nation's forests. Although these assumptions may be widely shared, some people may hold different views. Left unspoken and unexplored, these differences in perspective may hinder dialog and decisionmaking about the actions and polices need for sustainable forest management.

Landscapes Are the Critical Spatial Scale for Evaluating Sustainability

The best spatial scale for assessing sustainability is often the landscape scale. Although knowing the status of U.S. forests from a national perspective is useful, for the purposes of on-the-ground management, it is more important to know what is happening at smaller scales because it is at the local and regional levels that we can best target our actions and evaluate meaningful progress toward sustainability. The combined effect of the many individual decisions and actions taken across a landscape is what determines the progress being made toward sustainability, which is why the landscape level is the best vantage point for tracking that progress.

Watersheds are especially useful landscape-scale units for tracking changes in forests and evaluating sustainability; all the effects of human activities and ecological processes and perturbations become clear in watersheds. Trees are the key to healthy watersheds. Restoring and maintaining healthy watersheds and sustainable forest management are two sides of the same coin—you cannot have one without the other. Even in watersheds where agricultural or developed areas predominate, how the trees and forests are managed in those watersheds will often go a long way toward determining overall watershed health and condition, and ultimately, whether adequate supplies of clean water and manageable flow rates exist. Clean water and manageable flows are central to economic prosperity and quality of life, and ultimately, to sustainable development.

Actions at a Particular Spatial Scale Influence Actions at Multiple Spatial Scales

We should consider each policy or management action in the context of the spatial scale where it will be applied. For example, the desirability of a countywide policy of "no net loss of tree cover" needs to be considered in the context of that county's environmental conservation plan, economic development plan, and the desired quality of life in that county. Policies and actions at the local level, however, often have influence beyond that level. The forest sustainability reporting by Baltimore County, MD described in chapter 3 is already affecting the dialog about forests and sustainable development in surrounding counties in both Pennsylvania and Maryland and also at the State level in Maryland. Similarly, Maryland and Oregon's actions to improve forest sustainability are influencing the dialog in other States and nationally. The effects of policies and actions fostering sustainable forests at one scale inevitably affect sustainability at multiple spatial scales—both upward to broader spatial scales and downward to finer spatial scales. Similarly, national reports like this one can influence actions at State and local levels. The *National Report on Sustainable Forests—2003* helped influence Baltimore County officials to prepare their county-level report and launch a county-level dialog about sustainable forests, sustainable land use policies for the county, and sustainable economic development.

Sustainable Forests Can Be Achieved Only Within the Context of a Broader Sustainability

Today's forest issues did not arise solely within the forest sector nor can they be solved within the forest sector alone. Actions taken outside the forest sector often affect—directly or indirectly—forests and thus should be a concern of private forest landowners, public forest managers, and the people who love and use those forests. For example, the potential of producing liquid transportation fuels from forest biomass is rooted in worthy goals, including reducing petroleum energy consumption, improving domestic energy security, and reducing greenhouse gas emissions. Although considerable forest biomass exists in some places, initiating large-scale biomass energy production in those areas will change the conditions in those watersheds that will lead to tradeoffs between development and resource management goals. A key question is, can we foster effective dialog among the communities of interest, including energy interests, economic development interests, current forest products producers, and other forest stakeholders, to discuss whether and how everyone's objectives and the changes likely to occur might be managed to serve both sustainable energy development, sustainable economic development, and sustainable forest goals?

In the long run, it is impossible to have sustainable economic development without simultaneously having sustainable forests. Achieving sustainable forest goals will require additional focus on achieving sustainability goals in other sectors. If sustainable economic development and sustainable forests are so tightly linked, then it is unproductive for the dialog about sustainable forests to occur only within the circle of those keenly interested in forests. We must broaden participation in the dialog about sustainable forests to include those interested in sustainability in other sectors. Conversely, members of the forestry community should be engaged in dialogs addressing sustainability in other areas, such as agriculture, energy, or urban/suburban planning.

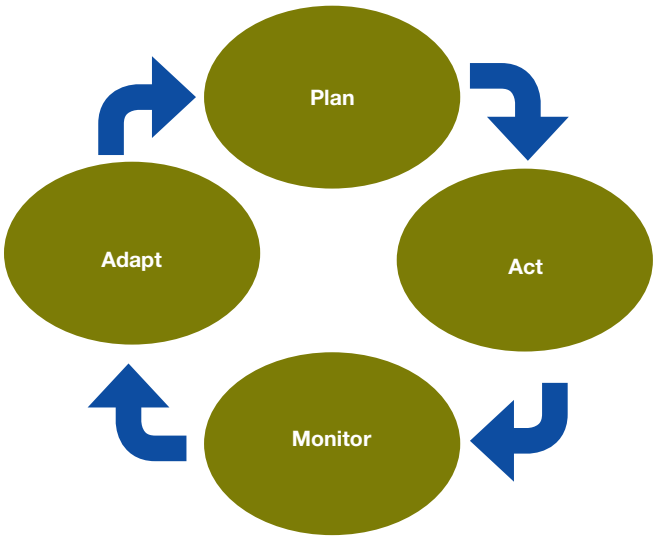
Active and Adaptive Management Is Essential To Achieve Sustainable Forests

It is impossible to achieve sustainable forests or sustainable development without active decisionmaking and subsequent on-the-ground activities to implement the decisions. Some may

argue that a policy of doing nothing—"benign neglect"—is the only safe course to sustainability. Examples from past century show where forests affected by natural or human disturbances were left alone and recovered. Today, however, many forested landscapes have been disturbed to the extent that the forests need active restoration practices to bring them back to a healthy and resilient condition. Simply allowing nature to take its course, particularly in fire-prone landscapes, can be both costly and dangerous. Choosing wisely how to use present landscapes while simultaneously choosing and improving what to leave for future generations is the essence of sustainability. Wise choices will involve a range of management strategies, from strict preservation to intensive development for commodity production. Often the best options will be found somewhere in between these two extremes. Active management is the context within which these choices are evaluated and made.

Not only are forests and landscapes changing ecologically, human values and interactions with forests and landscapes are continually evolving. Therefore, land management policies and practices should also evolve continually in response to new information and conditions. This need to evolve underlies the concept of adaptive management. Of course, the need to adjust one's actions in the face of new information has been recognized for a long time. But adaptive management strategies differ from past approaches because they *explicitly* call for monitoring and evaluation of past decisions and actions and allow for changing decisions or actions moving forward. The "Plan-Act-Monitor-Adapt" planning cycle exemplifies an adaptive management approach and is commonly used by proponents of sustainable forest management (fig. I-2).

Figure I-2. Adaptive Management Model.



Experience has shown that investing in dialog during all four steps of this cycle improves decisions and public support for actions. During the planning stage, dialog helps to shape decisions and build initial support. During the action stage, it helps people understand what is happening in the forests and how management actions contribute to desired sustainable outcomes. During the monitoring and adapting stages, dialog helps produce a more complete picture of conditions following the action and possible changes in future actions to improve outcomes and address unforeseen consequences.

Recurring national assessments, such as this report, are key products from the monitoring step of the planning cycle. State forest resource assessments, mandated by the Food, Conservation, and Energy Act of 2008, evaluate current conditions at a finer spatial scale and support Forest Service-State forestry agency dialog about plans and adaptive management actions needed to address problem areas identified. Both the national and State assessments rely extensively on the Forest Inventory and Analysis (FIA) program. FIA is a rigorous forest sampling and monitoring program that tracks conditions and trends in forests and is scalable from sub-State landscapes and watersheds up to the national level.[28]

The Pathway to Sustainable Forests Will Emerge Most Clearly from Open, Transparent, Public Dialog

The alliances formed during open, transparent public dialog provide essential support for the collaborative decisions needed to practice adaptive forest management and sustainable development. To the extent that the dialog is open to all interested parties and the substance of the discussions is freely and widely shared, the dialog process itself becomes an integral part of creating the social and political legitimacy necessary for practicing active forest management.

During the past decade, the Roundtable on Sustainable Forests (RSF) has engaged in the kind of open and transparent dialog that is especially valuable for creating legitimacy, support, and momentum for action. Incorporating the views of more than 100 participants, the RSF dialog has motivated and legitimized actions at the county, State, regional, and national scales. RSF meetings have provided the social settings needed to explore what sustainability means for each participant, and they have fostered a fuller and more comprehensive understanding of other perspectives. It is a testimonial to the value of the RSF dialog that similar roundtables have formed in the rangeland and water sectors after stakeholders in those sectors observed

[28] See http://www.fia.fs/fed/us for information about the FIA program and its data products.

the benefits enjoyed by RSF participants. The emergence of additional roundtables has helped to strengthen relationships within the broader community of interests for forests, rangelands, and watersheds in ways that have had positive results for the entire natural resource community.

Despite these successes, we can accomplish more with better dialog in the future. RSF leaders believe that forging closer working relationships among the roundtables would create additional benefits for all the sectors. Since the *National Report on Sustainable Forests—2003* was completed, several important issues have emerged that jointly affect forests, rangelands, and water resources. The time is ripe to form partnerships and create opportunities for multisector dialog focused on common issues.[29]

Open, transparent, public dialogs linking people from different professions, backgrounds, and sectors are already occurring across the country, as highlighted in chapter 3. More than any specific piece of new legislation, management decision, or silvicultural technique, open and transparent dialog among diverse participants offers great promise for building momentum toward achieving the best combination of sustainable forests, sustainable rangelands, and sustainable water resources for the citizens of the United States over the coming decade.

Confronting the Issues

The indicator results in Part II and analyses in previous chapters highlight a number of issues. When thinking about the threats that these issues pose to sustainable forests, three issues rise to the top of the list: (1) loss of forest lands and working forests; (2) forests, climate change, and bioenergy development; and (3) changing forest health and disturbance patterns. These issues have the potential to change the Nation's forests dramatically in the coming years.

Loss of Forest Lands and Working Forests Are Changing Landscapes and Reducing Ecosystem Services

Healthy forests are ecological life-support systems for us. They provide a suite of benefits that are vital to human health and happiness. These include commodity outputs as well as a wider range of benefits, called ecosystem services, which include wildlife habitat and diversity, clean water, clean air, carbon storage, and scenic landscapes. Historically, ecosystem services have been undervalued, considered free "public goods" provided to society by both privately owned and public forests.

All forests "work" by providing ecosystem services, but a "working forest" is one that is actively managed using a forest stewardship plan or similar framework as a guide. Working forests present an opportunity to protect not only the value of ecosystem services but also the economic and community benefits that arise from a forest's production of marketable goods and services. When working forests are undervalued, however, they are susceptible to development pressures and conversion to nonforest land uses. Recognizing the economic and social value of ecosystem services provided by working forests can help promote sustainability and more responsible decisionmaking about whether and how to actively manage a forest. An essential step in achieving sustainable forest management is to ensure that all forest values are sufficiently recognized and that all forests are managed in a purposeful fashion, whether it be for commodity production, the provision of wilderness values, or the range of values existing between these two extremes.

Forest Fragmentation Affects Working Forests

We are chiefly concerned with two types of fragmentation. The first is a reduction in the size of contiguous forest areas. As the size of forest stands grows smaller and as the patches of forest in a landscape become more separated, the integrity and pattern of the landscape changes, which often results in a decreased capacity of the remaining stands of trees to provide ecosystem services. The second type of fragmentation is a social construct often called "parcelization." As the number of private forest landowners in a landscape increases and the existing forest is split into smaller and smaller parcels divided among more owners, the forest becomes more fragmented from a social standpoint. Smaller landowners typically have a different set of interests than do owners of large tracts of forest land (Butler 2008).

The data in this report (Indicator 1.03) describes the current extent of forest fragmentation. Additional evidence also suggests that, as development progresses (Indicator 3.16), forests become increasingly fragmented in both a physical and a social sense. As working forests become increasingly fragmented in a landscape, it becomes progressively more difficult to obtain all the ecological, economic, and social benefits provided by more intact working forests, and it also becomes harder to manage smaller and smaller stands. Addressing the challenges presented by fragmentation will require a concerted effort to preserve

[29] Sustainable bioenergy production is one example of a common issue. Increasing the production of liquid transportation fuels from biomass will require sustainable supplies of biomass and sustainable supplies of water. Forest stakeholders are interested in how the increased woody biomass demands will affect other wood fiber users. Water stakeholders are interested in how the increased water demands for biomass production and conversion will affect other water users. On this issue, both roundtables have interests. Keeping the dialogs separate—or with only a handful of "go betweens"—is likely to be less productive than joining together to discuss their mutual interests.

intact forest areas even in places where development continues to occur, and it will require collaborative mechanisms to help coordinate the activities of diverse forest owners.

Loss of Working Forests Diminishes Ecosystem Services

Although from a national perspective the acreage of forest has varied little in recent years, this obscures the losses and gains that are occurring in specific regions and localities. Suburban expansion into adjoining forests is a leading cause of losses in working forests.

Suburban expansion into forested areas became an increasingly important issue in the last half of the 20th century. Up until the 1880s, most towns and cities were surrounded by a ring of woodland where the trees were managed by frequent and repeated cutting to provide fuel wood for nearby domestic (home heating and cooking) and industrial (steam generation for factories and railroads) uses. A transformative technological change occurred in the 1880s—coal replaced wood as the primary energy source for American society. The working forest that provided fuel wood for more than two centuries was idled, retired, and sometimes abandoned.

A period of benign neglect ensued, during which the forests continued to grow. By the 1950s, many older towns and cities in the eastern half of the country found themselves surrounded by more forests than had existed at anytime since initial European settlement (late 1600s to early 1800s), and they were enjoying many of the ecosystems services the regrown forests provided. The latter half of the 20th century, however, brought major changes in land use that directly impinged on these forests. The rapid expansion of the post-war years—population growth, changing social preferences for single-family homes in the suburbs and commuting to work via an increasingly dense network of highways—changed landscapes everywhere, including the forests in those landscapes. Forests near urban areas declined. In some settings, overstory trees were left standing, but houses, lawns, and streets occupied the understory where once saplings and seedlings had grown, essentially destroying the next generation of working forest. Consequently, many of the ecosystem services provided by forests in suburban areas were lost or diminished despite the fact that a few overstory trees remained.

Today, the magnitude of the loss in essential ecosystem services that forests near urban areas once provided has become evident. In recent years, some localities became so alarmed by the loss of these services that forest and tree retention ordinances were passed. These ordinances required developers to protect existing trees. Some ordinances went further, requiring that forests cleared for houses be replaced through forest restoration plantings elsewhere in the town or county. Another landscape management and forest stewardship tool emerged—conservation easements—where landowners voluntarily give up their rights to develop their property, usually in exchange for a monetary payment from government or conservation groups. In a growing number of landscapes, conservation easements help protect the remaining capacity of fragmented forests to provide some ecosystem services to nearby communities.

In the past several years, some stellar examples have emerged of forward thinking to restore and expand working forests and manage them on a sustainable basis. The work by Baltimore County, MD, described in chapter 3, is the kind of local action that could be emulated in many places throughout the country. Local officials, supported by local interests, created innovative landscape-level stewardship plans and undertook actions to conserve the forests that remained, to restore the forests that needed help, and to reintroduce forests where they had disappeared. The result is a reinvigorated landscape, where forests and the ecosystem services that they support are helping to provide clean water, ameliorate storm water runoff, and boost the quality of life countywide. This model, where the value of working forests is fully considered and actively managed for, is being applied, in various forms and to varying degrees, in other locations.

Lack of Markets for Ecosystem Services Also Plays a Role in Loss of Forests

An important factor contributing to the conversion of forests to other land uses is the fact that markets exist for only a few of the many ecosystem services forests provide. Timber is marketable, but few other ecosystem services, except perhaps hunting leases in some areas, are capable of generating income for landowners. Thus, despite the social value of the ecosystem services that working forests provide, when faced with few income-generating opportunities and annual property tax bills that continue to rise as suburban development creeps closer, converting forests to other uses often makes economic sense to individual landowners even if it is counter to the way in which they want to manage their land.

Therefore, creating viable markets for a broader array of ecosystem services can play an important role in keeping working forests working. Markets are emerging in certain locations to a limited degree (Indicator 6.27). Payments of public funds to landowners for services related to protecting water quality, for example, have been instituted in upstate New York. Elsewhere, some States and localities are using tradable development permits, and conservation easements are becoming increasingly common throughout the country. The scope of this activity, however, remains quite small relative to the immense value that working forests provide or in comparison to the income that real estate development can offer private landowners.

Slowing the Fragmentation and Loss of Working Forests Will Take Local and Regional Actions, Facilitated by National Policy

Because forest fragmentation and loss of working forests occur primarily on private lands close to urban centers, they ultimately must be addressed at the local or regional level. Numerous examples of successful local and State policies exist, ranging from land-use zoning to market mechanisms that reward landowners for forest stewardship. The best of these policies have some common features: they take an "all lands" approach that considers the role of forests in the entire landscape, they consider the full range of values that the forests provide, and they engage stakeholders and communities in discussions.

Government agencies can play several important roles in facilitating the process. One role is simply to provide information on forest conditions and on what has worked in other settings—a function this report is designed to partially fill. Another is to support dialog and collaboration through forums such as the RSF. By providing an array of technical and financial assistance, specific local and regional management efforts can be supported. Also, through the tax structure and targeted incentive payments, the Government can promote sound land management practices and the provision of ecosystem services while avoiding policies that unduly penalize forest owners and lead them to sell or develop their land.

Emerging ecosystem service markets and innovative land management policies do not lead to a single grand strategy to be implemented at the national level. Rather, they suggest a variety of approaches to be taken in different settings depending on particular landscape conditions and on the interests and hopes of local residents and community leaders. There is plenty of room for innovative policy solutions at the town, county, and State levels. Collaboration at these levels with the landscape clearly in view is central to moving along the pathway toward sustainable forests and also to sustainable economies and sustainable communities.

Climate Change and Bioenergy Development Present Both Challenges and Opportunities for Sustainable Forest Management

Climate change can potentially affect forests in a number of ways. The challenge for forest managers, however, is not to simply adapt to changes that may affect the forest. Forests are major carbon sinks; their leaves pull carbon dioxide, one of the principal gasses responsibly for climate change, out of the atmosphere. This ability to clean the air and sequester carbon is a beneficial ecosystem service that can be further enhanced by appropriate forest management activities. Therefore, the challenge becomes one of protecting our forests from the negative effects of climate change while helping them realize their full potential to curb that change.

Climate Change, Forests, and Forest Management Are Strongly Linked in Various and Complex Ways

Climate change has been a target for scientific investigation for 20 years. Each of the past three administrations have had high-level science teams studying various aspects of the issue. Researchers around the world have also been studying climate change. Despite all the research, questions remain about how much and how rapidly climates will change, how soon the changes will become apparent in ecosystems, and how specific landscapes will be affected. Although many uncertainties remain, we need to plan for the possible futures that climate change may bring. Such planning needs to focus on concrete actions and include increased dialog to build the necessary support for these actions. Many of the trees already growing in today's forests will be the ones affected by whatever climate changes occur over the next 75 years.

Rising atmospheric carbon dioxide levels result in increased forest growth, assuming sufficient nutrients and water are available, resulting in more carbon being stored in woody biomass. The more trees there are, the more carbon they can pull out of the atmosphere, offsetting carbon emissions elsewhere and reducing the severity of climate change. A forest's ability to help mitigate climate change effects through increased growth, however, is only one facet of this complex issue. Evidence is emerging that climate changes strongly influence temperature and precipitation patterns, and those changes cause forest disturbances, such as droughts, storms, insect and disease outbreaks, and fires. Although these disturbances are normal occurrences in forested ecosystems, climate changes are altering historic disturbance patterns, frequencies, and intensities. Changing disturbance patterns, in turn, will affect the ability of forests to store carbon.

The ability of forests to mitigate carbon emissions does not end at the edge of the forest. Durable forest products, such as construction lumber, continue to sequester carbon long after the trees from which they are produced are harvested. They can also serve as substitutes for more carbon-intensive products such as steel or concrete. Moreover, energy produced from woody biomass can reduce atmospheric carbon in the long run by offsetting emissions from fossil fuels. Determining the degree to which this actually is the case, however, is not a simple task, because it entails changes in the long-term dynamics of forest ecosystems following management actions as well as the behavior of consumers acting in a market economy.

Forest Management for Climate Change Should Be Adaptive and Take Changes in Forest Carbon Balances Into Account

A fundamental challenge for forest management in regard to climate change is to maintain resilient and productive forests in the face of changing forest disturbance patterns and other stressors while accounting for the change in carbon emissions resulting from management activity. Ideally, by carefully selecting adaptive management activities, landowners and land managers can help forests adapt to climate change; taking advantage of the desirable and reducing the undesirable effects, and maximizing the amount of carbon sequestered in the landscape. At the same time, the goal of maximizing carbon sequestration must be balanced with various other objectives we hold for the landscape. Obviously, this will be a complicated task, and it is unrealistic to think that all owners can or should manage explicitly for carbon sequestration. But consider the success attained over the past 20 years by States and counties in reducing nonpoint source water pollution from construction, agriculture, and forest management activities. Through development and consistent implementation of "best management practices," streams are cleaner. Many hope that markets for ecosystem services, such as carbon sequestration, will soon emerge and begin providing landowners with additional economic returns. In any case, the complexity and evolving nature of this challenge highlights the need for adaptive management strategies undertaken in collaboration among land managers, landowners, stakeholders, policymakers, investors, and the science community.

The Potential for Energy Production From Woody Biomass Presents Opportunities

Using wood for energy is, of course, not a new idea. What is new is the prospect of substantially increasing our use of wood as a substitute for fossil fuels—for electric power and steam generation and as feedstock for liquid transportation fuel. Some of the technologies needed for expanded woody biomass usage are already commercialized, such as burning wood chips to generate steam and electricity. Others are still concepts or at pilot-scale. But the possibilities present a number of opportunities to link forest management, wood products production, and energy production in innovative ways.

Recent Federal Initiatives and Legislation Encourage Biomass Energy Production

Indicator 2.11 reported that the standing volume of wood on forest land available for timber harvesting is 51 percent higher today than the volume available in 1953—a result of a relatively stable amount of forest land available for timber production (Indicator 2.10) and a historic pattern of growth that exceeded removals (Indicator 2.13). In many places, forests have become unnaturally dense and vulnerable to severe disturbances, including unnaturally severe wildfires, insect infestations, and disease outbreaks. To combat this situation, the Healthy Forest Initiative was launched in August 2002, and in 2003, the Healthy Forest Restoration Act was enacted. Among other goals, the Initiative encouraged biomass energy production through grants and assistance to local communities, creating market incentives for removal of otherwise valueless forest biomass from Federal lands. The Food, Conservation, and Energy Act of 2008 also contained several provisions on producing biofuels from woody biomass.

At the same time, some people are becoming increasingly concerned about the implications of these policies for carbon emissions and for other forest management objectives (e.g., Manomet 2010). The debate surrounding the use of woody biomass for energy is beginning to reflect these concerns, complicating the policy environment surrounding wood-based bioenergy.

Increasing the Use of Woody Biomass for Bioenergy and Biofuels Will Create Ripples Through the Landscape, Economy, and Society

Whether the result of increasing prices of fossil fuels, policies to reduce carbon emissions, or improved technologies, the demand for woody biomass and the energy it produces is likely to increase in the near future. This increased demand for biomass will have consequences—positive and perhaps also negative—on sustainable forests and sustainable development.

The potential benefits are numerous, ranging from more jobs in rural areas to increased resources for forest management activities aimed at reducing fire risk and restoring forest health. These are in addition to the benefits all Americans receive from securing an alternative domestic energy source. The negative effects, on the other hand, can be divided into two general categories. The first involves possible effects to existing industries and markets as firms face new competition for raw materials and the resulting price changes work their way down to consumers. These economic effects were evident in the corn market in 2007, when increasing corn ethanol production diverted large quantities of grain away from the food sector, contributing to price increases for grain in markets throughout the world.

Similar consequences for the forest products sector are possible. During the past 3 years, higher prices for and tightening supplies of fossil fuels have led many municipalities and public utilities to study the economic feasibility of converting existing power plants to burn woody biomass and of developing new biomass power plants. Those same studies

have documented the effects of increased competition for wood chips that is likely to occur if new wood-burning energy plants are constructed in areas where pulp and paper mills currently purchase wood chips. Higher prices for woody biomass could stimulate increased timber harvesting, which would mean more jobs in rural America, and it would put more money into the pockets of private landowners. At the same time, it would increase the wood costs and perhaps threaten the continued viability of some forest products mills, resulting in higher prices for consumers and fewer jobs in rural America. Jobs and communities are affected both ways.

As noted previously, however, there exists a large and expanding amount of wood available in many regions for various uses. So supply shortages of wood fiber for energy, papermaking, or similar uses, will most likely be restricted to the regional and subregional levels. The best way to avoid localized shortages is through proactive planning in collaboration with all stakeholders to make sure anticipated future demand for wood fiber is in line with sustainable regional supply. Moreover, energy and traditional wood products are not necessarily competitors; current use of mill residues for heat and electricity generation shows that the production of these different products can be complementary.

The second type of possible negative effect relates to overexploitation of forest resources at the local or regional levels, and the adverse environmental consequences that result. If wood-based energy emerges as a major industry, then careful planning will be needed to align raw material demands with the forest's ability to supply wood while maintaining important ecosystem functions. Here again, possibilities for complementary relationships between energy production and forest management goals exist, with new revenues available to help offset the cost of much needed management activities to restore and enhance forest health.

The bottom line is that there will be opportunities for more intensive engagement by the forest stakeholder community with the energy community to develop and evaluate options that are "win win" for energy, the forest industry sector, and forest health, and resiliency. By working together, solutions can be identified that both improve domestic energy security and sustainable forest management and also protect watersheds and restore healthy forests. Inside the Federal Government, the U.S. Departments of Energy and Agriculture are collaborating on this issue. Now is the time to broaden and deepen the involvement of the sustainable forestry community outside of government.

Addressing Changing Forest Disturbance Patterns Will Require Sustained Commitment and Flexibility

The information in this document demonstrates that increasing levels of forest disturbance are occurring throughout the country (Indicators 3.15 and 3.16). Indeed, the growing incidence of forest disturbances, especially insect induced tree mortality, is one of the clearest and most disturbing signals emerging from this report. Moreover, to the extent that climate change drives shifts in the temperature and precipitation patterns, and through them forest composition, much of the changes in forests will occur through specific disturbance pathways, such as storms, drought-induced fire, or changes in the range and virulence of forest pests. Add to this the increasing number of invasive species, new disease outbreaks, and other pathogens resulting from increased commerce in a global economy, and it is hard to avoid concluding that elevated levels of forest disturbance are likely for the foreseeable future.

Flexible, Adaptive Responses That Work With, and Not Simply Against, Disturbance Processes Are Needed

It is essential to realize that not all disturbances are bad; in many cases, they are an integral part of a healthy forest landscape. In fact, some of the problems currently being experienced in the West come from successful historical efforts to exclude a major disturbance category—fire—from forested landscapes that had evolved and adapted to its presence. Rather than attempting to simply exclude disturbances, what we need are new adaptive management approaches that use disturbances while limiting their most deleterious consequences.

Wildfires provide an excellent example. Completely excluding fires from all landscapes is neither possible nor desirable. Conversely, allowing all wildfires to burn freely is not a viable option either. Lives, property, and essential ecosystem services are at stake. We need to strike a balance between these two extremes through management strategies that are both proactive and responsive to rapidly changing conditions. One strategy that has received growing attention is the creation of defensible space around forested communities through forest thinning and related fuel reduction activities. When combined with the installation of fireproof building materials, such as nonflammable roofs and siding, the result is a greatly reduced risk of major property damage.[30] This strategy enables forest managers more flexibility to use fire as a management tool, either through

[30] See http://www.nifc.gov/preved/protecthome.htm.

prescribed burns or by choosing the places and conditions under which wildfires are allowed to burn, because major risks to life and property have been reduced or eliminated.

Effective adaptive management strategies should be tailored to specific landscapes and the characteristics of disturbance agents. Adaptive management plans should be nimble and flexible to accommodate new information, including new research findings, lessons learned from assessments of previous activities, changes in landscape conditions, and shifts in resident and stakeholder preferences. Especially where important human values or interests are involved, planning for adaptive management should incorporate open and transparent collaborative processes. Admittedly, this is a tall order, but there exists a large and ever-growing set of tools—in forest management, in collaborative planning, and in communications and social networking—that offer promise for meeting this challenge.

Elevated Levels of Forest Disturbance Are Likely for Many Years, so Commitments To Address Them Also Should Be Sustained

The insect outbreaks, fires, and other forest disturbances patterns of today are not aberrations that can be quickly eliminated. Most disturbances are the result of complex dynamic processes whose results play out over the long term. In the face of climate change, development pressures, and globalization of trade, the amount of disturbance likely to be experienced in the Nation's forest will probably increase in the coming decades.

A sustained commitment of attention to disturbances and their contributing factors will be needed, along with a sustained commitment of resources, to achieve significant improvements in forest resiliency and sustain the many ecosystem services that healthy forests provide. Dedicated funding may be needed for programs aimed at managing certain types of disturbances at low levels, where possible, and to respond to the acute disturbance events that will inevitably occur. Continued attention and support for programs to reduce risks may also be needed. For example, research has shown that the risks of southern pine beetle (*Dendroctonus frontalis*) outbreaks can be substantially reduced through an active management program of thinning overly dense stands. Such efforts, however, need to be deliberate and sustained; fluctuations in commitments—attention and resources—may put gains at risk.

Lessons Learned

America's forests played a key role in the economic development of this Nation. During the past 125 years, the forests of the United States have undergone several transformations. Despite the fact that total forest area in the United States has varied less than 5 percent during that period of time, the kinds of forests and where they are located have sometimes changed dramatically.

Looking ahead to the near future, the three issues highlighted in this section—forest fragmentation and the loss of working forests, climate change and bioenergy, and forest disturbances—are this generation's challenges. What lessons can be drawn from recent history to help this generation both meet its current needs while leaving resilient, healthy, productive, working forests; livable landscapes; and vibrant communities for future generations?

Lesson #1: Left Unaddressed, These Three Issues Will Materially Change Forests—Both Here in the United States and Globally

Experience since the 1950s with fragmentation and losses of working forests, particularly to uncontrolled sprawl, shows the undesirable consequences of landscape changes that can result from inattention or ineffective engagement. Although the Forest Service has a longer history and more experience dealing with the loss of working forests, we have little reason to expect that the changes resulting from more plentiful disturbances, climate change, or the unbridled expansion of bioenergy/biofuels industries would not result in similar undesirable consequences. In confronting these issues, the question is, can integrated solutions be designed that create positive outcomes from these agents of change that help keep forested ecosystems healthy, our working forests working, and rural communities and economies vibrant?

It is also important to recognize that forests in the United States represent only 7.6 percent of global forests. Nonetheless, these issues not only affect forests in this country but also forests around the world. Therefore, although it is important to tackle these three issues within this country, it is also important for all members of the U.S. forest community to work with other countries and international organizations to address them at the global scale. A prime example is the Montréal Process Working Group of 12 member countries, which provided the initial impetus for this report.

The good news is that recent successes in several locations where these issues have been addressed offer hope for a more sustainable future. Notably, the use of a criteria-and-indicators approach to forest monitoring and the use of monitoring results to adapt plans and management activities have yielded benefits. Further, successful efforts at county and State levels provide momentum for taking action to shape the future of America's forests in more desirable, more sustainable ways.

Lesson #2: These Three Issues Are Inter-Related; Therefore, Integrated Solutions Are Likely To Yield Better Outcomes Than Individual Solutions

Restoring and maintaining healthy, productive, forested ecosystems can help mitigate climate change. As markets or other incentive programs emerge for increasing carbon storage in forests, they may provide financial incentives for private landowners and public land managers to plant more trees and manage natural stands more actively, leading to more working forests and more ecosystem services in the future.

As long as the value of ecosystem services remains outside of functioning markets, they run the risk of being undervalued and underrepresented in decision and policymaking. We need to create markets and market values for the services that working forests provide to society.

Increased use of woody biomass to generate bioenergy and produce biofuels can help us achieve a successful domestic energy policy and sustainable development goals and also mitigate climate change effects. But the potential also exists that rapid shifts to cellulosic ethanol or wood-powered electricity generation could result in a number of negative effects to both the forest sector and the forest resources upon which it relies. Management for increased production of wood-based energy must be integrated with activities that address these effects in an overall framework that seeks to increase both economic vitality and forest health and resiliency.

Lesson #3: Providing Sound, Comprehensive Information Is Crucial, But It Is Only the First Step in Sustainable Forest Management

Since the initial national report on sustainable forests was published, dialog has improved and decisions were made that moved forests down the pathway toward sustainability. This report chronicles some of those steps and presents more and better information on current conditions and recent trends. But *having* a second report is not nearly as important as *using* this report to build more momentum for action. The steps taken by the forestry community over the next 5 years will ultimately determine the value of this report. The dialog stimulated and motivated by the data in this report and the forward-looking decisions that emerge from that dialog—those are the important outcomes. In other Montréal Process countries, actions based on their second reports will be undertaken and outcomes secured. What will the outcomes be in the United States?

Lesson #4: The Forest Service Cannot Tackle These Issues Alone; Collective Action Is Needed and Collective Action Requires Shared Leadership

The Forest Service is directly responsible for only 25 percent of the forests in the United States—the National Forest System. Other public agencies and private landowners are responsible for the other 75 percent. Because sustainability depends on what happens across the entire landscape, an "all lands" vision is needed. Effective, landscape-level solutions to these issues will require collective action by the entire community of people who value forests and the ecosystem services they provide. Although the Forest Service and State forestry agencies have already begun to address each of these issues, we will succeed more quickly and at more places across the landscape if others join us. The more we can broaden and deepen the dialog and the more open and transparent that dialog becomes and the more people we get to participate, the greater the likelihood of success. Broader and deeper engagement should create the broad-based public support that makes it easier to reach collective decisions and take effective, coordinated actions.

The Forest Service understands that this requires a shared vision and shared leadership. The Forest Service's history of participation in the three roundtables (forests, rangelands, and water) demonstrates its willingness and commitment to shared leadership at the national level. At the regional level, agency leaders are taking steps with partners to practice landscape-scale conservation through activities aimed at restoring forests, protecting and enhancing water resources and watershed health, making landscapes more resilient to climate changes, creating green jobs and a green economy, and elevating community-based stewardship to protect forests.

Hopes for the Future

The year 2011 has been designated as "The International Year of Forests." During this year, special attention and focus will be given to raising awareness and promoting actions aimed at conserving and sustainably managing all types of forests. The year-long global celebration of forests will highlight their importance to people and communities, and the threats forests are facing. What better time than this to move from dialog about the issues facing U.S. forests to the decisions and actions needed to conserve, manage, and use them wisely?

The RSF is well positioned to begin the broader, deeper dialog needed to tackle these issues. Dialog will need to occur on a different stage than just within the roundtable itself, and the dialog will need to be broader than merely collaborating with the other two roundtables.

During the 7 years since the *National Report on Sustainable Forests—2003* was released, the forestry community has witnessed many actions that have made important contributions to increasing the sustainability of our Nation's forests. Landscapes are different today in several areas because of the foresight of people who adopted the tools of forest sustainability and dedicated themselves to sustainable outcomes. Their actions are important demonstrations of the ability of people working together to create positive changes in forests and landscapes. These actions and their results strengthen hopes about what might be achieved in the coming years.

Looking ahead, more actions are needed to deal with the issues identified in this report. The actions must be brisk, in every sense of that word: lively and energetic; keen and sharply focused; and hopeful and effervescent! The actions must not only build momentum for change and for sustainable management of forests within the forest community, but they must also carry that momentum for sustainable management to stakeholders outside the forest community.

The late 1800s were a time of tremendous change in forests and forestry in the United States. In 1872, concerns about timber scarcity—unsustainable uses—led to the first inventory and study of forest conditions and productivity. The American Forestry Association (AFA) was established in 1875 and the First American Forest Congress was held in 1882. Information from the initial study and dialog fostered by AFA and the Congress provided momentum for change—formation of the Division of Forestry in USDA in 1886, and creation of the Forest Reserves in 1891. Those actions, which occurred 130 years ago, set in motion a series of changes in how forests—both public and private—were conserved, used, and protected in the first half of the 20th century. Today, we salute the visionaries who set those changes in motion.

Our actions in the coming 5 to 10 years—to adapt to climate change and the potential for wood-based energy production, to stem the loss of intact forest lands and the ecosystem services they provide, and to maintain forest health in the face of growing disturbances—have the potential to shape for future generations the forests they will have to manage, conserve, protect, and use. Will future foresters and citizens 130 years from now be able to look back at this point in time and say, "Well done!" Will forest historians and policymakers in the early 22nd century be able to point to actions taken now as turning points in the sustainable management of the Nation's forests? We hope so. But it will take brisk action from all of us.

Part II.

Data Presentation

Part II.

Data Presentation

1. Introduction

While the first part of this report focuses on discussions of the broader concept of forest sustainability and its application to U.S. forests, this, the second part, focuses on a more detailed presentation of the data that underlie these discussions. Specifically, Part II presents indicator briefs for each of the 64 indicators included in the Montréal Process Criteria and Indicators set (MP C&I)—the factual data that constitute the nuts and bolts of sustainability reporting.

Part II begins with a brief description of the MP C&I and its component parts, followed by a summary of findings for each of the MP C&I's seven criteria. The remainder and bulk of Part II is devoted to the indicator briefs, each of which is limited to two pages. Many of these briefs contain a wealth of factual information with further data and analysis that could not fit into the format of this document. This information is included in the supporting documentation we have posted on the project Web site (http://www.fs.fed.us/research/sustain/). Other indicators enjoy less exhaustive treatment, either because relevant data are not available, or because the indicator itself is not amenable to concise reporting in this kind of setting. In these cases, we've generally relied more on narrative description.

The main goal in presenting all of this data is to provide a better foundation for assessing the sustainability of our Nation's forests. In many cases, the indicators and their current data are directly pertinent to this task. In other cases, the information is inconclusive or incomplete. Forest sustainability reporting, however, will always be a work in progress, and it is important to continue to struggle with those indicators where we currently do not have adequate data or analysis techniques. Just because something cannot be readily measured does not mean that it is not important to our effort to manage forests sustainably.

Although gauging sustainability is our primary goal, it is important to remember that the information presented here can be used for many other purposes. More than 30 Forest Service, U.S. Department of Agriculture, scientists and collaborators were involved in assembling the information in this report, all experts in their respective fields. As a result, the indicator briefs presented in this report should be seen as windows into broad areas of forest science and research. Moreover, because of the comprehensive nature of the MP C&I and its explicit hierarchical structure, the information presented in this section of the report constitutes a reference resource for forests in the United States that is unparalleled in terms of its breadth and easy accessibility.

1.1 Structure of the MP C&I

The foundations of the MP C&I, how it got started, and the fundamental concepts that guide it are addressed in Chapter 1 of Part I. Here, we merely want to describe the structure of the MP C&I as an aid to access the information in the criterion summaries and indicator briefs that follow.

The MP C&I are comprised of 64 indicators arranged under seven criteria spanning ecological, social, and economic dimensions. Table II-1 displays the entire MP C&I in an abbreviated form with page numbers where the indicator briefs can be found in this report. This important resource allows for easy access to the information included in the indicator briefs, and readers should spend a little time familiarizing themselves with the table.

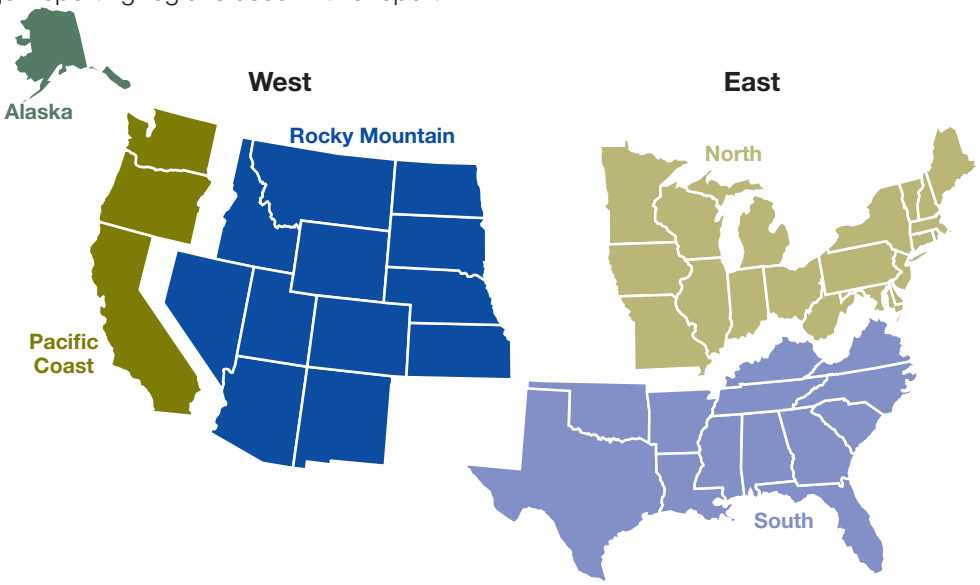
1.2 Organization of the Indicator Information

In the following section, each of the 64 Montréal Process 2010 indicators are arranged under their respective criteria. Each criterion is introduced with a brief description and tabular display of the criterion and its indicators, including their history of revision since 2003. The criterion introduction is followed by the two-page indicator briefs. For most indicators, the briefs include a graphical display of the data, an explanation of what the indicator is and why it is important, a narrative description of what the data show, and, in some cases, an explanation of current limitations in our ability to report on the indicator.

Supporting technical documents for the indicators are available at http://www.fs.fed.us/ research/sustain/.

Where possible, the presentations in this section will provide information on the five major geographic regions depicted below (fig. II-1).

Figure II-1. Major reporting regions used in this report.



In most cases, the statistics presented in this report for the Pacific Coast Region include statistics for Hawaii. Additional statistics for Hawaii will be provided in a separate report on the sustainability of U.S. tropical forests (in preparation). The report on U.S. tropical forests will also include statistics for Puerto Rico, the Virgin Islands, and U.S. Island Territories in the Pacific.

Table II-1. Montréal Process Criteria and Indicators at a glance (1 of 2).

Ind. #[1]	Abbreviated Indicator Title[2]	MP #	Page
Criterion 1. Conservation of Biological Diversity			
Subcriterion. Ecosystem Diversity			
1.01	Area and percent of forest by type.	1.1a	II–16
1.02	Area and percent of forest in protected areas	1.1b	II-18
1.03	Fragmentation of forests	1.1c	II–20
Subcriterion. Species Diversity			
1.04	Number of native forest-associated species	1.2a	II–22
1.05	Number and status of native forest associated species at risk	1.2b	II–23
1.06	Status of onsite and offsite efforts focused on conservation of species diversity	1.2c	II–25
Subcriterion. Genetic Diversity			
1.07	Number of forest associated species at risk of losing genetic variation	1.3a	II–27
1.08	Population levels of selected representative forest-associated species to describe genetic diversity	1.3b	II–29
1.09	Status of onsite and offsite efforts focused on conservation of genetic diversity	1.3c	II–31
Criterion 2. Maintenance of Productive Capacity of Forest Ecosystems			
2.10	Area and percent of forest land available for wood production	2.a	II–34
2.11	Total growing stock and annual increment available for wood production	2.b	II–35
2.12	Area, percent, and growing stock of plantations of native and exotic species	2.c	II–37
2.13	Annual harvest of wood products	2.d	II–39
2.14	Annual harvest of nonwood forest products	2.e	II–41
Criterion 3. Maintenance of Ecosystem Health and Vitality			
3.15	Area and percent of forest affected by biotic processes	3.a	II–46
3.16	Area and percent of forest affected by abiotic agents	3.b	II–48
Criterion 4. Conservation and Maintenance of Soil and Water Resources			
Subcriterion. Protective Function			
4.17	Area of forest whose management focus is the protection of soil or water	4.1a	II–52
Subcriterion. Soil			
4.18	Management activities that meet best management practices to protect soils	4.2a	II–53
4.19	Area and percent of forest land with significant soil degradation	4.2b	II–54
Subcriterion. Water			
4.20	Management activities that meet best management practices to protect water	4.3a	II–55
4.21	Area of water bodies in forest areas with significant change in conditions	4.3b	II–56

Table II-1. Montréal Process Criteria and Indicators at a Glance (2 of 2).

Ind. #[1]	Abbreviated Indicator Title[2]	MP #	Page
Criterion 5. Maintenance of Forest Contribution to Global Carbon Cycles			
5.22	Total forest ecosystem carbon pools and fluxes	5.a	II–60
5.23	Total forest product carbon pools and fluxes	5.b	II–62
5.24	Avoided fossil fuel carbon emissions by using forest biomass for energy	5.c	II–64
Criterion 6. Socioeconomic Benefits To Meet the Needs of Societies			
Subcriterion. Production and Consumption			
6.25	Value and volume of wood and wood products production	6.1a	II–69
6.26	Value of nonwood forest products produced or collected	6.1b	II–71
6.27	Revenue from forest-based environmental services	6.1c	II–73
6.28	Total and per capita consumption of wood and wood products	6.1d	II–75
6.29	Total and per capita consumption of nonwood forest products	6.1e	II–76
6.30	Value and volume of exports and imports of wood products	6.1f	II–78
6.31	Value of exports and imports of nonwood products	6.1g	II–80
6.32	Exports and imports of wood products as a share of production and consumption	6.1h	II–82
6.33	Recovery or recycling of forest products	6.1i	II–84
Subcriterion. Investment in the Forest Sector			
6.34	Capital investment in forest management, forest-based industries	6.2a	II–86
6.35	Annual expenditure in forest-related research, extension, and education	6.2b	II–88
Subcriterion. Employment and Community Needs			
6.36	Employment in forest products sector	6.3a	II–89
6.37	Average wage and injury rates in major forest employment categories	6.3b	II–91
6.38	The resilience of forest-dependent communities	6.3c	II–93
6.39	Area and percent of forests used for subsistence purposes	6.3d	II–95
6.40	Distribution of revenues derived from forest management	6.3e	II–97
Subcriterion. Recreation and Tourism			
6.41	Area and percent of forests available and managed for public recreation and tourism	6.4a	II–99
6.42	Number of visits attributed to recreation and tourism and related to facilities available	6.4b	II–101
Subcriterion. Cultural, Social and Spiritual Needs and Values			
6.43	Area of forests managed primarily to protect cultural, social, and spiritual needs and values	6.5a	II–103
6.44	The importance of forests to people	6.5b	II–105
Criterion 7. Legal, Institutional and Policy Framework for Forest Conservation and Sustainable Management[3]			
Subcriterion. Extent to Which the Legal Framework Supports Sustainable Forest Management			
7.45	Clarifies forest property rights and land tenure	7.1a	II–110
7.46	Provides for periodic forest-related planning, assessment, and policy review	7.1b	II–111
7.47	Provides opportunities for public participation in public policy and decisionmaking	7.1c	II–113
7.48	Encourages best practice codes for forest management	7.1d	II–114
7.49	Provides for the management of forests to conserve a range of values	7.1e	II–115
Subcriterion. Extent to Which the Institutional Framework Supports Sustainable Management			
7.50	Provides for public involvement activities and public education and extension programs	7.2a	II–117
7.51	Implements periodic forest-related planning, assessment, and policy review	7.2b	II–118
7.52	Develops and maintains human resource skills across relevant disciplines	7.2c	II–119
7.53	Maintains physical infrastructure to facilitate forest management	7.2d	II–120
7.54	Enforces laws, regulations, and guidelines	7.2e	II–121
Subcriterion. Extent to Which the Economic Framework Supports Sustainable Management			
7.55	Regulation, investment, and taxation policies	7.3a	II–122
7.56	Nondiscriminatory trade policies for forest products	7.3b	II–124
Subcriterion. Capacity To Measure and Monitor Changes in Sustainable Management of Forests			
7.57	Availability of data and other information for addressing Montréal Process Criteria and Indicators	7.4a	II–125
7.58	Scope, frequency, and reliability of forest inventories and related information	7.4b	II–126
7.59	Compatibility with other countries in reporting on indicators	7.4c	II–129
Subcriterion. Research and Development Capacity Aimed at Improving Forest Management			
7.60	Development of scientific understanding of forest ecosystems	7.5a	II–130
7.61	Methods to integrate costs and benefits into markets, policies, and accounting	7.5b	II–131
7.62	New technologies and the consequences associated with their introduction	7.5c	II–132
7.63	Enhancement of ability to predict impacts of human intervention on forests	7.5d	II–133
7.64	Ability to predict impacts on forests of possible climate change	7.5e	II–134

[1] The indicator reference numbers used in this report differ from those used by the Montréal Process at the international level. Although the MP numbers maintain the C&I structure and hierarchy, they can be confusing and difficult to remember. For this reason, we have opted for a simpler scheme involving the criterion number followed by an ascension number starting at 1 and ending at 64, the last indicator in the MP C&I.

[2] Indicator titles are abbreviated in some cases. See indicator briefs for full title. Each criterion and indicator In the MP C&I are accompanied by an official statement of rationale and suggested measurement approaches. These statements can be found in the Montréal Process Handbook, "Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests," Fourth Edition, October 2009 (http://www.rinya.maff.go.jp/mpci/2009p_4.pdf).

[3] This version of Criterion 7 indicators was recently superseded by a newer, simplified version for use in the next round of forest Sustainability reporting. See Montréal Process Handbook (see citation in note 2 above).

Data Adequacy

Indicator 7.58 provides an overview and tabular display of the coverage, recency, frequency, and data sources for each indicator. As such, Indicator 7.58 spans all of the indicators in the 2010 report and is important both as a general reference and as a specific source of information to address the indicator in question. For this reason, we have allotted Indicator 7.58 four pages instead of the customary two.

2. Summary of Key Findings by Criteria

This section identifies key conditions and trends for each MP Criteria and describes, in general terms, the data and analyses that underlie them. By summarizing by criteria, we are explicitly using the MP C&I as a framework to make sense of the various pieces of information contained in the indicators.

As in the case with the overall summarization of key findings presented in Part I, this summary of findings by criteria involves numerous judgment calls. Readers are encouraged to develop their own opinions and judgments based on the information contained in this report. Previous review comments provided alternative interpretations and assessments of the indicator data and helped us in drafting the final version of this report. This is an example of the public dialog that is an essential part of the process of assessing the sustainability of our Nation's forests.

2.1 Criterion 1. Conservation of Biological Diversity

The MP divides this criterion into three subcriteria: ecosystem diversity, species diversity, and genetic diversity. The indicators in the criterion are organized accordingly, addressing first the extent, conservation status, and structure of different forest ecosystem types; then the number and status of forest-associated species along with related conservation efforts; and, finally, a similar set of indicators describing genetic diversity of forest-associated species. Several of the indicators in the species and genetic diversity subcriteria address "species at risk" in their titles, a category comparable to the concept of threatened or endangered species in the United States but more broadly defined (and lacking the same legal implications).

Current data allow us to present a relatively complete picture of the overall extent of forest ecosystem types and their conservation status. The total area of forests in the United States currently stands at 751 million acres. Overall, this number has been stable to slightly increasing in recent decades. Gains in broadleaved forests in the Southern and interior Northern Regions have been largely offset by declines in forest area in the more developed coastal regions, particularly in coniferous forests.

Although the size of forest area may be relatively stable, the other indicators in the criterion paint a more troubling picture about forest sustainability. Though the data on forest fragmentation presented in this report are not directly comparable to those in 2003, common knowledge and anecdotal evidence strongly suggests that the area of forests impacted by fragmentation has been increasing at a steady rate. Impacted areas include lands on the fringes of major population centers and in rural areas where growth in smaller centers and in the number of second homes continues to drive development and thereby fragmentation. This conclusion is supported by the information on the impacts of housing development on forest area included in Indicator 3.16.

Species richness and genetic diversity of forest-associated species are closely linked to the availability and quality of forest ecosystems. These ecosystems, in turn, are impacted by human and natural forces—such as development patterns, fire suppression, and climate change. As a result, species diversity and healthy populations of keystone species are viewed as crucial indicators of forest sustainability. The indicators covering species richness and genetic diversity do not yield a clear signal regarding changes in richness and diversity since 2003. The inability to compare current data with past data is due in large part to increased sampling intensity resulting in higher species counts and the identification of more species at risk during the past decade (the more you look, the more you find). In addition, changes in richness and diversity are highly variable across geographic regions and general species categories (vascular plants, mammals, birds, and so on), with declines in species counts in some areas or categories being offset by gains in others. Ideally, we will be able to develop more consistent ways of tracking these indicators over time, but changing taxonomy and improved sampling will remain a challenge. Currently, 28 percent of forest-related species have been determined to be presumed or possibly extinct (1 percent), or at risk of extinction (27 percent—includes imperiled, critically imperiled, or vulnerable).

In addition to the indicators in Criterion 1 that describe the extent and condition of forests and their biological components, three indicators in this criterion describe our society's efforts to conserve these resources. Of these indicators, only Indicator 1.2, which measures the area of protected forests, was reported in 2003. The area of forests that are formally protected by government designation totals some 106 million acres; this number has changed little since 2003. At the same time, alternative ways of protecting forests through land trusts and conservation easements have been gaining popularity, accounting in total for

more than 10 million acres in 2005 (http://www.landtrustalliance.org/). This acreage is small relative to the size of the officially designated protected areas, but it is an important addition to the U.S. portfolio of protected forest lands and has been growing rapidly. Indicator 6.27, which tracks payments for ecosystem services, including conservation easements, provides more information on this topic.

Indicators 1.6 and 1.9 describe U.S. efforts to conserve species and genetic resources respectively. These indicators are new, and, because they cover a broad spectrum of activities on the part of the Government, academia, and the private sector, they are not easy to measure. The information presented for these indicators in Part II provides a picture of the breadth of current activities in this area, ranging from experimental forests and wildlife conservation areas to zoos and seed banks. It does not, however, indicate whether these activities have increased, nor does it answer the crucial question of whether they are adequate to help secure the sustainability of biological diversity in our forests. Future editions of this report should be able to better answer these questions.

2.2 Criterion 2. Maintenance of Productive Capacity of Forest Ecosystems

Criterion 2 addresses the ability of the Nation's forests to continue to provide raw materials for the wood products industry and nonwood forest products for sale and personal use. This criterion has five indicators. The first three indicators track traditional measures of timber production capacity, and the last two track measures of harvest of timber and nonwood forest products, respectively. The data presented in this criterion generally support the conclusion that our current use of the Nation's forests is sustainable from the perspective of timber production capacity; the area of timber land is stable and timber stocking on these lands has been increasing. In the case of nonwood forest products, the data are not sufficient to reach a definitive conclusion about the sustainability of productive capacity.

Capacity for timber production. Timber land is defined as the potential area of forest land available for, and capable of wood production. As is the case with forest land, the area of timber land in the United States has been very stable during the past 50 years. It currently stands at 514 million acres (69 percent of all forest land). The highest concentration of timber land is in the Southern Region,[31] where 95 percent of the forest is classified as belonging to this category. A similar percentage of the Northern Region forests are also timber land, but the total area of timber land there is 20 percent less than in the South. Smaller amounts of timber land are located in the Rocky Mountain and Pacific Coast Regions, where, because of lower stocking and productivity (notably in the Rocky Mountain Region) and more area in higher protection categories (see Indicator 1.2), the proportion of timber land to forest land is relatively less. Alaska also has considerable forest lands, but only 7 percent is classified as timber land because of low productivity and relative inaccessibility.

Ten percent of U.S. timber land is classified as mixed forest. The remainder is either predominantly conifer or broadleaf forest types, with the former constituting the overwhelming majority of timber lands in the western half of the country and the latter found mostly in the eastern half. Of conifer forest types in the East, 41 million acres (44 percent) of the 93 million acres are of planted origin, mainly in the South.

In contrast to the stable area of timber lands, timber growing stock volume on these lands has steadily increased during the past 50 years, reaching a current level of 932 billion cubic feet—51 percent higher than that reported in 1953. Most of this increase was in the Northern and Southern Regions. As a result of initially high-stocking volumes in mature stands and continued harvest offsetting growth in younger stands, The Pacific Coast Region saw only a 4-percent increase in growing stock during the past five decades.

Currently, 63 million acres of planted timber lands exist in the United States, consisting mainly of pine plantations in the South. The small proportion of planted land relative to total timber lands (only 12 percent) belies their importance as a timber resource. Planted lands play a large role in current and anticipated future supplies of timber because of their high growth rates, easy operability, and overall intensity of management, and, as a result, the South is expected to continue to serve as the major U.S. timber producing region well into the future. Since 1982, more than 2 million acres have been planted annually, virtually all with native species. A significant percentage of the planted conifer seedlings also come from tree improvement programs emphasizing superior growth grades, form class, and disease resistance. It should be noted, however, that the rate of new plantings has declined significantly in the South and elsewhere since its peak in the 1980s.

The South supplied 62 percent of all timber removals in 2006, up from 49 percent in 1953. On public lands in the West, where timber management has been sharply curtailed in recent

[31] Where possible, we have used the major regions depicted in figure II-1 (page II-2), although data considerations have sometimes required different regional definitions.

years, removals have declined from 4.4 billion cf in 1976 to 2.8 billion cf in 2006, a fall of 35 percent. Net growth in timber stocks currently exceeds harvest by a considerable extent in all regions of the United States.

Although increasing timber stocks indicate that the United States will not be running out of wood anytime soon, mounting evidence suggests that the intensity of forest management for timber production is declining. This decline is perhaps most clearly evident in falling rates of plantation plantings. The sale of timber lands by forest management companies to real estate investment trusts and similar entities is cited as a major factor in this development, and these trends are exacerbated by low stumpage prices arising from a surfeit of available wood fiber and growing wood products imports. This situation has certainly not been improved by the recent recession. Although not immediately apparent in gross statistics on growth and harvest, the potential effect of declining management intensity on our ability to supply our needs for timber in the coming decades bears watching.

Nontimber forest products. The indicators in this criterion that track timber production capacity benefit from an extensive and well established set of statistics, primarily from the Forest Service's Forest Inventory and Analysis (FIA) program. Nontimber forest products (NTFPs) do not enjoy the same statistical foundation.

The data we do have indicate that NTFPs represent a major source of economic activity and value from use for many people. In 2006, more than 14,000 permits and contracts were issued for the collection and consumption of food and forage plants on national forests and Bureau of Land Management (BLM) properties. Approximately 156,000 pounds of fruits and berries, 468,000 pounds of mushrooms and other fungi, more than 7,000 tons of decorative foliage, and over 2,000 tons of forage were harvested and/or consumed using these permits. Since 1998, the number of permits and contracts issued has increased by 65 percent Although data on the volume of NTFPs harvested on private land is lacking, a 2006 survey of private forest landowners indicated that nearly 10 percent of the estimated 10 million private forest landowners collected edible plants, nuts, and berries either for sale or personal consumption. During the past three decades, an estimated 2.7 million pounds of ginseng have been harvested from eastern hardwood forests.

2.3 Criterion 3. Maintenance of Ecosystem Health and Vitality

Criterion 3 measures forest disturbance processes and contains only two indicators. The first (Indicator 3.15) addresses biological processes, such as insect infestations and the influx of invasive species, that can affect forest health, and the second (Indicator 3.16) addresses physical processes, such as fire and storms, that likewise affect forests. The relatively small number of indicators, however, is no indication of the relative importance of this criterion. The processes described here have a crucial effect on the health, character, and extent of forest ecosystems and are, thus, closely linked to all the other indicators contained in this report.

In many cases, forest disturbances—both biological and physical—can be seen as leading indicators foreshadowing changes in the distribution of forest ecosystem types across the landscape. Disturbances also affect the ability to provide an array of valuable goods and services, whether traditional commodity outputs like timber or livestock forage, ecosystem services such as water purification and streamflow regulation, or more intangible values such as aesthetic character or species habitat. The indicators in this criterion may register major changes that are not yet apparent in the other indicators describing the biophysical characteristics of forests and their associated values and outputs. Moreover, to the extent that climate change will affect our forests, these effects will likely first be clearly apparent within Criterion 3.

A certain level of disturbance is natural in healthy ecosystems. The real question is not the absolute level of disturbance, but whether it represents a significant departure from the background, or "natural," level of disturbance for a given ecosystem. For this reason, the MP C&I definitions for both Indicators 3.15 and 3.16 stipulate "reference conditions" against which current levels of disturbance are to be measured. Of course, determining valid reference conditions can be a difficult and controversial undertaking. The strategy used in this report is to identify the average measures for the 1997-to-2002 time period as the reference and analyze current measures accordingly. This approach is not without its problems, since the 1997-to-2002 reference period may not represent a natural or sustainable level of disturbance. Because of fire suppression activities throughout much of the past century, for example, fire incidence in many of our forests is less than occurred before suppression, and, as a result of accumulated fuels, fire intensity is higher today in many fires that do burn. So the reference conditions should be taken merely as benchmarks for comparison and not as targets representing an ideal situation.

The findings for the indicators in this criterion point to a substantial increase in the levels of biotic disturbance and an increase in fire extent and intensity relative to the 1997-to-2002 reference period. In the lower 48 States, cumulative total forested area with notable mortality due to biotic agents has risen to 37 million acres, compared to the reference condition of 12 million acres. Bark beetle, engraver beetle, and gypsy moth are the leading contributors to this increase, along with increasing mortality in the pinon-juniper forest type. When defoliation

is taken into account alongside mortality, the number of acres affected since 2003 rises to 50 million, or 8 percent of forest area in the lower 48 States.

The growing incidence of nonpathogenic invasive plants and animals likewise threaten forest health, although here the effects are not registered in terms of forest mortality so much as changing species distributions. Aside from radically altering forest character and displacing native species, these invasive species can predispose forest stands to other types of disturbance such as insect infestation and fire.

Drought and the increasing density of forest stands, because of tree growth and fire suppression have been cited as important factors undermining forest health and thereby the ability of trees to resist insects and disease. Another factor may be the increased senescence of shorter lived species, such as lodgepole pine (*Pinus contorta*), which are now reaching older ages in the absence of traditional disturbance agents such as fire. In the future, climate change may further complicate the picture, as water availability, precipitation patterns, and the ranges of certain insects and pathogens are expected to change. The causes and possible effects to forest ecosystems are complex, and many of the processes themselves can be considered natural, even if they are in response to anthropogenic changes such as fire suppression or climate change. Therefore, the implications of these changes for sustainability are difficult to determine both in both a conceptual and a practical sense. What is clear, however, is that the findings for Indicator 3.15 point to a major increase in biotic forest disturbance with the potential for broadscale impacts, many of which society will likely find undesirable.

For most forest ecosystems, fire is the most important abiotic (nonbiological) disturbance category in Indicator 3.16. Other disturbance factors considered in the indicator include weather damage, damage from airborne pollutants, and impacts from human development. Climate change is also identified as a potential abiotic disturbance factor, but there are numerous specific pathways through which it can affect forests, including biotic disturbance agents alongside more direct paths such as drought and fire. This fact brings up an important point: disturbance factors are often linked through various biophysical processes, and evidence of one type of disturbance may indicate the presence, or probable future occurrence, of other types of disturbance. Catastrophic fire following insect induced mortality is a common example of this.

Fire. The findings for Indicator 3.16 point to an increase in fire extent and intensity relative to the 1997-to-2003 time period. Current fire levels are significantly less than those witnessed before the advent of broadscale fire suppression efforts in the first half of the last century, but the fires that do burn are likely more intense, and, without significant forest management efforts, the number and extent of fires are likely to continue to increase in the future. Increases in biotic disturbance and mortality documented in Indicator 3.15 support this conclusion.

Weather. Weather-related damage has also increased significantly relative to the reference period, rising from approximately 800 thousand acres to nearly 1.8 million acres during the past decade. Most of this is related to a roughly 10-fold increase in the forest area affected by drought, and this, in turn, may foreshadow increases in other disturbances, such as fire and disease, to which drought-stressed trees are more susceptible. Storm damage is another aspect of weather disturbance that is locally significant though not all that visible in national level statistics.

Pollution. Little direct evidence exists linking airborne pollution to widespread forest mortality or decline at the regional scale, but this does not necessarily mean pollution is not a problem; it is just hard to identify and may be more clearly seen in other indicators such as Indicator 4.19, which addresses soil degradation.

Development. Human development impacts a growing area of forest land. In 2000, the past year for which consistent data were available for this report, our development footprint (meaning affected area) accounted for more than 13.3 percent of total land area in the United States, up from 10.1 percent in 1980. This expansion significantly exceeds population growth, and it has no doubt continued since 2000.

Climate Change. Climate change will potentially affect forests in numerous and complex ways. Some of these are identified in the analysis of Indicator 3.16. But as yet little data exists documenting these effects or providing direct evidence that climate change is the proximate cause.

2.4 Criterion 4. Conservation and Maintenance of Soil and Water Resources

Soil is a major building block for healthy forest ecosystems. Water, in addition to being a limiting resource determining forest type and vitality in many areas, often constitutes a valuable forest output for downstream users. These two substances, although perhaps not as visible as the trees, plants, and animals considered in Criteria 1, 2, and 3, are nonetheless crucial components in understanding forest ecosystems and their sustainability.

Soil and water are closely linked through the processes of erosion and sediment transfer. As a result, indicators of watershed condition often treat the two simultaneously, and forest management activities aimed at water quality and flow

regulation usually have a strong soil conservation component. This linkage is clearly evident in our reporting for the indicators in this criterion.

The five indicators in Criterion 4 measure the current condition of soil and water resources in our forested ecosystems on the one hand, and our management actions designed to conserve these resources on the other. As such, they draw on qualitatively different data sources and analysis techniques. Indicators 4.19 and 4.21, which respectively measure soil degradation and physical changes in forest streams, rivers, and lakes, rely on direct observations of biophysical conditions or inferred measurements modeled on these direct observations. Indicators 4.17, 4.18, and 4.20, on the other hand, measure forest areas subject to certain land use designations or management practices. The first set of indicators provides a direct measurement of actual conditions—the second a measure of our efforts preserve and enhance these conditions.

A recent expansion of the Forest Service's Forest Inventory and Analysis program (FIA) to include certain types of soils information has allowed us to more fully report on forest soils conditions for Indicator 4.19 in this report. We cannot yet determine trends over time, but we can point to regional differences and areas of concern. In this regard, the Northern and Southern Regions both contain substantial areas of degraded or otherwise suboptimal soils, to a degree that substantial negative impacts to certain forest ecosystems may result. Acid rain from airborne pollutants is cited as a factor underlying this degradation. Whether these conditions mark a deterioration or improvement relative to the past is not yet clear, but we will be able to determine this in the future with continued reporting for this indicator.

Indicator 4.21, which measures water conditions in forested ecosystems, does not benefit from the same systematic sampling that provides the soils information in Indicator 4.19. Instead, we have used State-level water quality reports that are reported biennially to the U.S. Environmental Protection Agency (EPA) by the States. This information does not allow for a direct measurement of water conditions, but it does identify the sources the water degradation as perceived by State reporting agencies. The indicator finds that municipal and industrial development is the largest cause of water degradation in the United States. Forestry activities, on the other hand, account for the least amount of damage of all sources identified—about one-tenth of the impairment attributed to development activities. These results, however, do not shed much light on conditions and trends in water quality in forest streams and lakes, the intended focus of the indicator. Here, as in many other cases, we are limited by the data on hand, and significant improvements in reporting can be hoped for in the future if water quality monitoring in forest areas can be expanded and improved.

Indicators 4.17, 4.18, and 4.20 focus on management practices and land-use designations designed to protect soil and water resources. Because a strong biophysical linkage exists between soils and hydrological functions, conservation land-use designations and best practices for forest management usually combine soil and water conservation objectives. For data, these indicators rely largely on State level reports of management activity and land-use designations. The lack of consistency in these reports presents considerable challenges in addressing the indicators. None of these three indicators were included in the 2003 report, and relevant comparisons could not be drawn with past activities to determine significant trends. We hope to improve on this situation in future reports, but the lack of consistency in the underlying data streams will continue to present challenges. In any case, the importance of intact forest ecosystems in conserving soil and water resources is widely recognized, as evidenced in forest practice regulations and watershed rehabilitation efforts across the United States.

2.5 Criterion 5. Maintenance of Forest Contribution to Global Carbon Cycles

Criterion 5 describes stocks and flows (pools and flux) of carbon in forested ecosystems (Indicator 5.22) and forest products (Indicator 5.23) along with avoided carbon emissions from the use of forest biomass for energy (Indicator 5.24). As such, the criterion provides valuable information regarding the current and potential role of forest management efforts in offsetting or otherwise mitigating carbon emissions from fossil fuels and associated sources. It also provides an indication of how broadscale ecosystem processes may mitigate or exacerbate carbon balances, and thereby climate change, in the long term.

Indicator 5.22 relies directly on FIA forest inventory data. The process by which these data are translated into carbon stocks for various components (live biomass, forest soils, and so on) involves a number of assumptions and modeling techniques, which continue to be developed and refined over time. The inclusion of carbon stocks in forest soils, which were omitted in the 2003 report, is a major innovation in the current report.

According to Indicator 5.22, forested ecosystems in the United States currently contain an amount of carbon equivalent to more than 165 billion metric tons of CO_2, a figure close to 27 times the 5.9 billion tons of CO_2 emitted nationally every year through the burning of fossil fuels and similar sources. Live trees and forest soils account for the bulk of forest-based carbon stocks. In terms of flows, forests sequester approximately 650 million metric tons of additional CO_2 every year, offsetting close to 11 percent of total U.S. annual carbon emissions. This rate of sequestration has been relatively stable for several decades, reflecting the long-term increases in forest volume described in Criterion 2.

Indicator 5.23 measures carbon stored in forest products, underlining the important fact that many long-lived forest products continue to sequester carbon long after the trees that supplied their raw materials have been harvested. The indicator shows that a carbon equivalent to around 8 billion metric tons of CO_2 are currently stored in long-lived forest products and in discarded forest products in landfills. Annual rates of sequestration are approximately 100 million tons, substantially less than 650 million tons annually sequestered by forests but still a significant number. As in the case of Indicator 5.22, Indicator 5.23 measures broad processes, although in this case social rather than ecological. Major variations are not likely in the short term, except in so much as they are driven by major changes in overall economic activity (such as the recent recession). Over the long term, the indicator will provide information on major shifts in consumption patterns and their relative effects on carbon stocks and flows, and thereby the role of forest products in global carbon balances.

Using forest biomass to produce energy is another means by which forests may help mitigate greenhouse gas (GHG) concentrations in the atmosphere. Indicator 5.24 measures avoided carbon emissions resulting from the replacement of energy from fossil fuels with that generated by the use of forest biomass. Although this process releases the carbon stored in the biomass, it is assumed that the subsequent regrowth of forests will sequester an equivalent amount over time and, thus, the process is considered to be carbon-neutral (at least in the long run). This is a simplification of a complex argument, but it is nonetheless broadly accepted that replacing fossil fuel consumption with energy from forest biomass will result in reduced carbon emissions in the long term.

The indicator shows that annual production of energy from the combustion of wood in the United States is around 2,100 trillion BTUs (British Thermal Units) (about 2 percent of the 101 quadrillion BTUs consumed in 2007). When converted to avoided carbon emissions, this number translates to between 100 and 200 million metric tons of carbon depending on the energy source used for comparison. Contrary to what one might expect, this number has been slightly falling since the mid-1990s, but the result is less surprising if one considers the fact that the use of fire wood for heating purposes has been declining for decades and that the wood products industry has long used wood residues and byproducts to generate energy as part of its production processes. Consequently, Indicator 5.24 may be tracking developments in these more traditional uses more than measuring the emergence of a nascent bioenergy sector. To the extent that forest-based bioenergy becomes more important in the future, this trend may be reversed in subsequent reporting cycles.

2.6 Criterion 6. Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits To Meet the Needs of Society

While Criteria 1 through 5 mostly describe biophysical conditions in our Nation's forested ecosystems, Criterion 6 covers a broad range of factors associated with social and economic benefits that are closely linked to forested ecosystems, their health and their management. The criterion includes 20 indicators divided into five subcriteria. These are:

1. Production and consumption
2. Investment in the forest sector
3. Employment and community needs
4. Recreation and tourism
5. Cultural, social, and spiritual needs and values

Each will be summarized in turn below.

Production and consumption. Indicators in this subcriterion track changes in the provision of traditional wood and paper products, nonwood forest products, and, various ecosystem services.

Information on traditional wood products is largely available from the U.S. Department of Commerce, including the Census Bureau's periodic Economic Census and annual Survey of Manufacturers, which provide periodic or annual data sometimes at the State level.

Nontimber forest products, on the other hand, encompass a broad array of forest herbs, mushrooms, and related products that are not tracked in standard industrial reporting statistics—with the exception of some trade statistics—and are not always fully integrated into the cash economy. Reporting in this category is significantly more challenging. Nevertheless, through the compilation of data not available to the 2003 report, we have substantially improved our reporting for products in this category.

A new indicator (Indicator 6.27) tracks revenue derived from ecosystem services such as water quality enhancement, carbon storage, or the provision of green-space. The work presented in relation to this indicator lays the foundation for future reporting by defining terms, identifying sources of quantifiable data, and explicitly recognizing activities that are not captured by these data.

The indicators covering timber and wood products (Indicators 6.25, 6.28, 6.30, 6.32, and 6.33) show that both timber harvest and wood products production are down slightly relative to 2003. At a little more than 20 billion cubic feet, consumption

has remained relatively stable, although levels dropped off in 2006 when the housing construction market slowed. More severe effects reflecting the recent crises in the housing market can be expected, but it is unclear whether these changes will manifest themselves simply in a temporary downturn or in a long-term shift in consumption and production patterns.[32] The long-term impact of the recession will be something to watch for in the next iteration of this report, anticipated in 2015.

The difference between production and consumption has been filled increasingly by imports, which now total 5.4 billion cubic feet, or 26 percent of total consumption. The recovery of recycled paper products has also increased its contribution to fiber supply in the United States. The total volume of recovered fiber now equals about one-half of total domestic paper consumption. A growing proportion of recycled paper is exported, however, so domestic use of recycled fiber in paper products has remained stable at about 38 percent for the past decade. Most of the developments described here follow long-term trends established in the last decades of the past century.

Production and trade figures for nontimber forest products (Indicators 6.26, 6.29, and 6.31) present a more complicated picture. Although the total value of production in this category is down 30 percent relative to 1998, exports are up 38 percent since 2003. Much of this may be related to difficulties in measurement and the dominant role of specific products (e.g., fuelwood in the case of production and pecans in the case of exports). In any case, the values reported for these indicators in 2007 are substantial, with a total estimated retail value of production of $1.4 billion and exports exceeding $450 million.

Payments for environmental services are also substantial. The indicator identifies payments of $553 million for ecosystem services in 2007 from public and private entities, but it also stresses the fact that these estimates are incomplete. While Federal payments have been relatively stable, payments from private entities in the form of carbon offset purchases, conservation easements and outright land purchases for conservation objectives are growing rapidly, increasing 38 percent in the past 3 years alone and now accounting for more than one-third of total payments identified in this report.

Investments in forestry and the forest sector. This subcriterion contains two indicators that call for measures of investments in forest-related economic sectors, and in research and education, respectively. These indicators point to investments whose effects will play out over many years, and, consequently, they constitute two of the most forward-looking indicators in the entire Montréal Process indicator set.

Indicator 6.34 includes both private sector and public sector investments in productive capacity (e.g., buildings and machinery) and forest management activities. Private sector capital investments in the wood products industry are extremely volatile, following both broad market cycle fluctuations and developments specific to the wood products sector. Investments in the wood products and pulp and paper sectors totaled $10.9 billion in 2006, up from $7.5 billion in 2003 but still substantial lower than the $13.6 billion reported for 1997 (all figures are in constant 2005 dollars). Indicator 6.34 also tracks substantial investments in silviculture, forest management, and recreation management on the part of public agencies like the Forest Service. These public investments are driven by the political process and have been much more stable than the private sector investments listed above.

Investments in research, extension services, and education (Indicator 6.35) rely primarily on public sources for their funding. Forest Service research expenditures and academic research funding from Federal sources are the primary investment streams reported for this indicator. Overall, research funding in these categories totaled $608 million in 2006, an increase of 18 percent in inflation adjusted terms since 2000. These expenditures, however, are only one piece of a larger pie involving State, local and private investments in research and extension.

The number of baccalaureate and post-graduate degrees are a measure of investment in human capital, and, in contrast to research funding, these numbers have declined from 2,263 to 1,810 degrees in the 2001-to-2006 time period, but this may represent a shift to environmental studies and similar programs rather than an absolute reduction in scholarship and training related to forest resource management. The sustainable management of forests can benefit from both areas of training. The decline in forestry-specific degrees, however, may carry important implications for future management of forests for timber production.

Employment and community needs. The indicators in this subcriterion track economic and social developments that directly affect individuals and communities that depend on forests for their livelihood and important aspects of their quality of life. They include economic measures such as employment and income in the forest sector, which are generally available from standard statistical reporting sources, but they also include more complex indicators involving concepts of community resiliency, wealth distribution, and the amount of resources available to support subsistence activities.

[32] The recession that begun in 2008 is addressed more fully in Chapter 2 of Part I.

Employment in the forest sector, measured in Indicator 6.36, includes a broad range of activities. Major categories covered in this report include public agencies engaged in forest management activities at the Federal and State levels (data for counties and municipalities, although certainly important, was not available for this report), employees in the solid wood products and paper products sectors, and workers in the forest-based recreation sector. Forest products industry employment, which currently stands at 1.3 million employees, decreased by about 15 percent since 1997, with much of the drop concentrated in the pulp and paper sector. This decline reflects stable to slightly declining production levels (see Indicator 6.25) in combination with increasing labor productivity requiring fewer workers to produce the same quantity of goods. Once again, the recent recession has no doubt exacerbated these declines. Public sector forest management employment is about one-tenth of that in the forest products sector and has been relatively stable with the notable exception of the Forest Service, which has declined to around 23,000 employees from a recent peak of 31,000 in 1991. The 2003 report estimated that forest-based recreation directly generated 1.1 million jobs, and it is assumed that this number has grown along with recreation participation in the intervening years.

Private sector wages in these major employment categories (Indicator 6.37) have generally been increasing, but at a relatively slow rate, especially in the lumber and wood products sector, where wages are currently well below the United States average for all manufacturing. Public sector wages have fared better in recent years. Injury rates in the wood products industry have continued a long-term decline with the exception of the furniture industry, which has experienced an uptick in the past few years—a development that bears watching.

Indicator 6.38 addresses the resilience of forest-dependent communities and is the only indicator that directly assesses community conditions and well-being. This complex indicator requires considerable effort both in conceptual development and in practical application. In 2003, we used county level census and employment data to develop indexes for vitality and adaptability. Although this was a logical and cost-effective approach, it was widely deemed inadequate for capturing the many dimensions that characterize the well-being of forest-dependent communities. Also, counties proved to be a poor surrogate for communities. For the revised indicator (the concept of resiliency has been substituted for vitality and adaptability in the indicator title), the 2010 report has taken a different tack, relying on survey and community assessment techniques to characterize the resiliency of individual communities. The work presented in this report is a pilot effort, and, although survey and analysis protocols have been developed, only five sample community assessments were available for inclusion in this report.

The remaining two indicators in this subcriteria address the area of forests devoted to subsistence use and the distribution of forest-derived revenues (Indicators 6.39 and 6.40, respectively). Subsistence use of the forest typically includes hunting, fishing, and gathering for personal consumption, but for many users, particularly in the Native American community, it also denotes a lifestyle involving a deep connection to nature and cultural traditions. This is in addition to tangible economic benefits in terms of foregone purchases of food and similar items. As with several of the other MP indicators that call for measures of forest land devoted to specific activities, providing quantified measures for the subsistence indicator is complicated by the fact that much of the Nation's public access forest lands are designated for multiple use, including, but not restricted to, subsistence activities.

Indicator 6.40, the distribution of forest-derived revenue, is a new indicator. In this report, we identify the major revenue sources as coming from wood products industry activity and from the sale of "stumpage," or standing timber. Major recipients of forest-derived revenue include industry (via profits), labor (wages), government (taxes), and landowners (stumpage receipts). Payments to labor and nonindustrial landowners comprise most of revenues and come from the wood products industries and stumpage sales respectively.

Recreation and tourism. Recreation and tourism is a major and increasing use for the Nation's forests. It provides direct benefits to citizens, contributes to a diverse and growing industry, and fosters appreciation for the importance of conservation and sound stewardship. The two indicators in this subcriterion track the availability of forest land for recreation activities (Indicator 6.41) and the number and type of these activities (Indicator 6.42).

Almost all U.S. public forest lands are available for a broad range of recreational activities, with some restrictions on uses that adversely impact the environment or the experiences of other users. Currently, 44 percent of forest land is in public ownership, much of it in Federal custody in the Western States. The remainder is in private hands, where family and individual ownerships predominate. Indicator 6.41 estimates that only about 15 percent of family forests are available to the public for recreation, and this number has been falling for at least the past two decades. Although the area of public forest lands have increased to a very slight degree since 2003, the falling percentage of private lands that are accessible for recreation use points to an overall decline in forest land available to recreation. This is increasingly important in the Eastern United States, where private forest lands predominate and large population centers mean higher demands for outdoor recreation activity.

At the same time that available lands for recreation are decreasing, recreation use has been rapidly increasing. As shown in Indicator 6.44, the number of recreational activity days has increased by 25 percent since 2000 and currently stands at 83 billion days. The number of people participating in these activities has increased at a slower pace—4.4 percent. An estimated 217 million people have participated in forest-based recreation activities in 2007 (both of these measures have specific definitions that need to be considered when comparing them with other measures—see the data report for details). Walking for pleasure and nature viewing are the most popular activities, and most of these occur on public lands.

Chapter 1 of Part I noted a growing alienation of urban populations, particularly the young, from forests and forest-based activities as one of the underlying forces driving forest policy and sustainability. The recreation numbers presented here do not provide explicit evidence of this shift, but major changes related to population demographics and cultural values take a long time to occur. Many of the indicators in Criterion 6, and the recreation indicators in particular, will provide an initial indication of the effects these potential changes will have on forest management and use.

Cultural, social, and spiritual needs and values. While the other subcriteria and respective indicators in Criterion 6 mostly measure specific outputs, values, and activities associated with forest ecosystems, the two indicators in this subcriteria seek to address the more intangible values and attachments people have to forests.

Indicator 6.43 calls for the measurement of land area protected specifically for cultural, social, and spiritual values. In this report, however, it simply measures the total amount of forest land in protected status of all types in the United States. The logical connection between protected status and cultural, social, and spiritual values lies in the fact that many people view natural landscapes as a source of spiritual renewal and their conservation as a transcendental goal. The indicator shows only a slight increase in protected public lands since 2003, but it also notes the rapid increase in protected private lands through mechanisms such as conservation easements and outright purchase (see Indicator 1.02 for additional information).

Indicator 6.44, a new indicator, seeks to measure the importance of forests to people. It involves considerable challenges both in conceptual development and in actual measurement. The pilot approach explored in this report relies on survey techniques to assess the various dimensions of people's relationship to forests and the importance they attach to them. Because of the difficulty in obtaining a truly representative sample, the team tasked with addressing Indicator 6.44 opted for a focus group approach, and has conducted some 30 focus groups as of this writing. Results highlight the diversity of feelings people have for forests, and the fact that these are largely determined by cultural background.

2.7 Criterion 7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

Criterion 7 contains 20 indicators and addresses the crucial question of whether current legal, institutional, and economic structures are adequate to sustainably manage the Nation's forests. Most of the indicators in the criterion, however, are not amenable to concise quantified measurement. Characterizing national trade policies in terms of their affect on forest sustainability, for example, entails an analysis framework and synthesis of information more appropriate to a full research paper than to a limited set of numerical indicators presented in a two page brief. Consequently, much of the indicator development for Criterion 7 in the 2003 report relied on separate narrative assessments that identify key concepts and policy components, but had little in the way of quantifiable information and were difficult to update in a consistent fashion.

For the 2010 report, we have used a more systematic approach, applying a common framework for analysis across all of the indicators in the criterion. This framework characterizes the various policy elements covered by the indicators in terms of their scale (e.g., national or local); their mechanisms (e.g., command-and-control or market-based); and their approach (e.g., process-based or outcomes-based). This framework has lead to a more integrated approach entailing more front-end theoretical development than the other indicators, as described in the introduction to Criterion 7 indicator briefs.

The application of this approach to Criterion 7 indicates that a wide variety of legal, institutional, and economic approaches exist that encourage sustainable forest management in the United States, at all levels of government. Public laws govern public lands, which comprise about one-third of the Nation's forests. They dictate management and public involvement in various specific ways. Federal and State laws also provide for technical and financial support, research, education, and planning assistance on private forest lands. Federal and State environmental laws protect wildlife and endangered species in forests on all public and private lands, and foster various levels of forest practices regulation or best management practices to protect water quality, air quality, or other public goods depending on the State. Private markets allocate forest resources on most private forest lands, and market contracts for goods and services, or cost minimization at least, are integral parts of forest management on public lands. Many new market based

mechanisms, including forest certification, wetland banks, payments for environmental services, conservation easements, and environmental incentives are also being developed to implement sustainable forest management in the United States.

Ideally, the new approach taken in addressing Criterion 7 will help us develop a better understanding over time of the ways in which policy and institutional capacity affects forest sustainability. It should be noted, however, that the MP C&I revised the Criterion 7 indicators in November 2008, due in part to the difficulties experienced in addressing them in the 2003 report. The outcome of this process will determine the extent to which the work on Criterion 7 presented in this document becomes a foundation for future reporting. In any case, the analysis presented here should provide a useful way of characterizing and understanding a broad and complex topic area.

Of the many indicators in the criterion, Indicator 7.58 stands out as a special case. It provides a summarization of data adequacy for all of the indicators addressed in the report.

Criterion 1

Conservation of Biological Diversity

What is this criterion and why is it important?

Forests support a substantial proportion of biological diversity, particularly natural forests. Biological diversity enables an ecosystem to respond to external influences, to recover after disturbance, and to maintain essential ecological processes. Human activities can adversely affect biological diversity by altering and fragmenting habitats, introducing invasive species, or reducing the population or ranges of species. Conserving the diversity of organisms supports the ability of forest ecosystems to function, reproduce, and provide broader economic, intrinsic, altruistic, ethical, and environmental values.

The first three indicators in Criterion 1 cover ecosystem diversity. They describe the kind, amount, and arrangement of forest and habitats, which when taken together provide a measure of the capacity of forest habitats to provide for organisms and essential ecological processes. The last six indicators describe the abundance and biodiversity of plants and animals found in these habitats in terms of their species and genetic diversity. These six indicators are, in turn, strongly influenced by the conditions measured in the first three indicators of habitat capacity.

What has changed since 2003?

The data—The most significant change since 2003 is the freshness of the data. In 1999, the Forest Inventory and Analysis (FIA) program shifted from periodic surveys of each State on a roughly 10-year cycle to an annualized survey. The current exceptions are Wyoming (last survey 2001), New Mexico (last survey 2000), Nevada (last survey 1989), Hawaii (last survey 1986) and interior Alaska (no complete previous survey), which are scheduled to begin annualized inventories pending sufficient program funding. In the long term, this new approach will allow rolling average summaries of the status of forest inventory, health, and harvesting data every year. The land-cover data analyzed to quantify forest fragmentation is new in this report. The databases that were analyzed to quantify the number, population size, and conservation status of forest-associated species have been greatly expanded.

The indicators—The following table summarizes the revisions. Indicator reference numbers for 2003 and 2010 are provided to assist in comparisons with the previous report. A more detailed rationale for the revisions may be found at http://www.rinya.maff.go.jp/mpci/meetings/18_e.html.

Criterion 1. Conservation of Biological Diversity.

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
Ecosystem Diversity				
1	Extent of area by forest type relative to total forest area	Merge 2003 Indicators 1 and 2	1.01	Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure
2	Extent of area by forest type and by age class or successional stage	Merge 2003 Indicators 1 and 2		
3	Extent of area by forest type in protected area categories as defined by IUCN (International Union for Conservation of Nature) or other classification systems	Merge 2003 Indicators 3 and 4	1.02	Area and percent of forest in protected areas by forest ecosystem type, and by age class or successional stage
4	Extent of areas by forest type in protected areas defined by age class or successional stage	Merge 2003 Indicators 3 and 4		
5	Fragmentation of forest types	Change "forest types" to "forests"	1.03	Fragmentation of forests
Species Diversity				
6	The number of forest-dependent species	Change "forest-dependent" to "native forest associated"	1.04	Number of native forest-associated species
7	The status (threatened, rare, vulnerable, endangered or extinct) of forest-dependent species at risk of not maintaining viable breeding populations, as determined by legislation or scientific assessment	Change "forest-dependent" to "native forest associated" and delete "at risk of not maintaining viable breeding populations"	1.05	Number and status of native forest-associated species at risk, as determined by legislation or scientific assessment
		NEW	1.06	Status of onsite and offsite efforts focused on conservation of species diversity
Genetic Diversity				
8	Number of forest-dependent species that occupy a small portion of their former range	Change "forest-dependent" to "native forest associated" and reword	1.07	Number and geographic distribution of forest-associated species at risk of losing genetic variation and locally adapted genotypes
9	Population levels of representative species from diverse habitats monitored across their range	Add " forest associated" and reword	1.08	Population levels of selected representative forest-associated species to describe genetic diversity
		NEW	1.09	Status of onsite and offsite efforts focused on conservation of genetic diversity

Indicator 1.01. Area and Percent of Forest by Forest Ecosystem Type, Successional Stage, Age Class, and Forest Ownership or Tenure

What is the indicator and why is it important?

This indicator uses age-class distribution by broad forest type as a coarse measure of the landscape-scale structure of the Nation's forests. Within forest types, this serves as a surrogate for stand development or successional stage. A diverse distribution of forest lands across forest types and age classes is an indicator of tree-size diversity and is important for determining timber growth and yield, the occurrence of specific wildlife and plant communities, the presence of other nontimber forest products, and the forest's aesthetic and recreational values.

What does the indicator show?

Forest area in the United States stands at 751 million acres, or about one-third of the Nation's land area. Forest area was about one billion acres at the time of European settlement in 1630. Of the total forest land loss of nearly 300 million acres, most occurred in the East (divided into North and South regions in the accompanying charts) between 1850 and 1900, when broadleaf forests were cleared for agriculture (fig. 1-1). For the past 100 years, the total forest area has been relatively stable, although the U.S. population has nearly tripled.

Today, regional forest cover ranges from a low of 19 percent of the land area in the Rocky Mountain Region (fig. 1-2) to 45 percent in the Pacific Coast Region, 41 percent in the North, 40 percent in the South, and 34 percent in Alaska.

Broadleaf forests. Broadleaf forests cover 290 million acres nationwide (fig. 1-3), predominantly in the North and South (239 million acres). With 139 million acres in the United States, oak-hickory is the largest single forest cover type. It constitutes more than 19 percent of all forest land in the United States and nearly one-half of all broadleaf forests. Covering 54 million acres, maple-beech-birch forests, are also dominant in the Eastern United States. Combined, these two upland forest types constitute nearly two-thirds of all broadleaf forests and have increased 25 and 39 percent, respectively, since 1977. Broadleaf types have a fairly normal age distribution, showing

a bulge in the 40- to 79-year age-class, as second- and third-growth forests in the East continue to mature (fig. 1-4).

Conifer forests. Conifer forests cover 409 million acres in the United States and are found predominantly in the West (314 million acres) and South (69 million acres). Pines are the single-most dominant group of conifer forests. Loblolly-shortleaf pine and longleaf-slash pine types in the South and ponderosa and lodgepole pine types in the West combine to cover 121 million acres, or more than one-fourth of all conifer forest types.

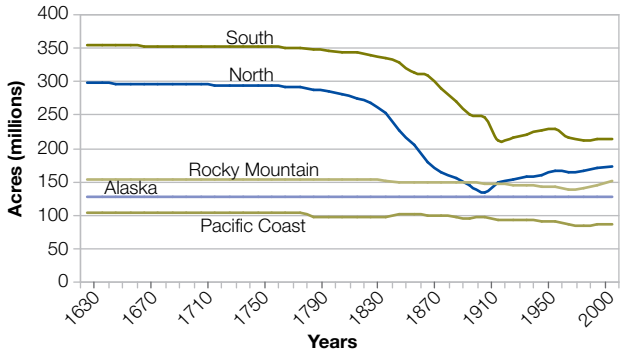
The largest single conifer type, with 58 million acres in interior Alaska, is the spruce-birch type. Douglas-fir follows closely, with 39 million acres found predominantly in the Pacific Coast Region. Conifer forests are somewhat bimodal in age structure with more acreage in younger age-classes because of more intensive management for wood production in the South and a preponderance of older stands in the West where most of the United States remaining old-growth forests occur and where recent policy changes have reduced harvesting of mature stands.

Mixed forests. Virtually all of U.S. mixed forests are found in the South, where oak-pine (30 million acres) and oak-gum-cypress (20 million acres) are the major forest types. Although oak-gum-cypress is found in the wet lowlands, oak-pine is usually found on the drier uplands of the South. The largest age class for these forests is 40 to 59 years old.

Although trend data on forest age-class are sparse, historic data are available for average tree size in forest stands (fig. 1-5). Stands with trees averaging 0 to 5 inches in diameter increase as older stands are harvested and regenerated. The recent trend in this diameter class is slightly downward. Although intermediate stands in the 6 to 10 inch diameter range have been declining, stands averaging more than 11 inches in diameter have been rising. This later trend is indicative of shifts in management that have decreased harvesting on public forests in the West, thus, increasing the acreage of larger diameter stands in that region, particularly in coniferous forests types.

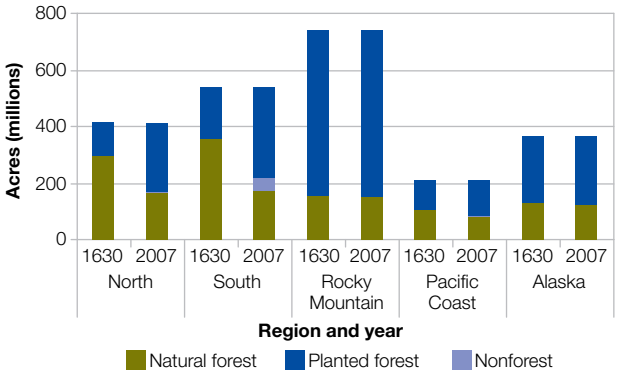
Ownership patterns have a profound effect on forest management policies and activities. Although 81 percent of forests of

Figure 1-1. Historic forest area in the United States by geographic region, 1630–2007.



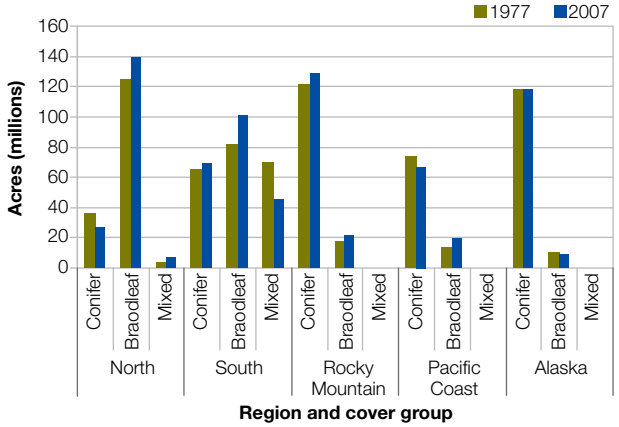
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 1-2. Area of natural forest, planted forest, and nonforest land by geographic region, 1630 and 2007.



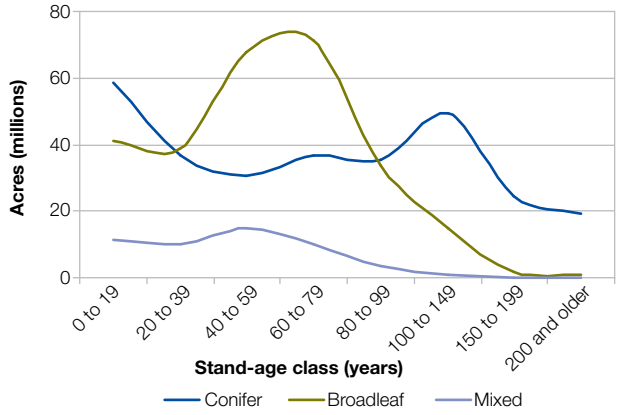
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 1-3. Area of forest land in the United States by major cover group, 1977 and 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 1-4. Forest area by stand-age class for conifer, broadleaf, and mixed forests, 2007 (excludes Alaska).



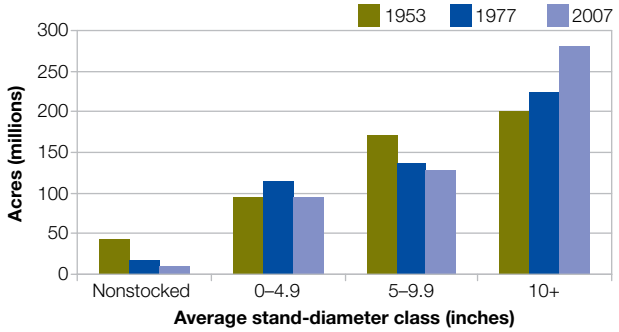
Source: USDA Forest Service, Forest Inventory and Analysis

the North and South are in private ownership, only 30 percent of forests in the West are in private ownership (fig. 1-6). Overall, 56 percent of U.S. forests are in private ownership. Thus, public land policies have a more significant affect on western forests and their use.

What has changed since 2003?

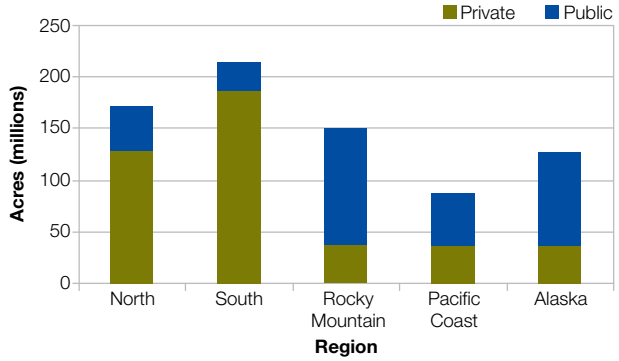
Forest land area has remained essentially stable since 2003. The data indicates an increase of 8 million acres (about 1 percent), but much of this increase came as result of changes in the classification of land cover types as either forest or nonforest. From a regional standpoint, a general loss of forest has occurred in the coastal regions of the East and West with offsetting gains in forest area in the interior region. Much of the loss can be attributed to urban sprawl, and much of the gain can be attributed to forest encroachment following decades of fire suppression. Generally the forest gained is of lower productivity than the forest lost.

Figure 1-5. Trends in timber land area by average stand-diameter class, 1953–2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 1-6. Forest land ownership in the United States by geographic region, 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Indicator 1.02. Area and Percent of Forest in Protected Areas by Forest Ecosystem Type, and by Age Class or Successional Stage

What is the indicator and why is it important?

The area and percent of forest ecosystems reserved in some form of protected status provides an indication of the emphasis our society places on preserving representative ecosystems as a strategy to conserve biodiversity. Important forest management questions also can be addressed by maintaining information on a network of representative forest types within protected areas. Traditionally, protected areas have been set aside, in part, for their conservation, scenic, and recreational values. The ecosystems in any one area might not represent the full range of biodiversity, but if it is part of a national conservation strategy (including rare and endangered species), then some degree of overall protection is available. Over time, forest types and their associated flora and fauna within protected areas will change and must be monitored as part of an overall strategy for conserving biodiversity. Adequate protection of the ecosystems and species in protected areas may also provide more management flexibility in forests under management for wood production and other uses.

What does the indicator show?

The United States has a long history of forest protection. Yellowstone, one of the world's first national parks, had its land area set aside in 1872. In the late 1800s, the Forest Reserves (now the national forests) were established to protect water and provide timber. The passage of the Wilderness Act in 1964 *(Public Law 88-577, 16 U.S. C. 1131–1136)* provided further protection to millions of acres of forest throughout the United States. Protected forest areas are scattered throughout the United States but are most abundant in the West, predominantly on Federal public land. In the East, the Adirondack and Catskills Reserves managed by the State of New York, at nearly 3 million acres total area, and set aside nearly 100 years ago as wild forever, are two of the largest areas of protected forest in non-Federal ownership.

This indicator currently addresses public protected forest areas, but millions of acres of private protected forests exist as well. These forests are primarily in various forms of conservation easements and fee simple holdings of several nongovernmental organizations (NGOs), such as The Nature Conservancy, Ducks Unlimited, The Conservation Fund, and The Trust for Public Land. The National Land Trust Census in 2005 conservatively estimated 37 million acres of private land in protected status. The overall data from the various sources, however, are inconsistent both spatially and as to how much of the areas are

forested. Major efforts are under way to improve the quality and coverage of this data and future reports will be able to address these areas in a more consistent way.

Public protected areas in the United States are found within six IUCN (International Union for Conservation of Nature) categories (wilderness, national parks, National Monuments, wildlife management areas, protected landscapes, and managed resource areas—see Glossary for more detailed descriptions), and are estimated to cover about 154 million acres (7 percent of all land) in the United States. An estimated 106 million acres of these protected lands are forested, representing 14 percent of all forest land (fig. 2-1). Conifer forests, particularly on public lands in the West (Rocky Mountain, Pacific Coast, and Alaska Regions), have a larger percentage of area in protected status in the United States (fig. 2-2a). The highest proportions of protection in conifer types are lodgepole pine at 49 percent, followed by western white pine at 38 percent and fir-spruce at 34 percent of total forest area in each type.

A smaller proportion of broadleaf forests are in protected status because many of these forests are in the Eastern United States, where private ownership is predominant. (fig. 2-2b). The highest proportions of protection in the East are spruce-fir at 6 percent, maple-beech-birch at 6 percent and white-red-jack pine at 5 percent.

Protected forests are relatively older than those on unprotected lands (fig. 2-3). Roadless areas have 52 percent of stands more than 100 years old and other protected areas have 49 percent of stands more than 100 years old, although all other forests outside protected areas have only 14 percent of stands more than 100 years old. The more active management for wood products on the latter skews the forest area to younger age classes. Many of the younger stands in protected areas are the result of fires that have occurred in western forests at higher levels of frequency in recent years.

If protected areas are not large enough to support the full range of habitat attributes need to sustain all ecosystem components, areas outside protected status are needed to contribute to biodiversity goals. The ability to manage both public and private unprotected forest lands for these broader goals will depend on the management objectives of the owners and their willingness to consider management options that can be integrated with those for protected areas.

What has changed since 2003?

The area of public protected forests has changed little since 2003. As described in Indicator 27 and earlier in this indicator, conservation easements and related mechanisms by which private lands are assured some level of protection are growing in importance. Currently, the total area protected in this fashion is smaller relative to the area of publicly protected lands, but it is growing rapidly with the support of both public and private funding sources and will play a significant role in future forest policies both locally and nationally.

Figure 2-1. Forest land by major forest land class in the United States (excluding Alaska and Hawaii), 2007.

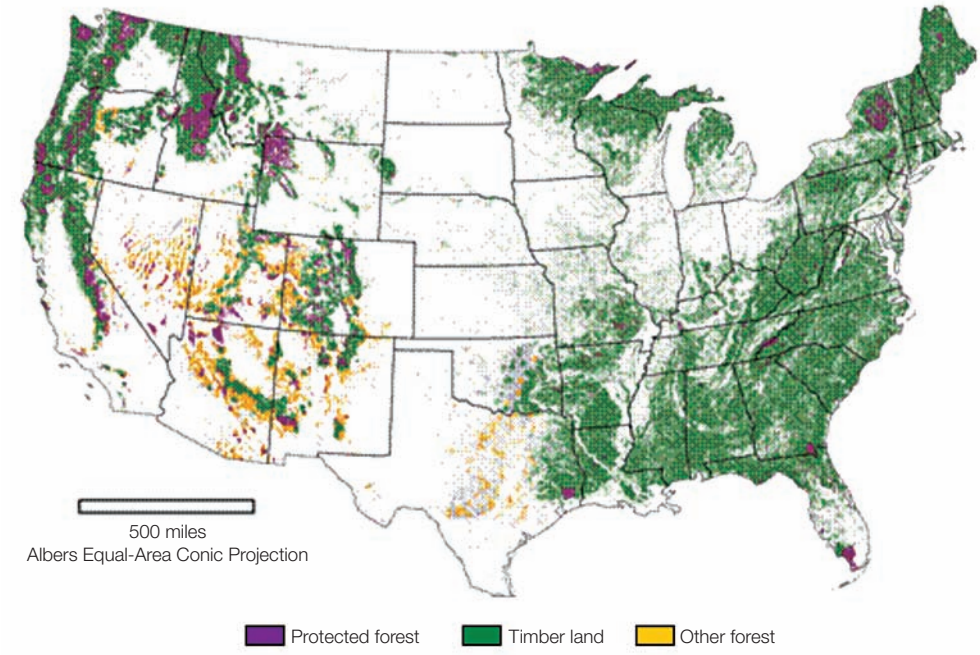
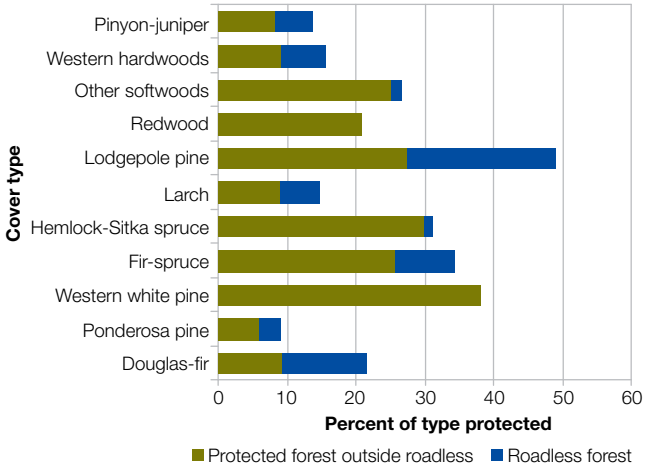
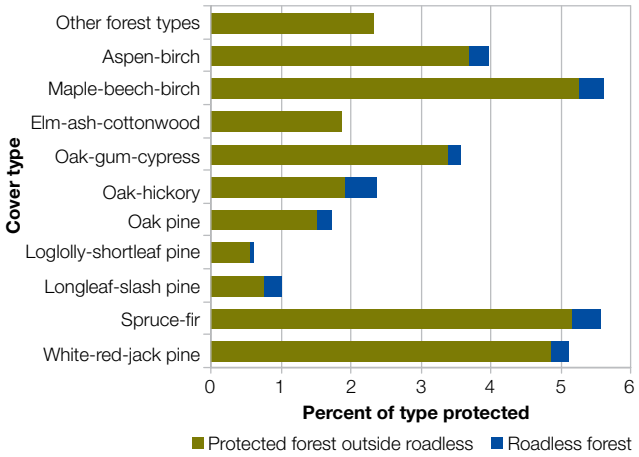


Figure 2-2a. Percent of public forest land protected by cover type in the West, 2007.



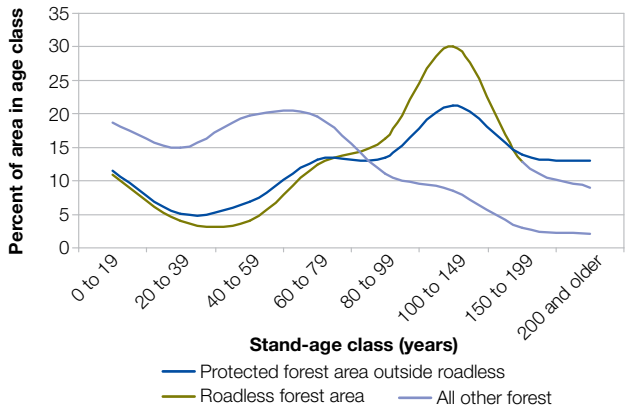
Source: Conservation Biology Institute and USDA Forest Service, Forest Inventory and Analysis

Figure 2-2b. Percent of public forest land protected by cover type in the East, 2007.



Source: Conservation Biology Institute and USDA Forest Service, Forest Inventory and Analysis

Figure 2-3. Protected and other forest land by stand-age class, 2007 (does not reflect private protected forests).



Source: Conservation Biology Institute and USDA Forest Service, Forest Inventory and Analysis

Indicator 1.03. Fragmentation of Forests

What is the indicator and why is it important?

This indicator provides information on the extent to which forests are fragmented by human activities and natural processes. Fragmentation may lead to the isolation and loss of species and gene pools, degraded habitat quality, and a reduction in the forest's ability to sustain the natural processes necessary to maintain ecosystem health. The fragmentation of forest area into smaller pieces changes ecological processes and alters biological diversity. This indicator includes several measures of the extent to which forests are fragmented at several spatial scales of analysis.

What does the indicator show?

Analysis of fragmentation is scale dependent. Consequently, maps or summaries of fragmentation differ depending on whether the forest map is separated into small or large pieces (landscapes) for analysis.

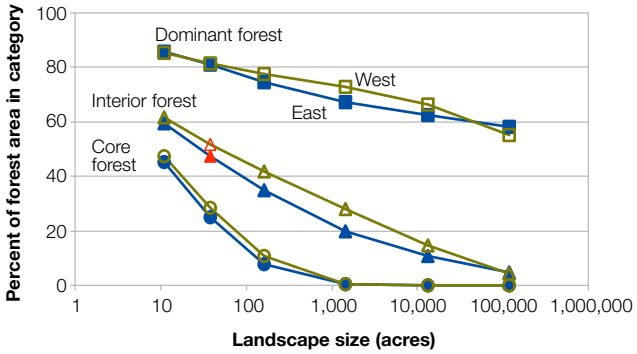
Maps of forest land derived from satellite imagery at 0.22-acre resolution (circa 2001) show that although forest is usually the dominant land cover in places where forest occurs, fragmentation is extensive. Simply stated, places that are forested tend to be clustered in proximity to other places that are forested, but blocks of forest land are usually fragmented by inclusions of nonforest land. This pattern is repeated across a wide range of spatial scales. For landscapes up to 160 acres, at least 76 percent of all forest land is in landscapes that are at least 60 percent forested. For larger landscapes up to 118,000 acres in size, at least 57 percent of forest land is in forest-dominated landscapes (figs. 3-1 and 3-2).

Core forest is forest on landscapes that are completely forested. The larger the landscape being examined is, the less likely that it will be core forest. For 10-acre landscapes, 46 percent of all forest land is classified as core forest. Less than 1 percent of forest land is classified as core forest in landscapes that are 1,500 acres or larger.

Interior forest is forest on landscapes that are more than 90 percent forested. As with core forest, larger landscapes are less likely to have interior forest. When examining landscapes that are 10 acres in size, 60 percent of all forest land is interior forest. For landscapes larger than 250 acres, however, less than one-third of forest land is classified as interior forest. Forest area in landscapes dominated by forest (more than 60 percent forest) is greater than either core or interior forest, and dominant forest area also decreases with increasing landscape size.

Edge habitats have a different microclimate and often support a different species mixture than forest, which is distant from an

Figure 3-1. Forest land fragmentation (circa 2001) from national land-cover maps (National Land Cover Database). The chart shows the percentage of forest land in the coterminous United States that is considered core (completely forested landscape), interior (greater than 90 percent forested), or dominant (greater than 60 percent forested), and how those proportions decrease with increasing landscape size. The West includes the Pacific and Rocky Mountain regions; the East includes the North and South regions. Red symbols identify the conditions mapped in figure 3-2.



Source: 2007 NLCD compilation of 2001 data

edge between forest and nonforest land. Overall, 54 percent of forest land is within 185 yards of forest land edge, 74 percent is within 330 yards of forest land edge, and less than 1 percent is at least 1,900 yards (1.1 miles) from forest land edge.

What has changed since 2003?

Due to changes in land-cover mapping protocols, the statistics shown here are not directly comparable to those shown in the 2003 report.

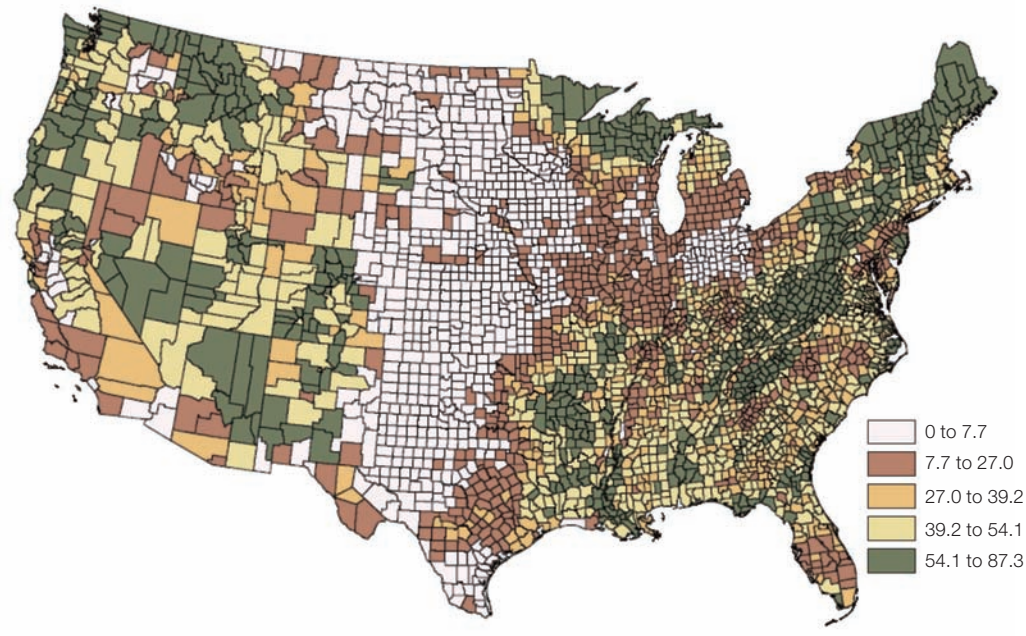
Are there important regional differences?

Western forests (Pacific Coast and Rocky Mountain Regions) are less fragmented than eastern forests (North and South Regions). This difference is most pronounced for landscapes smaller than 250 acres in size (fig. 3-1).

Why can't the entire indicator be reported at this time?

Regional baseline conditions and the specific ecological implications of observed levels of fragmentation are mostly unknown. The available data permit an analysis of overall forest land fragmentation but do not incorporate the influence of small roads nor differences in land ownership (parcelization).

Figure 3-2. The percent of all forest in a county that is interior forest (greater than 90 percent forested) when analyzed at an approximately 40-acre scale (corresponding to the red symbols in figure 3-1). Larger values indicate that a larger share of the existing county forest is relatively intact, in comparison to forest in other counties. In this quantile map, equal numbers of counties are shaded with each color.



Indicator 1.04. Number of Native Forest-Associated Species

What is this indicator and why is it important?

This indicator provides information on the health of forest ecosystems through the number of native forest-associated species. Because one of the more general signs of ecosystem stress is a reduction in the variety of organisms inhabiting a given locale, species counts are often used in assessing ecosystem well-being. The count of forest-associated species in a region will change when species become extinct, species colonize, or our knowledge base is improved. Although change in species counts because of improved knowledge of distribution or taxonomy is unrelated to biodiversity conservation, extinction, and colonization—it can alter ecological processes in ways that affect the kinds and quality of ecosystem services that humans derive from forest ecosystems. Therefore, the loss or addition of species in an ecosystem can provide valuable insights into the overall health and productivity of that system.

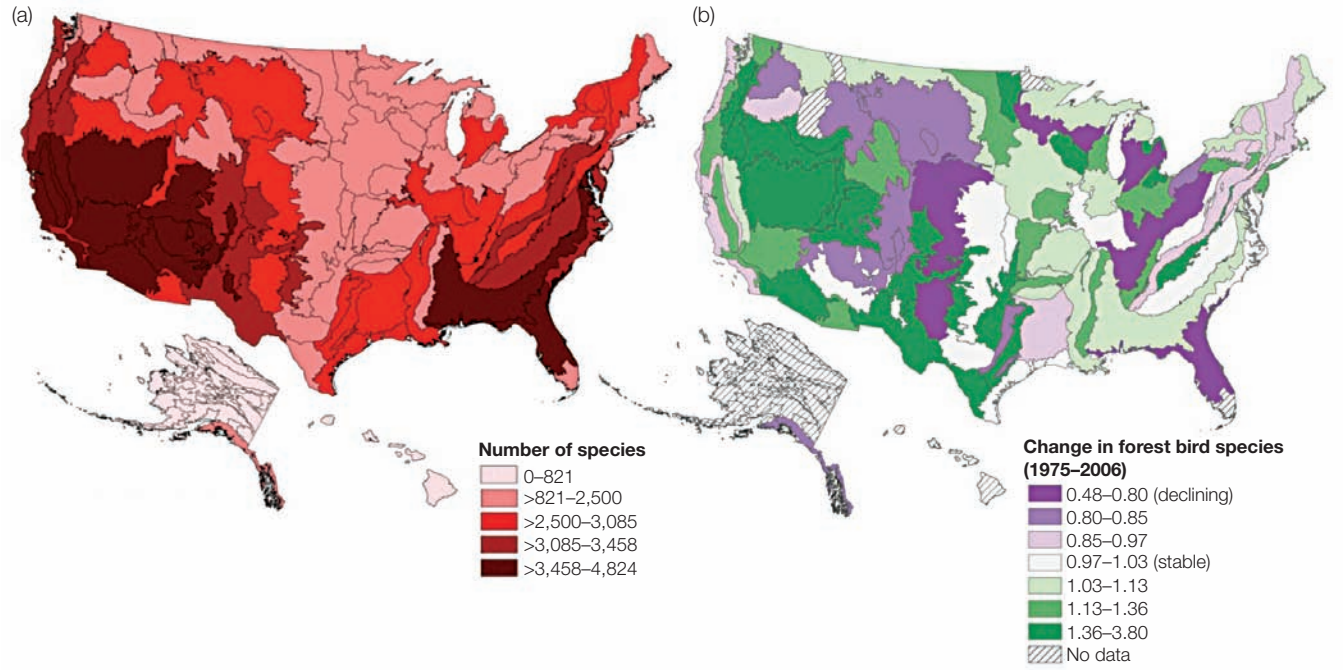
What does the indicator show?

Data on the distribution of 12,865 vascular plants and 1,000 vertebrate species associated with forest habitats (including 230 mammals, 388 birds, 184 amphibians, and 198 reptiles) reveal notable differences in the number of species that occur in major ecoregions of the United States. The number of forest-associated species is highest in the Southeast and in the arid ecoregions of the Southwest (fig. 4-1*a*). Long-term (1975 to 2006) trends in number of forest bird species within these ecoregions have been mixed (fig. 4-1*b*). Ecoregions where the number of forest bird species has had the greatest estimated increase include the desert systems of the intermountain West; the southern semi-arid prairie and plains; and scattered forest systems within the Great Lakes Region. The greatest estimated decline in forest bird numbers were observed in the semiarid prairies of the central Great Plains; the southern coast plain of peninsular Florida; and the plateau and mixed woodlands of the upper Midwest.

What has changed since 2003?

Since the 2003 report, a broader accounting of species that inhabit forests resulted in the addition of 11,690 species. Much of this increase is because of new habitat affinity data for vascular plants that extended the data beyond the 689 tree species covered in the 2003 report. These increases do not necessarily reflect national gains in forest species. Our knowledge of which bird species are associated with forest habitats has not changed since the 2003 report and we had sufficient data to quantify trends in the numbers of forest-associated bird species. Many regions throughout the coterminous United States have shown continued increases in the number of forest bird species or have changed to an increasing trend (42 ecoregions comprising

Figure 4-1. (a) The number of vascular plants and vertebrate species associated with forest habitats (2009, data provided by NatureServe). (b) The estimated change in the number of forest-associated bird species from 1975 to 2006 (data provided by U.S. Geological Survey). Change is measured by the ratio of the 2006 species count estimate to the 1975 species count estimate. Values greater than 1 indicate increasing species counts (green shades); values less than 1 indicate declining species counts (purple shades).



46 percent of the area) since the 2003 report (fig. 4-2*a*). Of particular note are the Appalachian Mountains; the Mississippi alluvial plains; the northern temperate prairies; the cold deserts of the central intermountain West; and the Cascade Mountains of the Pacific Northwest. Those regions, where the number of forest bird species have continued to decline or have changed to a decreasing trend (34 ecoregions comprising 47 percent of the area) since the 2003 report (fig. 4-2*b*), are prominent throughout the semiarid prairies of the Great Plains; the plateau region west of the Appalachian Mountains; coastal areas in New England, Texas, and the Pacific Northwest; and the regions that comprise the intensive agricultural lands in the upper Midwest.

Why can't the entire indicator be reported at this time?

Monitoring the count of different species over large geographic areas is difficult. For this reason, we lack systematic inventories that permit the estimation of species numbers for many groups (e.g., nonvascular plants, insects, and fungi). The increase in the number of forest-associated species reported here reflects growing inventory coverage among groups for which our understanding of habitat associations has been incomplete (e.g., vascular plants, and invertebrates). Until comprehensive biodiversity inventories are implemented, trends in the number of native forest species will have to be interpreted cautiously. The most fundamental need is to develop monitoring programs that are economically feasible and applicable across the diverse groups of species that inhabit forest ecosystems.

Indicator 1.05. Number and Status of Native Forest-Associated Species at Risk, as Determined by Legislation or Scientific Assessment

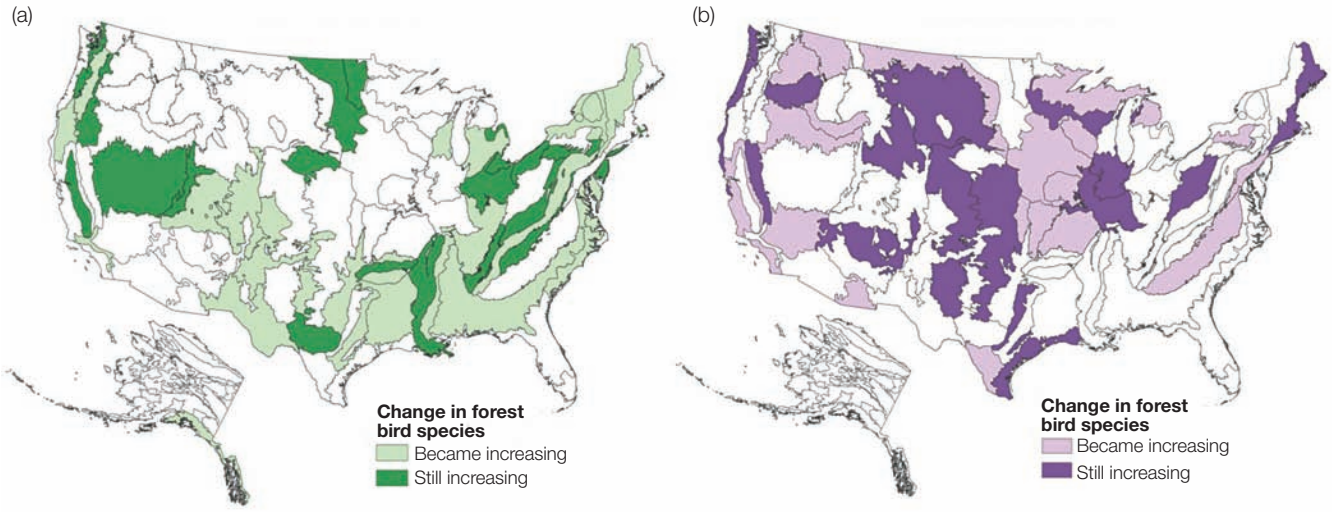
What is this indicator and why is it important?

This indicator provides information on the number and status of forest-associated species at risk or in serious decline. It accomplishes this by monitoring the number of native species that have been identified by conservation science or mandate to be at risk of global extinction. As the number of species considered to be rare increases, the likelihood of species extinction also increases. Demographic and environmental events such as failure to find a mate, disease, disturbance, habitat loss, and climate change interact to increase extinction risk as populations become smaller. Because important ecosystem functions (e.g., productivity, nutrient cycling, or resilience) can be degraded with the loss of species, concern exists that the goods and services humans derive from ecological systems will become diminished as more species become rare. For this reason, tracking the number and percent of at-risk species is a measure of the health of forest ecosystems and their ability to support species diversity.

What does the indicator show?

Among forest-associated species (vascular plants, vertebrates, and select invertebrates), 77 (less than 1 percent) were

Figure 4-2. A comparison of the 2003 report trends (1975–1999) to recent trends (1999–2006) in forest bird species counts. (a) Those strata that have continued to see increases in bird species counts or were declining in the 2003 report but have become increasing. (b) Those strata that have continued to see decreases in bird species counts or were increasing in the 2003 report but have become decreasing (data provided by U.S. Geological Survey).



determined to be presumed or possibly extinct, 4,005 (27 percent) were determined to be at-risk of extinction (includes species that are critically imperiled, imperiled, or vulnerable to extinction), and 10,576 (71 percent) were determined to be apparently secure. The percentage of forest-associated species in each conservation status category varies by taxonomic group (fig. 5-1a). The number of possibly extinct and at-risk species is proportionately greatest among select invertebrates (32 percent), followed by vascular plants (28 percent), and vertebrates (16 percent). Within forest-associated vertebrates, the greatest proportion of possibly extinct and at-risk species is found among amphibians (34 percent). Birds (14 percent), freshwater fishes (12 percent), mammals (11 percent), and reptiles (11 percent) show proportionately lower numbers of species that are of conservation concern. At-risk species that are associated with forest habitats are concentrated geographically in Hawaii, the arid montane habitats of the Southwest, chaparral and sage habitats of Mediterranean California, and in the coastal and inland forests of northern and central California (fig. 5-1b).

What has changed since 2003?

Since the 2003 report, a broader accounting of species that inhabit forests has resulted in an increase in the number of species that are considered possibly extinct or at risk of extinction, with the greatest increase reported among vascular plants (3,644 more species). The number of species of conservation concern also increased among select invertebrates (108 more species) and vertebrates (23 more species). The sizable percentage gains among vascular plants and invertebrates (fig. 5-2*a*) are largely attributable to newly available data rather than from a real increase in the percentage of species consider at risk. Among the relatively well-studied vertebrates, an increase of about 0.8 percent has occurred since the 2003 report. Among vertebrate species groups (fig. 5-2*b*) the greatest percent gains in species thought extinct or at risk of extinction were observed among amphibians (an increase of 2.2 percent), followed by mammals (an increase of 1.0 percent), reptiles (an increase of 0.9 percent), and birds (an increase of 0.5 percent).

Why can't the entire indicator be reported at this time?

Information on the conservation status of obscure species is lacking in many cases. Among all species (not just forest associated), 281 (1.7 percent) vascular plant, 14 (less than 1 percent) vertebrate, and 660 (9.0 percent) invertebrate species (select groups) have not been, as yet, assigned a conservation status category nor a habitat affinity. Given the number of species for which conservation status ranks are forthcoming, trends in the number of forest-associated species by conservation status will need cautious interpretation because gains are expected as unranked species are evaluated. Regional trend analyses were also limited by the fact that the ecoregional stratification changed from the 2003 to the 2010 reports.

Figure 5-1. (a) The percent of vascular plant, vertebrate, and invertebrate species associated with forest habitats determined to be possibly extinct, at risk of extinction, secure, or unranked. (b) The percentage of forest-associated species (vascular plants, vertebrates, and select invertebrates) occurring in each ecoregion determined to be at risk of extinction (does not include species classified as possibly extinct). (2009, data provided by NatureServe.)

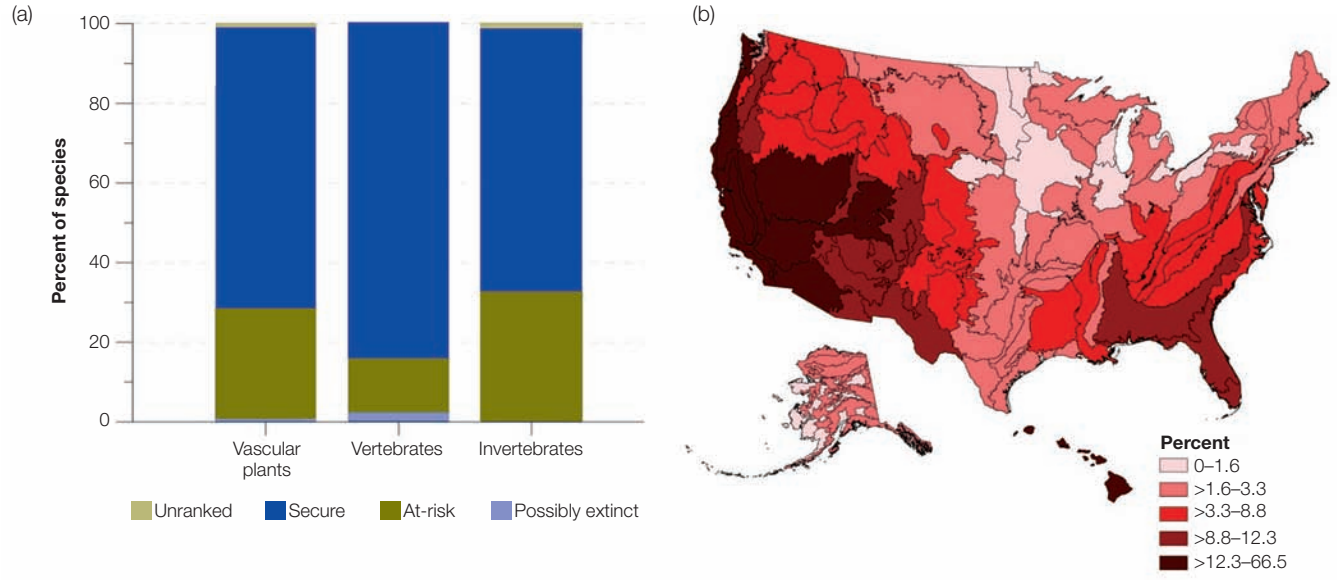
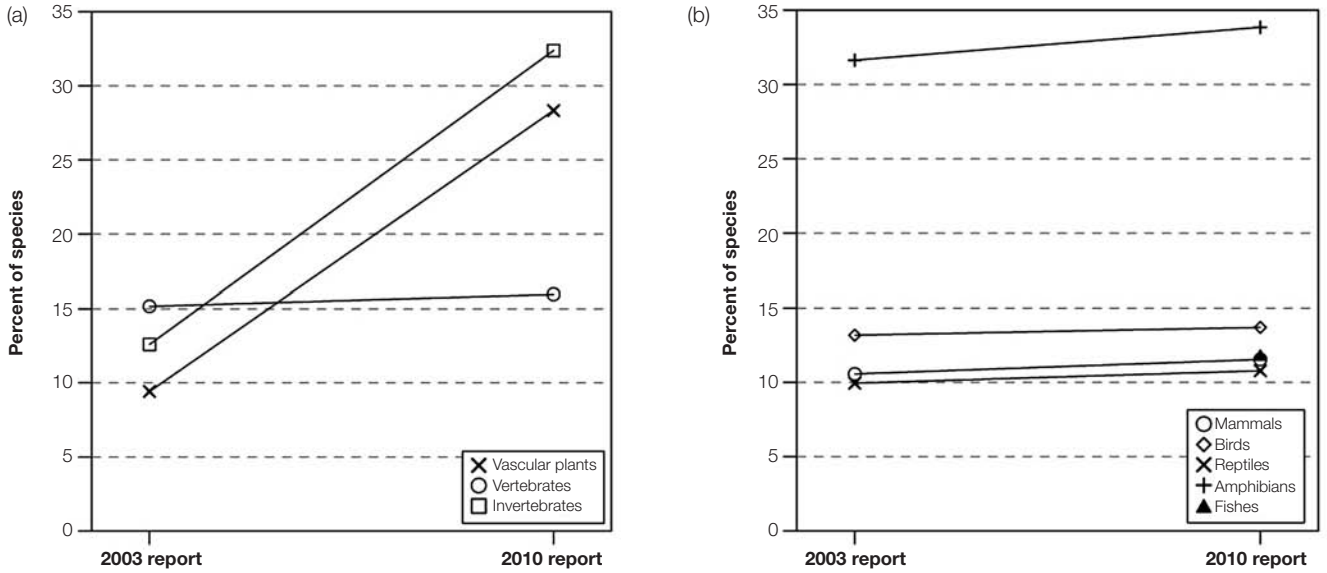


Figure 5-2. A comparison of the percent of forest-associated species that have been determined possibly extinct or at risk of extinction between the 2003 and 2010 reports among (a) vascular plants, vertebrates, and select invertebrates, and (b) among the relatively well-known mammal, bird, reptile, amphibian, and freshwater fish species groups. Because the conservation status of forest-associated freshwater fish species (▲) were unavailable for the 2003 report, only a single-point estimate for the 2010 report is shown. (Actual reporting dates were 2002 and 2009.)



Indicator 1.06. Status of Onsite and Offsite Efforts Focused on Conservation of Species Diversity

What is the indicator and why is it important?

This indicator provides information that describes onsite and offsite efforts to conserve species diversity. Onsite conservation efforts are those implemented within the forest. Offsite conservation efforts are usually measures of last resort which may move a species from its natural habitat or range to specially protected areas or into captivity as part of a breeding program or collection.

Some forest species and habitats may have declined to such an extent that intervention is required to safeguard them for the future. As a result of the biological diversity losses caused by human pressure, different sectors of society (governments, nongovernmental organizations (NGOs), and individual citizens) are increasingly involved in conservation measures. These conservation initiatives include scientific studies about species at risk, keystone species assessments, laws, and projects that reinforce conservation of biological diversity, forest restoration, and connectivity.

It is more practical to estimate expenditures associated with efforts to conserve biological diversity than to directly measure the results of those efforts. Expenditures by public agencies directed at conservation of biological diversity fall into four broad categories: (1) research associated with biological diversity, including among others, knowledge about keystone species, threatened species, functional groups, and spatial distribution; (2) environmental education and information about the importance of biological diversity, and (3) conservation projects related to habitat restoration and biological diversity management. A fourth category of this indicator is (4) the proportion of forest area managed for biological diversity conservation, outside of protected areas, relative to total forest area. This indicator is closely related to Indicators 1.02 and 1.09.

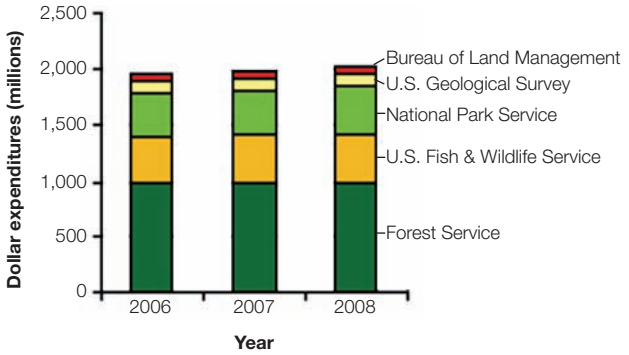
What does the indicator show?

Federal expenditures for research, education, and management associated with conservation of forest biological diversity are concentrated in five Federal agencies:

1. Forest Service
2. National Park Service
3. Bureau of Land Management
4. U.S. Fish and Wildlife Service
5. U.S. Geological Survey

In combination, those agencies spent approximately $2 billion in 2008 on research, education, and management that fosters conservation of forest biological diversity (fig. 6-1). These expenditures are the equivalent of $2.68 for every acre of forest land in the United States State natural resource agencies and hundreds of NGOs make additional expenditures associated

Figure 6-1. Expenditures by five U.S. agencies on research, education, and management associated with conservation of forest species diversity, 2008. Expenditures for conservation of biological diversity in general or conservation of species diversity in particular are not tracked separately in agency budgets. Therefore, values for each agency are a compilation of activities closely aligned with conservation of biodiversity and adjusted for relative proportion of forest versus nonforest land affected.



with research, education, and management for conservation of species diversity. Although the expenditures made by these groups for biological diversity conservation are impractical to compile and track separately over time, collectively, they represent significant investments that are assumed to have significant effects.

Most public forest land is managed with a priority on the conservation of species diversity but that objective is usually pursued as an integral part of a multiobjective management strategy. Of the 751 million acres of forest land in the United States, 328 million acres (44 percent) are in public ownership (fig. 6-2) (also see Indicator 1.01). Nationally, 106 million acres of predominantly public forest land are classified as protected (see Indicator 1.02). At least 37 million additional acres of private land are protected in conservation trusts and similar instruments; however, insufficient data exist to tally only the forested acres under private protection.

Protected areas are integral parts of a national and global strategy to conserve biological diversity, but management of some species of concern requires management prescriptions that are incompatible with protected area regulations. Consequently, forest land outside of protected areas is also essential to conservation of species diversity.

What has changed since 2003?

This indicator was not reported in 2003.

Are there important regional differences?

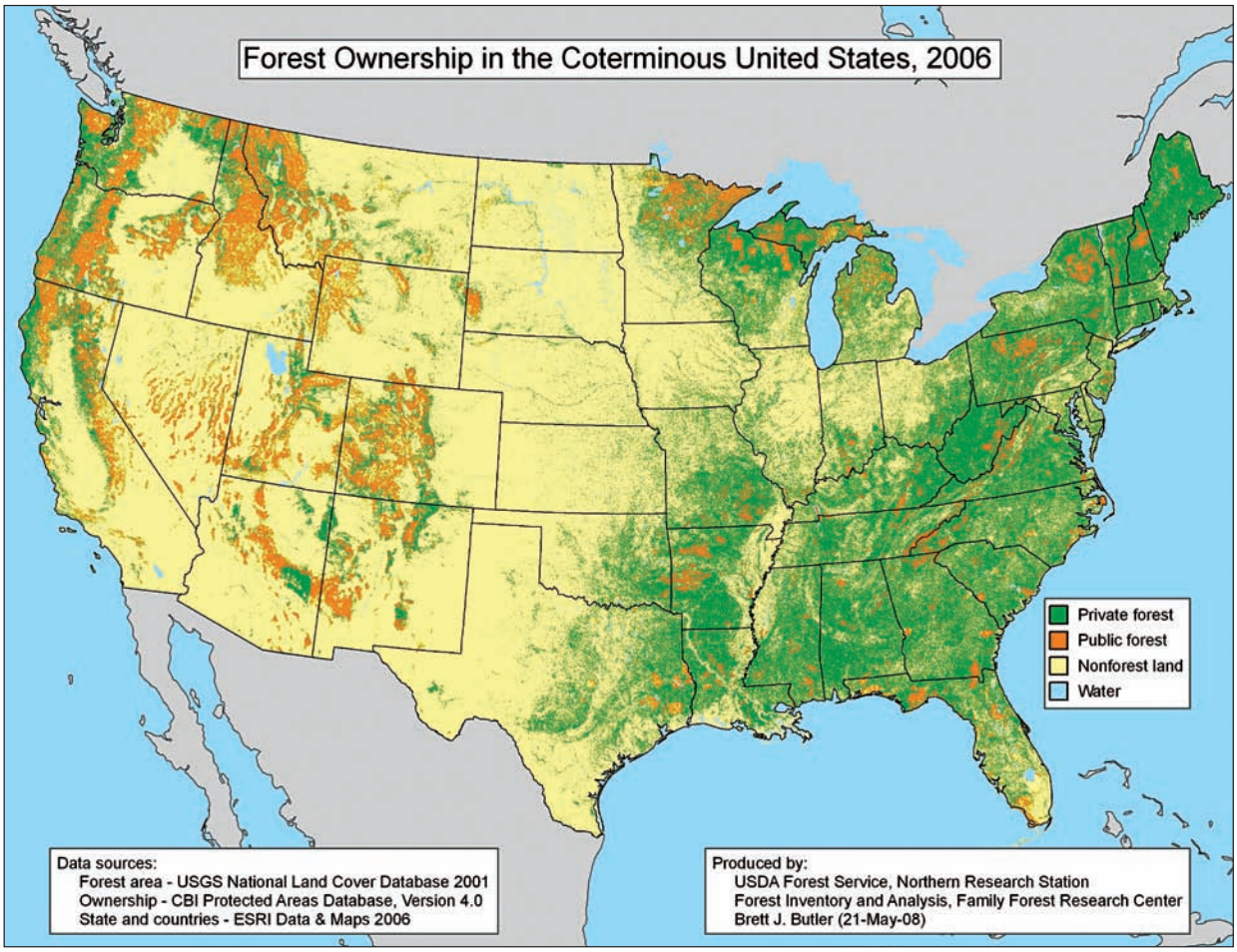
Most of U.S. public forest land is in the West where much of that public forest is managed for conservation of species diversity as part of a multiobjective management strategy (fig. 6-2). Conservation of species diversity and habitat restoration are priorities for much of the public forest land in the East, but 87 percent of eastern forest land is privately owned. Consequently private forest owners in the East are important in large-scale efforts to conserve species diversity.

Private landowners play a large role in many aspects of species diversity conservation research, education, and management. Consequently, this indicator underestimates the full magnitude of efforts directed at conservation of species diversity.

Why can't the entire indicator be reported at this time?

Conservation of species diversity is often linked with other management objectives, so associated Federal expenditures are impossible to fully separate from other objectives. Moreover, States, school districts, NGOs, and private landowners play a large role in many aspects of species diversity conservation research, education, and management. Consequently, this indicator underestimates the full magnitude of efforts directed at conservation of species diversity.

Figure 6-2. Forest land ownership in the conterminous United States. Public forest land is managed to conserve biological diversity, usually as part of a multiobjective management strategy. Public forest land is concentrated in the West. Alaska (72 percent) and Hawaii (34 percent) also have large proportions of their forest land in public ownership.



CBI = Conservation Biology Institute. ESRI = Environmental Systems Research Institute, Inc. USGS = U.S. Geological Survey.

Indicator 1.07. Number and Geographic Distribution of Forest-Associated Species at Risk of Losing Genetic Variation and Locally Adapted Genotypes

What is this indicator and why is it important?

This indicator provides information on the number and distribution of forest-associated species at risk of losing genetic variation across their geographic range. Comparing a species' current geographic distribution with its historic distribution is the basis for identifying those species whose range has contracted significantly. Human activities are accelerating changes in species' distributions through land use conversions, climate change, the alteration of native habitats, the introduction of exotic species, and direct exploitation. The size of a species' distribution is often related to the number of genetically distinct populations that exist. Consequently, species that currently occupy a smaller portion of their former distribution signals a potential lost of their genetic variation. This erosion in genetic variation makes species less able to adapt to environmental change, increases the risk of extinction, and lowers the overall resilience of forest ecosystems.

What does the indicator show?

The geographic distributions of most species (based on current and historical State-level occurrence records) have not been appreciably reduced. Geographic distribution data for 29,783 forest-associated species show that 90 percent fully occupy their former range. Of the 3,078 species that have been extirpated from at least one State, 50 percent still occupy greater than or equal to 90 percent of their former distribution. The number of species that now occupy less than 80 percent of their distribution varies by taxonomic group (fig. 7-1a). Range contraction of this magnitude is most commonly observed among freshwater fishes (6.2 percent). Species groups with

at least 5 percent of species occupying less than 80 percent of their former ranges include select invertebrates, birds, and mammals. Geographically, States that have lost the greatest number of species associated with forests are concentrated in the Mid-Atlantic Region and into New England (fig. 7-1b).

What has changed since 2003?

Comparisons of the percent of species occupying less than 80 percent of their former range with the 2003 report is restricted to terrestrial vertebrate taxa. Among these species groups, range contraction of this magnitude increased the most among forest-associated birds, followed by amphibians and reptiles (fig. 7-2a). The percent of mammals with range declines of this magnitude actually declined since the 2003 report. A broader accounting of species that inhabit forests has occurred because of new habitat affinity data. The number of forest-associated species that have been extirpated from States has increased noticeably in the Eastern United States (fig. 7-2b). The Mid-Atlantic, several New England States, and Missouri saw gains in excess of 75 species since the 2003 report. This gain in extirpated species is largely attributable to more comprehensive treatment of vascular plants and invertebrates that were not included in the 2003 analysis.

Why can't the entire indicator be reported at this time?

Estimates of species' geographic distributions are a basic need of conservation plans. Although historical records, species collections, and expert opinion are available to estimate the distribution of most vascular plant and vertebrate species, we lack much of these data for those species groups that collectively represent most of described species (e.g., many invertebrates, fungi). Even among vascular plants and vertebrates we lack the data needed to refine the coarse State-level analysis reported here to quantify species range changes across the landscape. In particular, reconstruction of former distributions is hampered by the absence of comprehensive historic records. Although efforts are under way to document species distributions, these compilations are often based on expert opinion that provides an estimate of the current range only. Because a species' geographic distribution is dynamic, a statistically designed inventory that permits an objective and systematic assessment of range occupancy over time is needed to fully meet the intent of this indicator.

Figure 7-1. (a) The percentage of vascular plants, vertebrates, and select invertebrates associated with forest habitats that now occupy less than 80 percent of their former geographic distribution (based on State-level occurrence data). (b) The number of forest-associated species (vascular plants, vertebrates [no freshwater fish], and select invertebrates) that have been extirpated within each State. (2009, data provided by NatureServe).

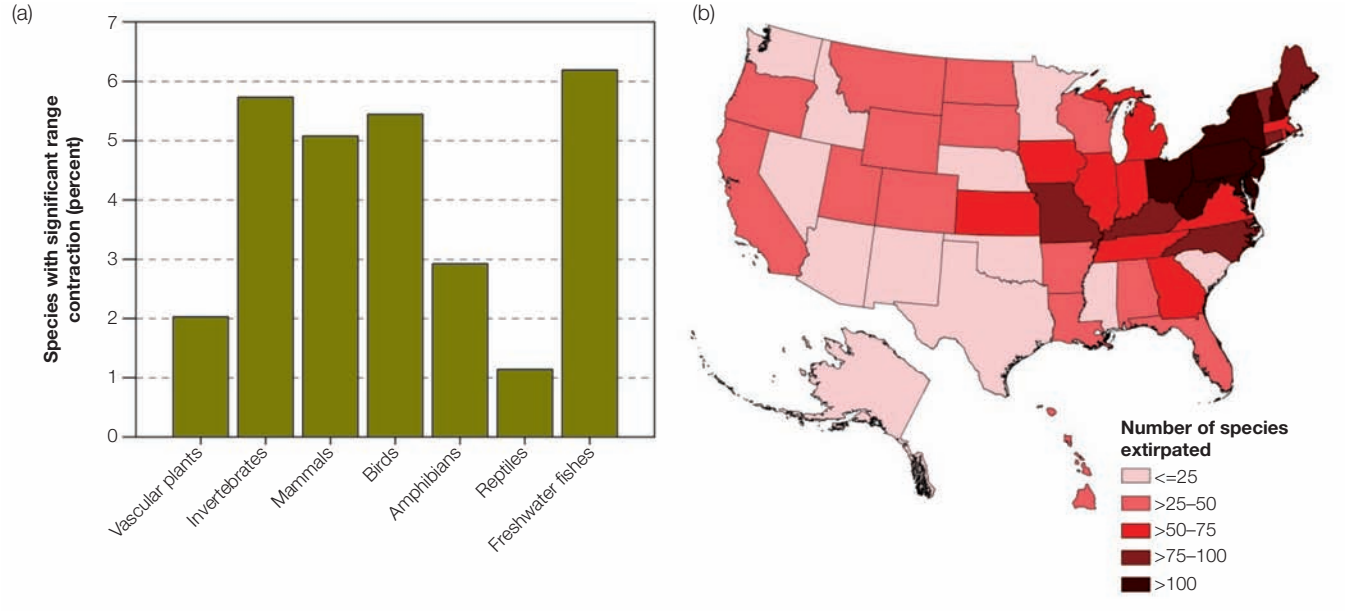
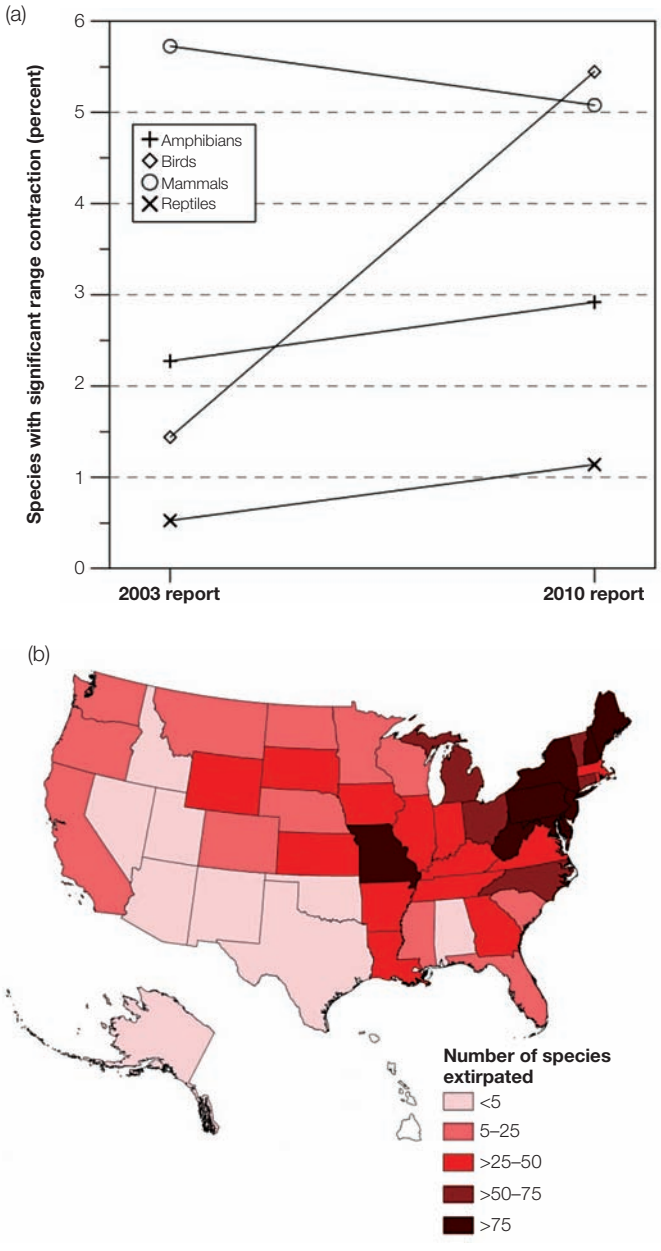


Figure 7-2. A comparison of the 2003 and 2010 reports for forest-associated terrestrial vertebrates on (a) the percentage of species that now occupy less than 80 percent for their former geographic distribution (based on State-level occurrence data), and (b) the number of species (vascular plants, vertebrates [no freshwater fish], and select invertebrates) that have been extirpated within each State. (Actual reporting dates were 2002 and 2009.)



Indicator 1.08. Population Levels of Selected Representative Forest-Associated Species To Describe Genetic Diversity.

What is this indicator and why is it important?

This indicator uses population trends of selected bird and tree species as a surrogate measure of genetic diversity. Population decreases, especially associated with small populations, can lead to decreases in genetic diversity, and contribute to increased risk of extinction. Many forest-associated species rely on some particular forest structure, vegetation associations, or ecological processes. Monitoring population levels of such representative species will indicate the status of the associations of species associated with specialized conditions. Management use of this indicator will ensure forest health conditions are being monitored and may help avoid species extinction.

What does the indicator show?

Between 1966 and 2006, about 27 percent of forest-associated bird species increased and 25 percent decreased; for nearly one-half the species no strong evidence existed for an increasing or decreasing trend. Most of 38 tree species or species groups analyzed showed increases in number of stems of greater than 50 percent for moderate to large diameter classes (greater than 12 inches in diameter) between 1970 and 2007 (fig. 8-1). State wildlife agency data indicate that populations of many big game species increased in the past 25 years, but forest-associated small game species showed mixed trends.

Are there important regional differences?

The South has the greatest proportion of physiographic regions with higher numbers of bird species with significantly decreasing trends compared to bird species with significantly increasing trends (fig. 8-2). For tree species, the Pacific Coast Region has a greater number of tree species or species groups showing declines in large diameter classes compared to other regions (fig. 8-3).

What has changed since 2003?

Most forest-associated bird species with significantly decreasing population trends between 1966 and 2003 also had decreasing trends between 1966 and 2006. Bird species associated with early successional and wetland habitats are among those with declining population trends; populations of some generalist bird species and some favored by burning have increased (fig. 8-4a). Most tree species showed relatively small changes in stem numbers since 2002, although a few species such as black walnut had increases greater than 15 percent and other species such as jack pine decreased by greater than 25 percent (fig. 8-4b).

Why can't the entire indicator be reported at this time?

Population data are lacking for taxa other than trees, birds, and a small subset of hunted species. We need systematic strategies for monitoring population levels of other taxa and an objective approach for selecting a minimum subset of species that will adequately represent the status of genetic diversity across the full biota.

Figure 8-1. Number of tree species or groups of species in the Forest Inventory and Analysis (FIA) database by percent change in stem numbers (a measure of tree population size), by FIA diameter class mid-points, for trees greater than 5 inches in diameter breast height, between 1970 and 2006.

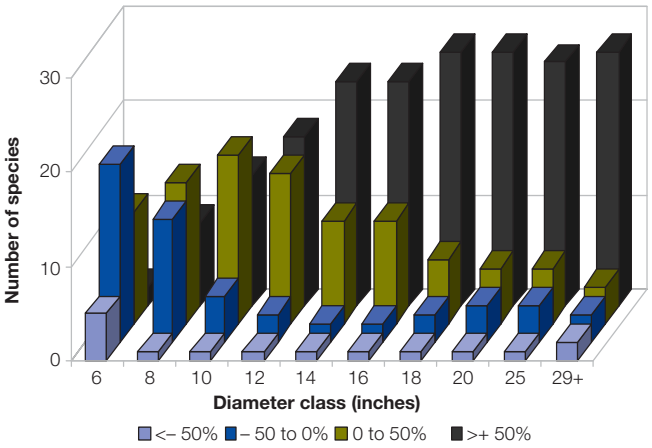


Figure 8-2. Difference (D) between the number of forest bird species with significantly (P is less than 0.1) increasing and decreasing population trends, by physiographic region, between 1966 and 2006, calculated from the U.S. Geological Survey Breeding Bird Survey database.

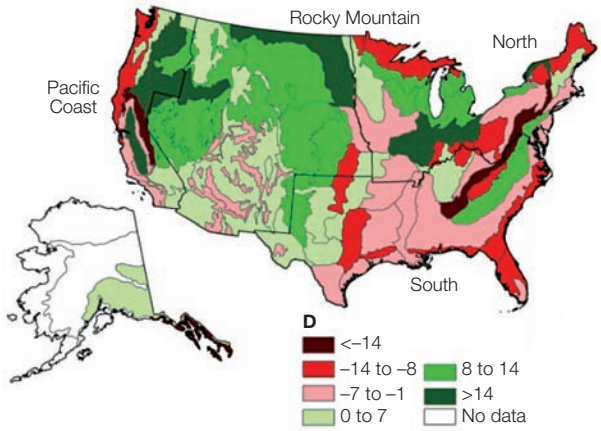


Figure 8-3. Number of tree species or groups of species in the Forest Inventory and Analysis (FIA) database by percent change in stem numbers, by FIA diameter class midpoints, for trees greater than 5 inches in diameter breast height (dbh), between 1970 and 2007, by region: (a) Pacific Coast, (b) Rocky Mountain, (c) North, and (d) South.

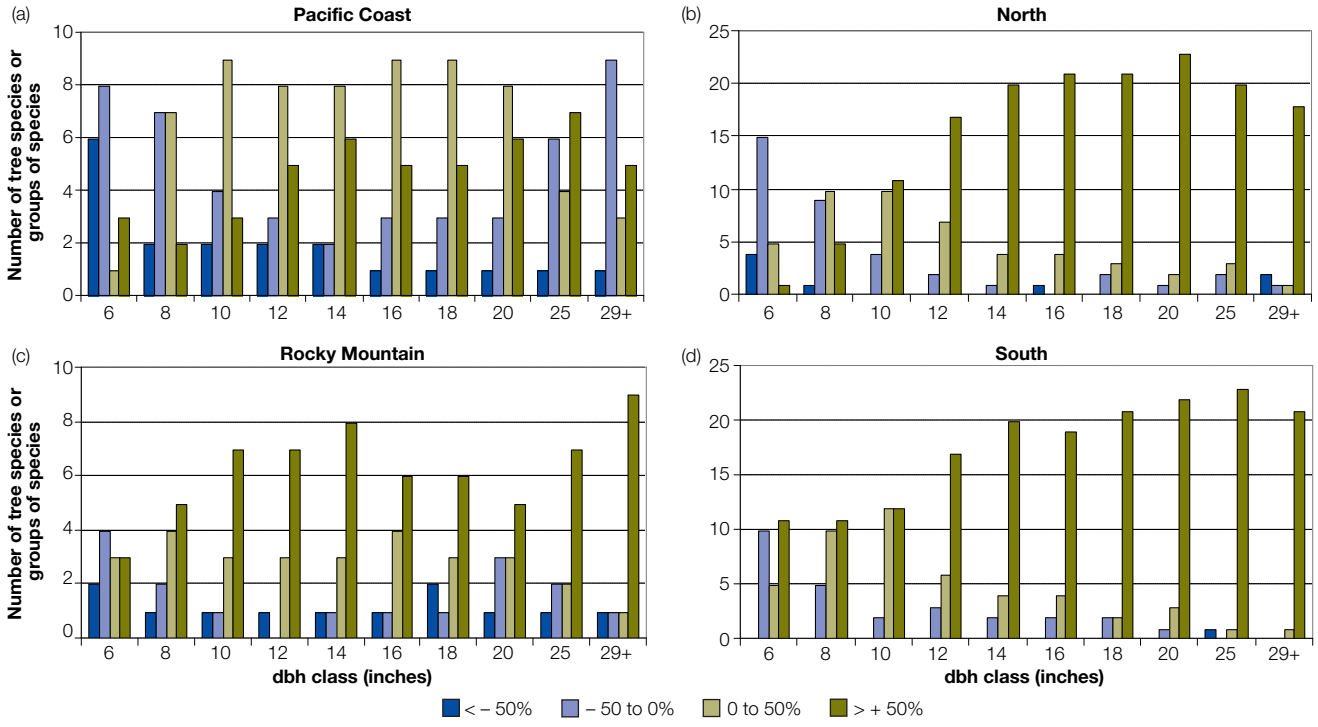
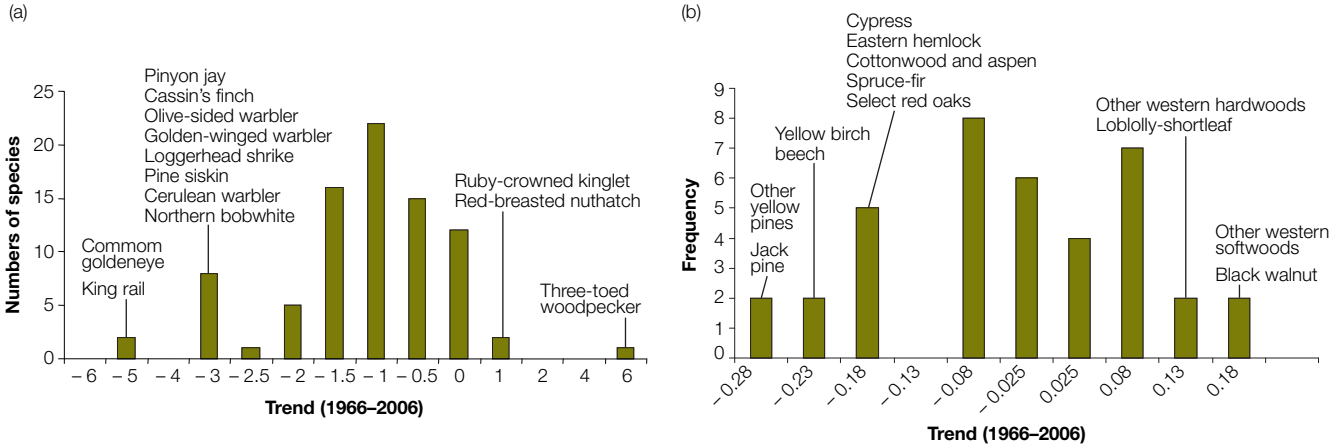


Figure 8-4. (a) Number of forest bird species by population trend. Classes between 1966 and 2006 for the subset of species that had significantly (P is less than or equal to 0.1) decreasing population trends between 1966 and 2003, calculated from the U.S. Geological Survey Breeding Bird Survey database. (b) Frequency of tree species or groups of species in the Forest Inventory and Analysis database by relative change classes in total stem numbers between 2002 and 2007.



Indicator 1.09. Status of Onsite and Offsite Efforts Focused on Conservation of Genetic Diversity

What is the indicator and why is it important?

This indicator describes the extent of onsite and offsite conservation efforts for native species at the genetic level. Onsite efforts are those conducted in the field, such as efforts to increase populations of endangered species. Offsite efforts are conducted in laboratories, greenhouses, arboreta, seed banks, seed orchards, and similar facilities. Sustainable forest management requires a commitment to conserve locally or regionally adapted populations of native species using a combination of onsite and offsite approaches.

What does the indicator show?

Onsite conservation of genetic diversity is provided by parks and other protected areas, genetic and ecological conservation areas, reserved forest areas, and through planned natural regeneration. Onsite conservation efforts for genetic diversity of plants and animals vary greatly in spatial extent and intensity of management. Many public forests include genetic conservation for common species as a primary management goal and are managed intensively for species that are rare, threatened, endangered, or of special concern. Some private forests also are managed to conserve genetic diversity. These onsite efforts to conserve genetic diversity largely overlap with efforts to conserve species diversity that are described for Indicator 1.06, and that material is not duplicated here.

Offsite genetic conservation efforts tend to be intensive and are often focused on breeding programs or archival programs. These measures are sometimes undertaken, for example, to ensure that seed used for replanting after harvest has sufficient genetic diversity. Offsite genetic conservation occurs at zoos, seed banks, seed orchards, clonal archives, arboretums, and similar facilities. These are summarized in table 9-1. Institutions differ in the proportion of total effort that is focused on forest species. Some institutions work on global and domestic forest genetic diversity conservation.

What has changed since 2003?

This indicator was not reported in 2003.

Are there important regional differences?

Many broadscale, onsite efforts to conserve genetic diversity are associated with public forest land and protected areas. Much public forest land is managed to conserve species diversity and genetic diversity as part of a multiobjective management strategy. Public forest land and protected forests in all ownerships are concentrated in the Western United States (see Indicators 1.02 and 1.06).

Offsite programs for conservation of genetic diversity are widely dispersed. Zoos, arboretums, and seed banks often work on global and national issues associated with genetic conservation. Facilities such as seed orchards, clonal archives, and provenance tests that grow plant material are constrained by the climate where they are located, but they also can participate in international efforts to conserve genetic material.

Why can't the entire indicator be reported at this time?

Conservation of genetic diversity occurs in many places and many ways. Arboretums, herbaria, seed collections, seed orchards, zoos, and dedicated breeding programs are intensive approaches (primarily offsite) for conservation of genetic diversity. These are funded by Federal, State, and local governments and by NGOs. Ecologists, botanists, biologists, and foresters at universities across the United States are engaged in projects to conserve genetic diversity of forest plants and animals. State and local native plant societies organize private individuals devoted to both genetic and species conservation. No practical way exists to enumerate all such efforts or the proportion of their efforts that is concentrated on forest associated species.

Extensive (primarily onsite) efforts aimed at genetic conservation take place on public and private lands across the United States. Most management decisions affecting forest land managed by the Forest Service, U.S. Fish and Wildlife Service, National Park Service, Bureau of Land Management, and Corps of Engineers consider effects on genetic and species diversity, with particular emphasis on species of regional, national, or global conservation concern (see Indicator 1.05). Some State, county, and private forests are managed with emphasis on conservation of species and genetic diversity. So are numerous private lands, including those protected by conservation easements or land trusts. It is not possible to enumerate all such efforts, or to discern the proportion of such efforts that is associated with conservation of genetic diversity of forest-associated species. The quantitative information presented in this indicator does not include many of these efforts and, thus, underestimates the total magnitude of work devoted to the conservation of genetic diversity.

Table 9-1. Summary of agencies, institutions, and organizations that work on conservation of genetic diversity (complied in 2009).

Category	Number
Arboretums affiliated with the American Public Gardens Association. Arboretums work largely, but not exclusively, with trees and other woody species. The American Public Gardens Association also has 176 affiliated botanical gardens and 14 native plant gardens. Some of these include forest-associated species and some (e.g., Missouri Botanical Garden) work on issues related to global forest diversity sustainability.	91
The Center for Plant Conservation coordinates the national efforts that conserve threatened and endangered species in offsite collections (primarily botanic gardens and arboreta).	36
Zoos accredited by the Association of Zoos and Aquariums. All focus on education, some have active research programs, and many feature forest-associated species from outside the United States.	181
Accredited aquariums. Populations of freshwater and anadromous fish, in particular, are closely tied to forest ecosystems.	37
States that fund forest tree nursery programs with total expenditures of $37 million. Many have associated seed orchards. Hundreds of private tree nurseries compliment State efforts as do the 58 commercial suppliers of tree and shrub seed.	33
The Federal Government has a number of agencies that actively manage offsite seed stores that conserve much native genetic diversity. These include the Forest Service genetics programs (primarily forest species), the BLM Seeds of Success program (range and forest species) and the National Genetic Resources Program (a small percentage of which is forest species), which is managed by the USDA/ARS. The U.S. Department of Agriculture National Center for Genetic Resources Preservation cooperates in the storage of forest species germplasm. The United States cooperates with other international gene bank programs, including the Consultative Group on International Agriculture Research and the Svalbard Global Seed Vault.	Several
The Plant Conservation Alliance is a consortium of 10 Federal agencies and 270 non-Federal cooperators representing various disciplines within the conservation field. Cooperators include many of the arboretums and botanical gardens mentioned above. Agencies and cooperators work collectively to solve the problems of native plant extinction and native habitat restoration. Federal agencies in the Alliance include the Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, and U.S. Geological Survey.	280
Native plant societies in the United States. They collect, preserve, and propagate native seed sources for use in restoration projects. Many are associated with the Plant Conservation Alliance.	88
Herbaria in the United States that maintain millions of plants specimens. They document plant biodiversity, serve as a valuable reference for plant taxonomy, and can also serve as sources of DNA. The U.S. National Seed Herbarium is part of the U.S. National Arboretum.	697
Databases such as NatureServe and the U.S. Department of Agriculture Plants database compile information about taxonomy, range, and status of many forest-associated plants and animals. This activity aids in measuring biodiversity.	Several

ARS = Agricultural Research Service. BLM = Bureau of Land Management. DNA = Deoxyribonucleic acid.

Criterion 2

Maintenance of Productive Capacity of Forest Ecosystems

What is this criterion and why is it important?

Forests, directly or indirectly, provide a wide range of extractive and nonextractive goods and services. The nature of theses goods and services change over time as a consequence of changes in social and economic demands, technology, and actions taken in the forest to provide the goods and services. Changes in the productive capacity of forests could be a signal of unsound forest management or unforeseen agents affecting ecosystems. This criterion has five indicators for evaluating the productive capacity of forest ecosystems. The first four indicators track traditional measures related to status and trends in forests available for wood supplies and the final indicator addresses trends nonwood related goods and services of the forest. The presentations in this criterion will provide information by major geographic region.

What has changed since 2003?

The data—The most significant change since 2003 is the freshness of the data. In 1999, the Forest Inventory and Analysis (FIA) program shifted from periodic surveys of each State on a roughly 10-year cycle to an annualized survey, which collects data in each State every year. The current exceptions are Wyoming (last survey 2001), New Mexico (last survey 2000), Nevada (last survey 1989), Hawaii (last survey 1986) and interior Alaska (no complete previous survey), which are scheduled to begin annualized inventories pending sufficient program funding. In the long term, this new approach will allow rolling average summaries of the status of forest inventory, health, and harvesting data every year. For nonwood products, a wider range of data sets is available for public lands since 2003, but data for private lands are still incomplete.

The indicators—Readers wishing to compare results of the 2003 and 2010 reports need to be aware of changes in the criteria and indicators. In 2007, the Montréal Working Group completed a review and revision of the indicators in Criteria 2 based on the experiences of the first round of country reports. The following table summarizes the revisions. Indicator reference numbers for 2003 and 2010 are provided to assist in comparisons with the previous report. A more detailed rationale for the revisions may be found at http://www.rinya.maff.go.jp/mpci/meetings/18_e.html.

Criterion 2. Maintenance of Productive Capacity of Forest Ecosystems.

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
10	Area of forest land and net area of forest land available for timber production	Change “timber” to “wood”	2.10	Area and percent of forest land and net area of forest land available for wood production
11	Total growing stock of both merchantable and nonmerchantable tree species on forest land available for timber production	Change “timber” to “wood”	2.11	Total growing stock and annual increment of both merchantable and nonmerchantable tree species in forests available for wood production
12	The area and growing stock of plantations of native and exotic species	No change	2.12	Area, percent, and growing stock of plantations of native and exotic species
13	Annual removal of wood products compared to the volume determined sustainable	Add comparison to “net growth”	2.13	Annual harvest of wood products by volume and as a percentage of net growth or sustained yield
14	Annual removal of nontimber forest products (e.g. fur bearers, berries, mushrooms, game), compared to the level determined to be sustainable	Change “timber” to “wood”	2.14	Annual harvest of nonwood forest products

Indicator 2.10. Area and Percent of Forest Land and Net Area of Forest Land Available for Wood Production

What is the indicator and why is it important?

This indicator provides information fundamental to calculating the wood production capacity of existing forests and shows how much forest is potentially available for wood production, compared with total forest area. The availability and the capability of forest land to provide desired goods and services is a critical indicator of the balance of forest ecosystems relative to potential end uses. The multitemporal nature of the management objectives and planning guidelines for diverse U.S. owners, however, make it difficult to summarize the area of forest available for wood production in a single value at a single point in time, much less consistently over time. Within the context of this report, forest available for wood production will be defined as forest land not precluded by law or regulation from commercial harvesting of trees or timber land. In practice, the area available for wood production at any given time will always be a value less than total timber land. The amount of the area adjustment required to determine the actual availability of timber land will depend on the ownership mix and the management constraints in place at the time of analysis. This adjustment will affect all other indicators in Criterion 2 as well.

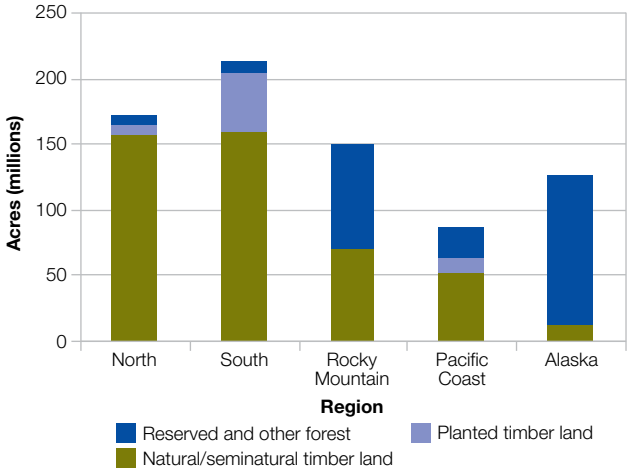
What does the indicator show?

Forest land in the United States, totaling 751 million acres, is nearly equally distributed between East and West, with 387 million acres in the East (North and South Regions) and 365 million acres in the West (Rocky Mountain, Pacific Coast, and Alaska Regions). Timber lands, including natural and seminatural stands and planted forests comprise the largest category of forest (fig. 10-1) with 514 million acres nationally; 368 million acres (72 percent) of this total is in the East and 146 million acres in the West. Planted forests currently comprise 12 percent (63 million acres) of all U.S. timber land and the area is increasing.

Planted forests are most common in the South where 45 million acres (72 percent) of all such forests in the United States occur. Planted forests are discussed in more detail in Indicator 2.12. The total area of timber land in the United States has been stable during the past 50 years with an overall loss of only 1 percent (fig. 10-2).

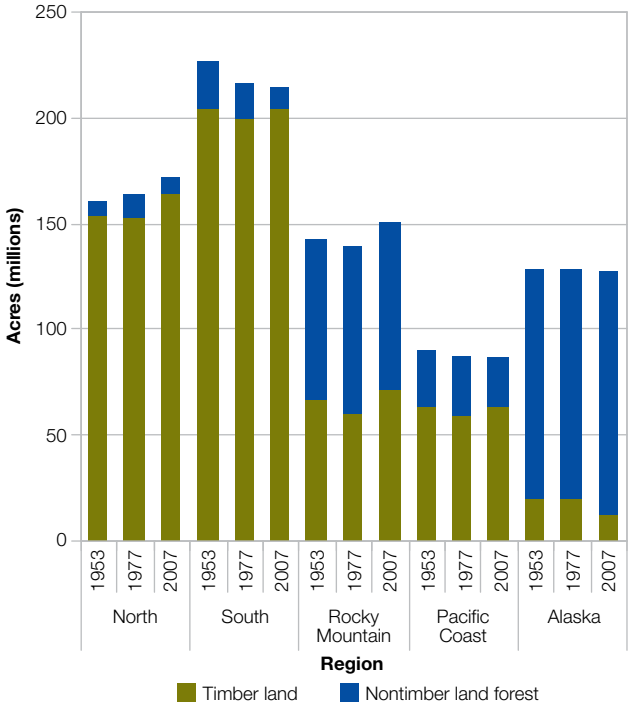
Ownership also plays a key role in the area available for U.S. wood production. Timber land is generally concentrated on private lands in the East (fig. 10-3) and public lands in the West. Overall, private timber lands account for 356 million acres, about 69 percent of all forest available for wood production in the United States.

Figure 10-1. Forest land by region and forest class, 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 10-2. Timber land and nontimber land forest area by region, 1953, 1977, and 2007.

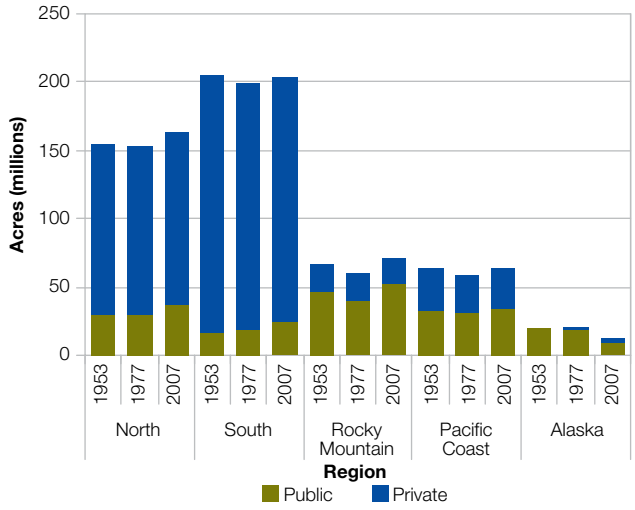


Source: USDA Forest Service, Forest Inventory and Analysis

Conifer forest types are fairly equally distributed between the East and West and broadleaf types are dominant in the East (fig. 10-4).

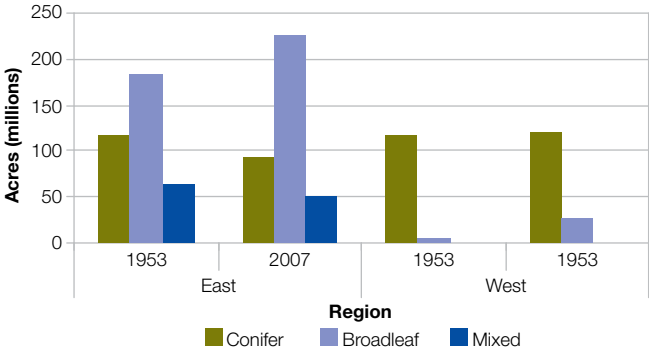
Private timber lands currently account for 91 percent of U.S. wood production, compared to 86 percent in 1952 (fig. 10-5). Although public ownerships have the benefit of very long-term tenure, recent public land policy shifts toward reducing the amount of wood harvested from public lands have contributed to increased pressure on private forests in the United States and increased imports to meet U.S. wood needs.

Figure 10-3. Timber land area by ownership and region, 1953, 1977, and 2007.



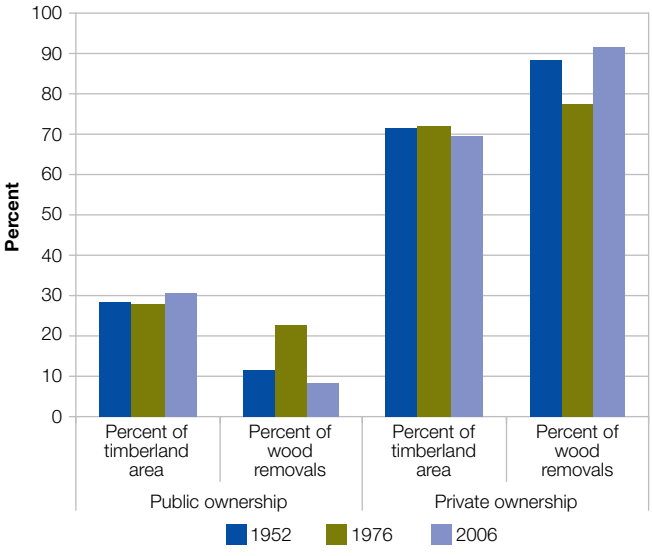
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 10-4. Timber land in the United States by major cover type, 1953 and 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 10-5. Percent of timber land area and wood removals by ownership group.



Source: USDA Forest Service, Forest Inventory and Analysis

The notion of sustainability of forest available for wood production is linked to the demand for these forests for other uses. Natural events, and competing societal forces can also affect availability. Fire, weather, and insect and disease outbreaks can seriously affect supplies at any given time. Forest productivity can also be altered by pollution and human-caused degradation. Consumer preferences, recycling, and investments in the forestry sector and availability of workers also play a significant role in wood production. Sound institutional frameworks that provide continuous monitoring of critical aspects of forests are invaluable. Simply put, wood production relies on the existence of available forest land and all of the factors that influence the sustainability of that land.

What has changed since 2003?

Timber land has increased by 7 million acres in the East (2 percent) and 3 million acres in the West (2 percent) since 2003. Much of the increase came from the reclassification of previously marginal timber lands or areas, particularly in the mid-section of the country, that were previously classified as nonforest. This reclassification is more consistent with national standard definitions, and was applied to areas that tended to be privately owned.

Indicator 2.11. Total Growing Stock and Annual Increment of Both Merchantable and Nonmerchantable Tree Species in Forests Available for Wood Production

What is the indicator and why is it important?

Growing stock is a fundamental element in determining the productive capacity of the area identified as forest available for wood production. Knowledge of growing stock of the various species that make up the forest and how it changes over time is central to considerations of a sustainable supply of wood for products and the sustainability of the overall ecosystems that provide them.

What does the indicator show?

The Nation's forests contain more than 800 species of trees. Because changes in markets and technology dictate species use for wood products, it is difficult to assign the status of nonmerchantable to any given species except those of very small stature or those with rare, threatened, or endangered status. Variability in the condition of the size and quality of these trees has considerable bearing on their value in wood products. Generally speaking, about 94 percent of all live tree volume on timber land in the United States is considered to be growing stock or wood capable of being used for commercial

products. The remaining 6 percent are trees of poor form, small stature, or otherwise unsuited for wood products. Given the minor influence of nonmerchantable volume relative to total live volume of timber on forests available for wood production, the remainder of the discussion for this indicator will focus on merchantable or growing stock volume.

Overall, growing stock volume (fig. 11-1) has been rising in all regions of the country, for the past 50 years. The exception being the Pacific Coast and Alaska where harvesting of large timber and losses of high-volume timber lands to reserves in the 1970s and 1980s resulted in declines. Recent reductions in harvest in this region have reversed this trend.

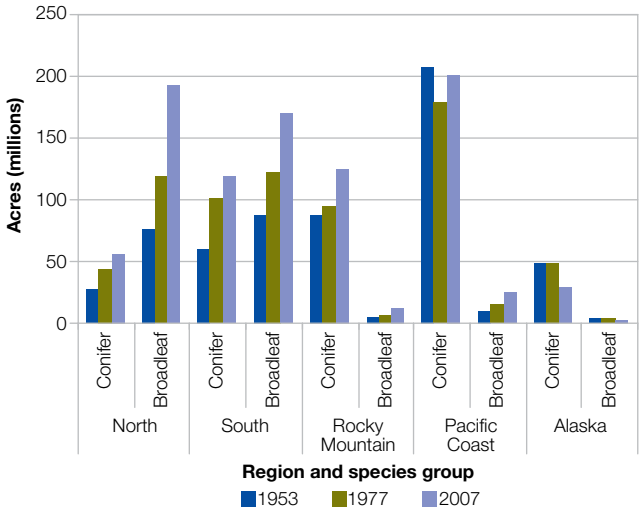
With a relatively stable base of forest land available for timber production or timber land (Indicator 2.10) and a historic pattern of growth exceeding removals (Indicator 2.13), the volume of growing stock in the United States has been rising steadily for more than 50 years. The current total of 932 billion feet of growing stock is 51 percent higher than the volume in 1953. U.S. conifer growing stock volume totals 529 billion cubic feet or 57 percent of all growing stock. Conifer growing stock volume is concentrated primarily in the West and South. Broadleaves, at 403 billion cubic feet, account for 43 percent of all growing stock volume in the United States. Broadleaf volume has risen 118 percent since 1953 as second and third growth forests of the North and South continue to mature.

Growth rates on timber land have increased on all land ownerships (fig. 11-2). The higher rate of increase on National forests due, in part, to a response to vigorous young stands replacing older slower growing stands harvested in the 70s and 80s or lost to fire. The higher overall rates and lower net change on private lands reflects the history of these lands being the primary source of wood production in the United States for decades.

As mentioned in other indicators in this Criterion, ownership has a direct bearing on management policy and access to available timber. Timber volumes are distributed unevenly among owners because of many factors (fig. 11-3), among them history of use, land productivity, and degree of management. As public agencies have adjusted management policies to respond to increasing demand for uses of public forest land for recreation, wildlife habitat, and biodiversity conservation, the area and corresponding volume of wood available for harvest from public timber lands is declining and placing additional pressure on private timber land and imports. This pressure is further heightened by improved technologies, which allow a shift to broadleaves, which are dominant on private timber lands, for many uses previously dominated conifers such as paper and composite products to meet demand. Overall, growth on private timber land is increasing, but has slowed in response to increasing demand caused by shifts in policy and technology and the slowing growth of maturing broadleaf stands. This slowing growth will likely abate slightly as regeneration following the recent increases in harvesting gets established. The reduction of harvest on public land is reflected in sharply rising volumes per acre in these forests, which may create new management issues relative to fire and overall forest health.

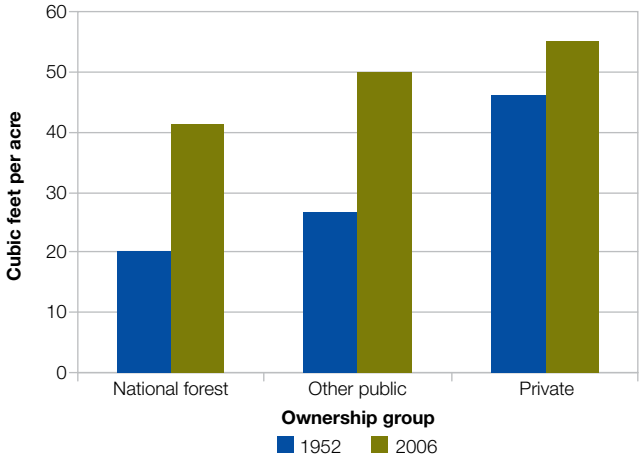
National forests, which account for only 19 percent of U.S. timber land, have 30 percent of all timber volume, and 46 percent of all conifer timber volume. Changing management policies have significantly affected the national forests and the wood they supply. The national forests supplied 15 percent of U.S. wood in 1976, today they supply 2 percent. The future of wood supplies from this source is in question, but is likely to remain low.

Figure 11-1. Growing stock volume on timber land by region, 1953, 1977, and 2007.



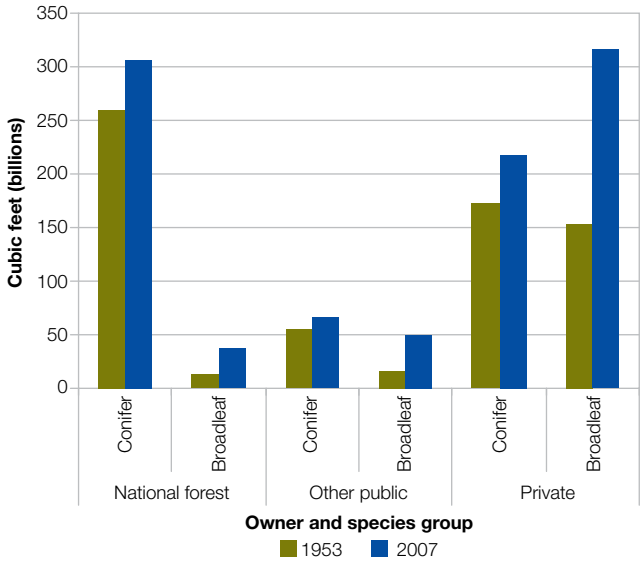
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 11-2. Average growing stock growth per acre on timber land by ownership group, 1953 and 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 11-3. Growing stock volume on timber land by region, owner, and species group, 1953 and 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

What has changed since 2003?

Growing stock volume increased from 856 billion to 932 billion cubic feet (9 percent) as net growth continues to exceed removals. Current conifer volume increased 8 percent (37 billion cubic feet) from the 492 billion cubic feet reported in 2003 and broadleaves increased 11 percent (39 billion cubic feet) from the 364 billion cubic feet reported in 2003. Recent large divestitures of timber lands by private corporate landowners, particularly forest industries, have left the future of what these lands will provide under their new ownership uncertain. Arrangements for wood availability from these lands, ranging for 10 to 50 years, however, were part of the forest industry divestiture strategy.

Indicator 2.12. Area, Percent, and Growing Stock of Plantations of Native and Exotic Species

What is the indicator and why is it important?

This indicator is a measure of the degree to which forest plantations are being established in response to increasing demand for forest products and competing nontimber uses for forest land. The provision of forest products from intensively managed plantations, which are more productive and efficient, can enhance the potential range and quantity of goods and services available from the forest.

In this indicator, we will look at planted forests in general. Planted forests in the East tend to be traditional, intensively managed pine plantations and in the West planting is generally used to augment stocking with a preferred species, usually Douglas-fir or ponderosa pine. In both cases the target is a crop tree stand dominated by the preferred species and we will treat them as similar because they have a common management goal.

What does the indicator show?

In contrast to many other countries, virtually all tree planting in the United States is of native species with nonnative species comprising less than 1 percent of all planted forest. Two types of planting can be identified; traditional plantations of intensively managed trees where other vegetation is actively suppressed, and planting to augment stocking of naturally regenerating forests. The former, predominantly occur in the East and the latter, predominantly in the West. Although conifers overwhelmingly dominate, broadleaves such as high-value species like black walnut and oaks are planted as well. In addition, a nonnative hardwood, royal Pawlonia (*Paulownia tomentosa*) is planted to produce wood for export markets. Although forest planting is common in the United States, it should be noted that fully two-thirds of all of the annual 11 million acres of forest harvested in the United States regenerate by natural means.

During the past 50 years more than 100 million acres of forest have been planted in the United States (fig. 12-1), including regeneration after harvest of previously planted stands and converted natural stands. During this time incentive programs established millions of acres of planted forest, including the Soil Bank Program in the 1950s and the Conservation Reserve Program during the late 1980s and early 1990s. Although most of these planted forests were established on private land, public funding was often used to help put them into place. Historically, forest industries also leased private forest land or offered management assistance to private landowners to establish or maintain planted forests to assure future wood supplies. Recent large divestitures of most forest industry land, however, may have altered this practice and data from the new owners needs to be monitored to evaluate this situation.

Overall, planted forests account for 8 percent of all U.S. forest land and 12 percent of timber land, predominately comprised of conifer species. In the West, planted forests account for an estimated 12.2 million acres or 19 percent of all planted timber land (table 12-1). About 95 percent of these occur in the Pacific Coast Region. In the East, planted forest totals 51 million acres or 80 percent of all planted timber land. Most planted forests are in the South which has 45 million acres, or about 71 percent of all planted timber land, and are primarily comprised of longleaf, slash, loblolly or shortleaf pine. Planted forest acreage continues to rise in the South and currently accounts for 22 percent of all timber land in the region. Increases at the current rate are not likely to continue as incentive programs subside and as previously planted stands are harvested and reestablished with no increase in net area in planted timber land.

Planted forests make up a substantial component of only a few forest type groups across the country. In the South, loblolly-shortleaf pine has the greatest acreage of planted timber land (fig. 12-2) at 30 million acres or 48 percent of all planted timber land followed by longleaf-slash pine with nearly 8 million acres. In the North Region, white-red-jack pine planted timber lands are the most common with 2.8 million acres. And, in the West, Douglas-fir has the largest area of planted timber land at 7 million acres.

Nationwide, about 75 billion cubic feet of growing-stock inventory are contained in planted stands, about 8 percent of total growing-stock inventory (fig. 12-3). This seemingly low contribution to inventory relative to percentage of all timber land planted (12 percent) is because of the young age class structure of the planted resource. Because of high productivity, planted stands make a significant contributions to timber inventory, even with a very young age-class structure.

In the South, planted stands are currently providing two-fifths of the region's softwood removals—a percentage that will rise as the relatively young stands increase in age. A forecast that planted timber lands in the South would supply more than one-half of the softwood removals in the region by 2010, appears on track.

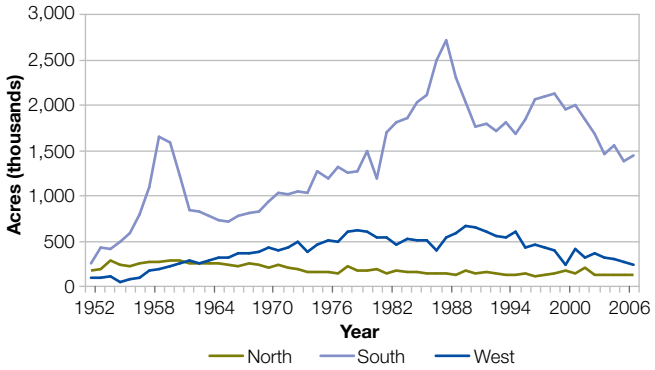
Plantations are considered one of the best alternatives for maintaining wood supplies in the face of shrinking areas of forest available for wood production because of competing uses. Because the Southern Region will likely continue its dominance as the Nation's wood basket well into the future, this region's high-yield planted forests will likely continue to play a crucial role in sustaining U.S. wood production.

During the past decade, significant changes in forest ownership have occurred in the United States. Large-scale divestiture of landholdings by forest industry has resulted in the shift of millions of acres of these acres primarily to timber investment management organizations (TIMOs) and real estate investment trusts (REITs). Future changes in wood availability created by these shifts will need to be monitored.

What has changed since 2003?

The broader definition of planted forest versus plantations allowed for the inclusion of large areas of forest where augmented stocking of natural regeneration takes place, mainly in the West. On this basis, planted forests increased from 56 million acres in 2003 to 63 million acres currently. The South continues to be the main area for planted forests and increased from a reported 38 million acres in 2003 to 45 million acres in 2007. Volume on planted forests increased from an adjusted 57 billion cubic feet in 2003 to 75 billion cubic feet in 2007, a 32-percent increase. Volume in the South increased from 30 to 42 billion cubic feet (40 percent).

Figure 12-1. Area of tree planting in the United States by major geographic region, 1952–2006.



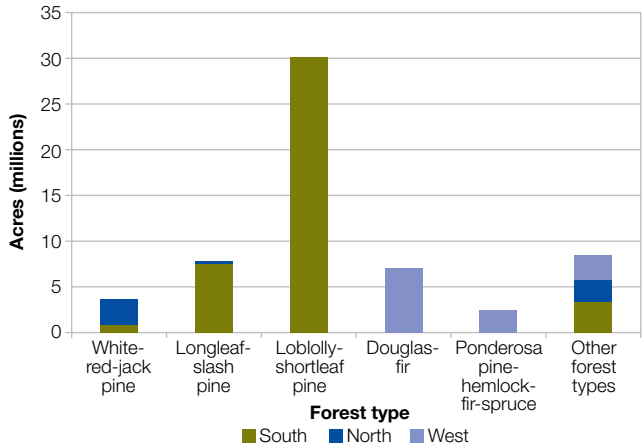
Source: USDA Forest Service, Cooperative Forestry

Table 12-1. Area of forest land and planted and natural timber land.

Region and type	Forest land	Timber land		
		Total	Planted	Natural
East	*Million acres*			
Loblolly-shortleaf pine	55	55	30	24
Longleaf-slash pine	15	14	8	6
White-red-jack pine	11	10	3	7
Oak-pine	30	29	4	24
Other types	277	260	6	255
Total	**387**	**368**	**51**	**317**
West				
Douglas-fir	39	35	7	28
Ponderosa pine	25	23	1	22
Hemlock-fir-spruce	92	34	1	33
Other types	209	54	3	52
Total	365	146	12	134
U.S. total	**751**	**514**	**63**	**451**

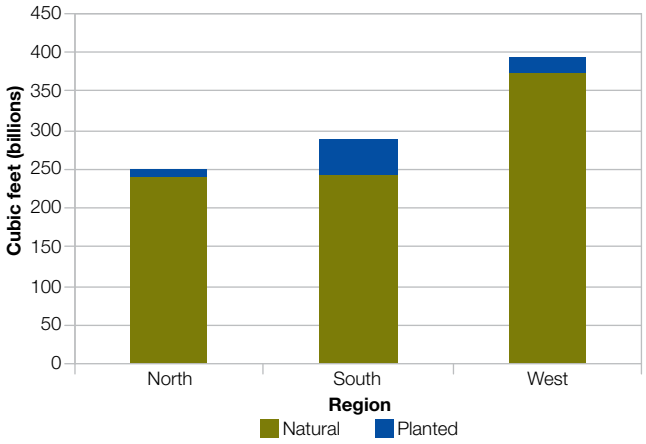
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 12-2. Area of planted timber land by major forest type and region, 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 12-3. Growing stock volume on planted and natural forest by region, 2007.



Source: USDA Forest Service, Forest Inventory and Analysis

Indicator 2.13. Annual Harvest of Wood Products by Volume and as a Percentage of Net Growth or Sustained Yield

What is the indicator and why is it important?

This indicator compares net growth with wood harvest (removals) for products on timber land. This comparison is a frequently used method of assessing whether or not wood harvesting is reducing the total volume of trees on forest available for wood production. Growth is the net annual increase in the volume of growing stock between inventories after accounting for effects of mortality, but before accounting for the effects of harvest. Removals are a measure of the average annual volume of growing stock trees harvested between inventories. Timber land is assumed to be the subset of forest land on which some level of wood harvesting is potentially allowed. So long as growth (net of mortality) exceeds removals, the volume of trees on timber land is considered sustainable. This measure, however, conveys no information about quality, biodiversity, other attributes of ecology, or management objectives, and it should be considered in conjunction with other indicators as part of an overall analysis of objectives for forest ecosystem sustainability.

What does the indicator show?

Growth has exceeded removals on U.S. timber lands for several decades (fig. 13-1), although the area of timber land has remained relatively stable. The result has been a substantial increase in the volume of growing stock on U.S. timber lands. In the past decade, growth continued to exceed removals for both publicly and privately owned timber lands in the East (North and South Regions) and West (Rocky Mountain, Pacific Coast and Alaska Regions). Trends in growth on timber land since 1952 are attributable to several factors. In general, positive growth trends reflect regrowth and maturation of forests on lands that had been harvested before 1952. Investments in fire protection, landowner education, and silviculture are also reflected in the trends. Changes in harvest patterns in the 1990s resulted in growth and removals shifts by ownership and region. Historically, most harvesting occurred on private timber lands in the East and recent data show a further shift of removals from public timber land in the West to private timber land in the East as policies to reduce harvesting on public lands in the West were implemented. Thus, growth has been exceeding removals by a wider margin in the West while the gap has been decreasing in the East. Interpreting growth trend data in the West, particularly on public land, can be complicated by the reductions in harvesting and set asides of large areas of public timber land into reserves since the mid-1970s, thus, apparent declines may be an artifact of this situation.

Although this situation is significant, recent major planting of conifers in the South are rapidly becoming of commercial size and are expected to improve the situation in that region. Current growth measures in the South may not fully reflect anticipated growth on these planted forests. Currently, 91 percent of U.S. wood output is produced on private lands.

Since 1952, overall conifer volume has increased 23 percent and broadleaf volume has increased 118 percent. The lower percentage for conifers is reflective of higher demand for wood products from these species. Growth exceeding removals in all regions for both conifers and broadleaves is reflective of this trend (figures 13-2 and 13-3).

Based on site productivity data measured during field inventories, an estimate can be made of the productive potential of U.S. forests and how they relate to the current situation (fig. 13-4). This measure provides and estimate of the productive capacity of forests based on maximum growth at the culmination of mean annual increment. Overall, U.S. timber lands are growing at 51 cubic feet per acre per year, as opposed to a potential of 77 cubic feet. Thus, current growth is 66 percent of its estimated maximum potential. A clear capacity exists to sustain present levels of timber harvest from a pure wood volume standpoint, even at current growth rates. Many reasons exist, however, as to why the potential growth may not be achieved. The main reason is that the diverse objectives of the many different owners of U.S. timber lands may not have the maximization of wood fiber production as their primary objective.

Saw and veneer logs and pulp wood are the dominant primary wood products from U.S. timber lands, comprising 94 percent of all wood removals, up from 75 percent in 1953 (fig. 13-5).

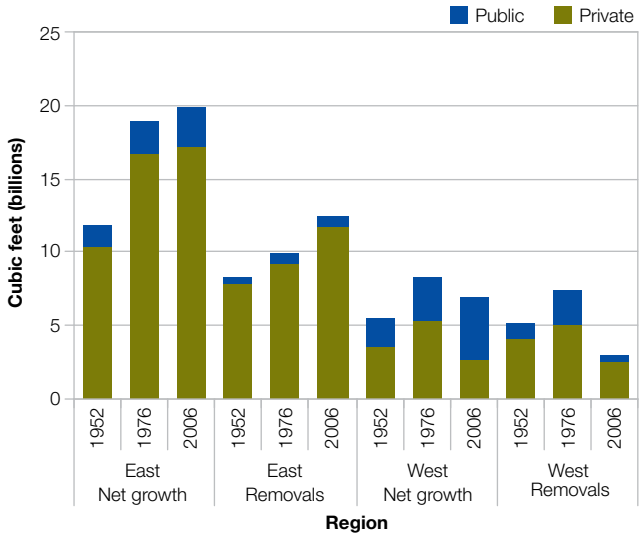
Timber land is concentrated on private lands in the East and public lands in the West. Recent studies indicate that 58 percent

of noncorporate private owners have harvested wood on their land. Recent large divestitures of forest land by private corporate landowners, particularly forest industries, have left the future viability of these lands for wood production less clear.

What has changed since 2003?

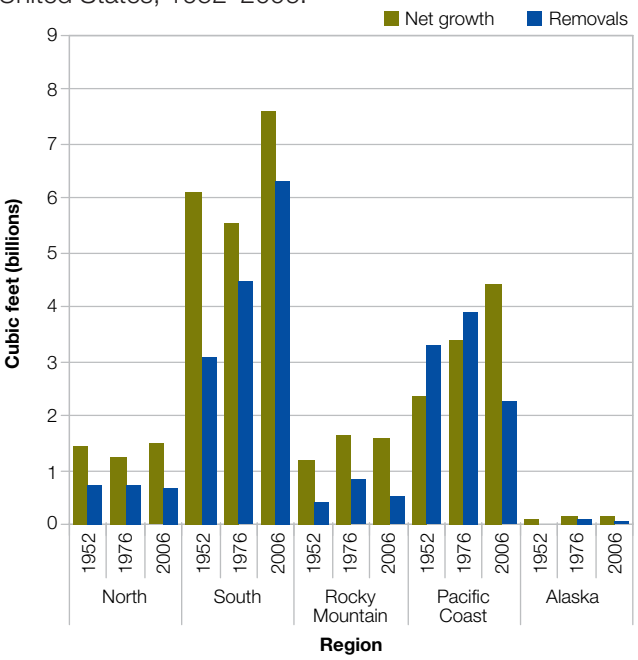
Growth continues to exceed removals on U.S. timber lands, as it has for more than 50 years. Overall, domestic removals of growing stock have declined from 15.8 to 15.5 billion cubic feet since 2003. This decline is also reflected in the statistic that conifers and broadleaf removals were 75 and 58 percent of growth respectively in 2003, and currently these values are 65 and 49 percent respectively. Demand has not subsided, and imports continue to rise to meet U.S. wood needs (Indicators 6.28, 6.30, and 6.32).

Figure 13-1. Growth and removals of growing stock on timber land by owner group and region, 1952–2006.



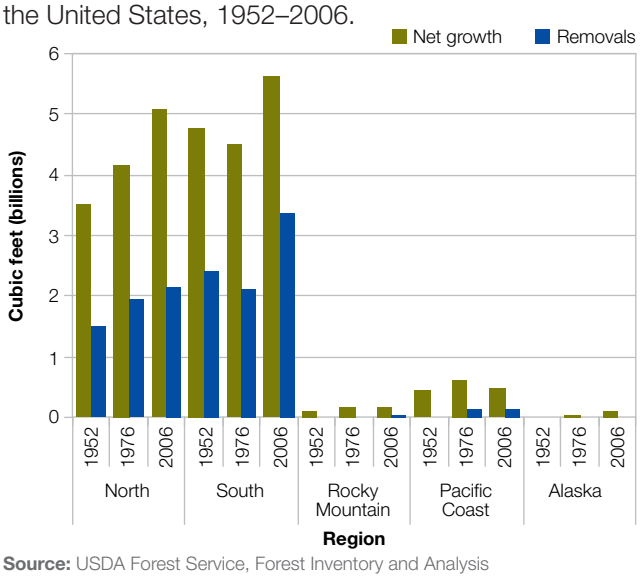
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 13-2. Net growth and removals of conifers in the United States, 1952–2006.



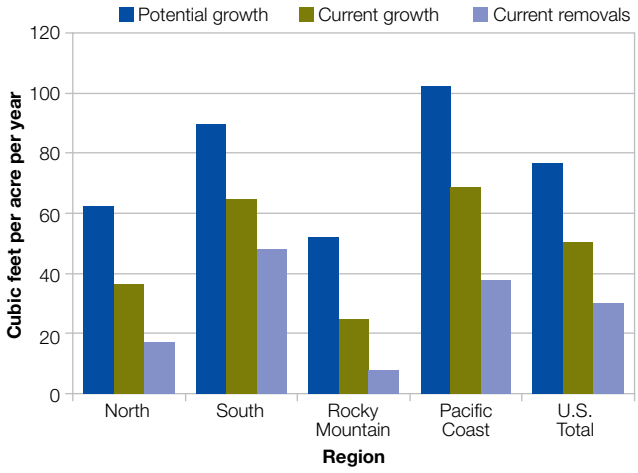
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 13-3. Net growth and removals of broadleaves in the United States, 1952–2006.



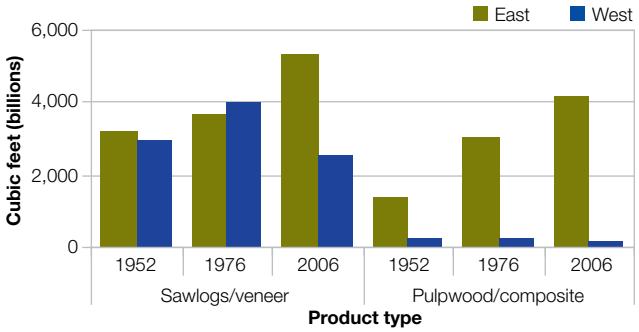
Source: USDA Forest Service, Forest Inventory and Analysis

Figure 13-4. Potential and current growth and removals on timber land by region, 2006.



Source: USDA Forest Service, Forest Inventory and Analysis

Figure 13-5. Removals of growing stock for major forest products, 1952, 1976, and 2006.



Source: USDA Forest Service, Forest Inventory and Analysis

Indicator 2.14. Annual Harvest of Nonwood Forest Products

What is the indicator and why is it important?

This indicator measures harvest levels of nonwood forest products (NWFPs). NWFPs include medicinal plants, food and forage, floral and horticultural products, resins and oils, arts and crafts materials, and game animals. As demand for these products grows, it becomes increasingly important to monitor the removal of products from forests, and the effects of their removal on the viability of current and future forest ecosystems. Lack of management of NWFPs may result in negative effects to species diversity, ecosystem dynamics, cultural practices, and other ecological, economic, and social frameworks.

What does the indicator show?

Nonwood Forest Products run the gamut from pinecones to fur-bearing animals, so it is not currently feasible to measure a total harvest for the United States across all categories or even within an individual category. Instead, harvest levels are given here for representative products of particular importance or interest ecologically, economically, or socially. Information on additional products for which data are available can be found in the supporting technical document in the data report.

Medicinal Plants—17 of the 22 medicinal plants studied by the American Herbal Products Association (AHPA) in 2004 and 2005 were wild harvested. Harvests of medicinal plants occur throughout the country, although the temperate forests of the Eastern United States supply larger quantities of medicinal plant species. Of the species recorded by AHPA (2004 to 2005), 16 occur in the South, 14 occur in the North, 10 occur in the Rocky Mountain Region, and 2 occur on the Pacific Coast. Not enough data were available to state with certainty which specific States within regions harvested particular medicinal species from wild (not wild cultivated) stock. According to AHPA, saw palmetto (*Serenoa repens*) fruit was the most harvested medicinal plant in terms of dry weight (tons). The 2005 reported wild harvest of saw palmetto berries reached 2,893 tons—nearly double the 2004 reported volume. AHPA attributes the increase to fluctuating berry prices and supplies (AHPA 2004 to 2005). The top six primary commodities in terms of harvest volume following saw palmetto include cascara bark (*Frangula purshiana*), slippery elm bark (*Ulmus rubra*), black cohosh root (*Actaea racemosa*), Echinacea spp. herbs and roots, goldenseal leaves and roots (*Hydrastis canadensis*), and wild yam tubers (*Dioscorea villosa*) (fig. 14-1).

Food and Forage Plants—The Forest Service and the Bureau of Land Management (BLM) keep records of permits and contracts issued for harvests on their respective land, and provide some insight into harvest quantities. Contract and permit data are based on approximations only, because they represent the volume of permitted harvest rather than actual harvest. In addition, based on the proportion of public to private land in the United States, we make the assumption that harvests on National Forest System (NFS) lands probably represent about 20 to 30 percent of total national supply, although harvests on BLM land probably represent between 2 to 15 percent of the total national supply (*Susan Alexander, Forest Economist Forest Service Region 6, personal communication, 2009*). Approximately 1.6 million pounds and an additional 250 bushels of edible fruits, nuts, berries, and sap were permitted for harvest on NFS land in 2007; nearly double the quantity permitted for harvest on public land in 1998 (fig. 14-2a). Permitted harvests of edible plants on public lands were highest in the Pacific Coast, at 1.4 million pounds, or about 3 pounds for every 100 acres of public NFS and BLM forest lands. Although data on the volume of NWFPs harvested on private land are lacking, a 2006 survey of United States private forest landowners indicated that, of an estimated 10 million private landowners nationwide (excluding Alaska, Hawaii, west Oklahoma, and west Texas), 10 percent collected edible plants (Butler 2009).

Maple syrup represents a large NWFP industry in the North Region. In 2007, 1.3 million gallons of maple syrup from more than 7 million taps were produced in the United States (National Agricultural Staitistics Service 2007). Only a little more than 10,000 (about one-half of 1 percent) of those taps were permitted taps on public land. Maple production has remained stable in the United States since 1998, and currently only a small proportion of the available resource is being used for syrup production (Hansen et al., *In Press*).

Permits purchased on BLM and NFS land for forage plants were included here even though some harvested grasses may occur outside areas defined as forest. Alfalfa, hay, and grass permits were lumped together for this analysis, although some grasses (e.g., beargrass) are also used for Arts, Crafts, and

Floral products. Permitted harvests of alfalfa, hay, and grass for forage and crafts use on public lands were highest in the Pacific Coast Region, at more than 2,000 tons permitted. Permitted harvest quantities on public land have remained fairly stable since the late 1990 and early 2000s (fig. 14-2b). The spike in 2004 is because of the sale of beargrass, which is typically used in the arts industry. Much of the alfalfa, hay, and grass grown on private land is considered an agricultural commodity rather than a NWFP, and is therefore outside the scope of this report.

Christmas trees—According to the National Christmas Tree Association (NCTA), 25 to 50 million live trees are sold yearly in the United States (NCTA, 2005). The overwhelming majority of Christmas trees sold in lots or stores come from farms where trees are planted, grown, harvested, and replanted just as any other agricultural crop, therefore it is difficult to separate out trees wild harvested for use as Christmas trees from trees commercially grown for that purpose. A small proportion of live trees are harvested from public land, yearly. Permits issued on national forest lands for Christmas tree harvest have declined steadily since 1998. In 2006, a little more than 50,000 permits and contracts were issued for Christmas tree collection—a 20-percent increase from 2005, but a 71-percent decrease from 1998. Permitted Christmas tree harvests have declined on BLM land, also. The number of Christmas trees harvested on BLM land decreased from 27,709 trees in 1998 to 13,866 trees in 2007. Most of the wild-harvest Christmas trees coming from publicly owned land are harvested in the Pacific Coast and Rocky Mountain Regions.

Figure 14-1. Quantity of top six wild-harvested dried plants (excluding saw palmetto) for 1999 to 2005 as reported by the American Herbal Products Association (Voluntarily reported by survey respondents. American Herbal Products Association 2004 to 2005).

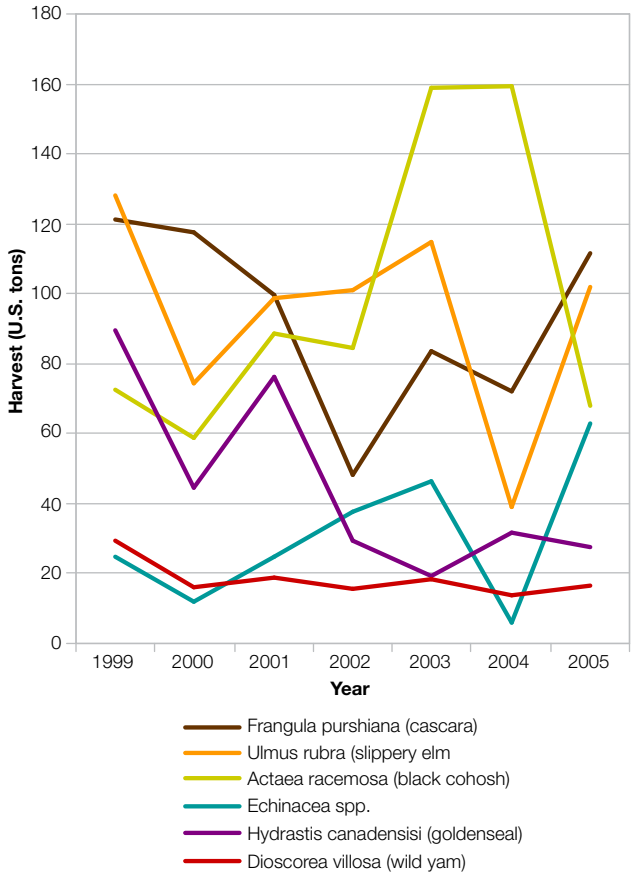
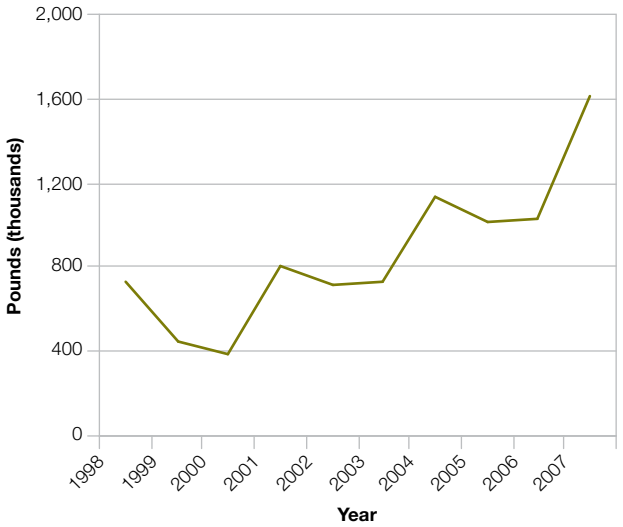
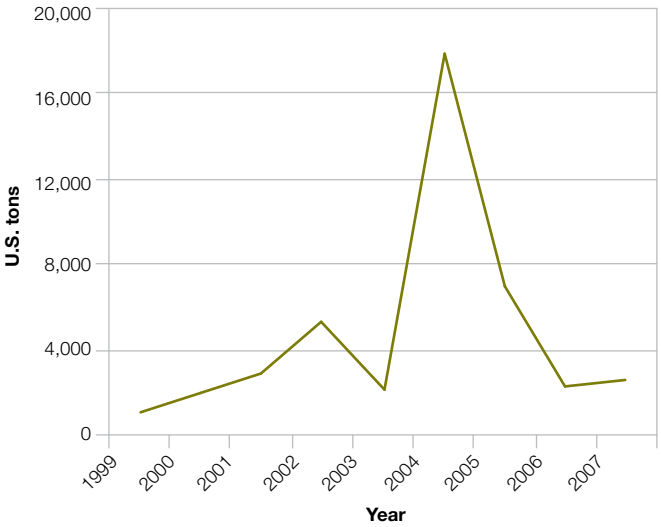


Figure 14-2a. Quantity of edible fruits, nuts, berries, and sap permitted for harvest on National Forest System and Bureau of Land Management land by year.



Source: USDA Forest Service and U.S. Department of the Interior, Bureau of Land Management

Figure 14-2b. Quantity of grass, hay, and alfalfa permitted for harvest on National Forest System and Bureau of Land Management land by year.



Source: USDA Forest Service and U.S. Department of the Interior, Bureau of Land Management

Arts, Crafts, and Floral—Permitted harvests quantities of arts, crafts, and floral products on public lands totaled more than 622,000 tons in 2007. Foliage, limbs, and boughs comprised the largest product category of removals by weight in tons. Most of the permitted harvests occurred in the Pacific Coast and Rocky Mountain Regions. An estimated 727,000 private landowners also collect NWFPs from their own properties for decorative use, according to 2006 surveys, although the volume of their harvests is unknown (Butler 2009).

What has changed since 2003?

The availability of a wider range of data sets represents the most significant change since the 2003 sustainability report. Based on the available data, nonwood forest products continue to be in demand, although the cultivation of some resources (for example, Christmas Tree farms) may be replacing the wild harvesting of select products. Although we now have the data necessary to track some harvest levels on public land, and some information about use on private land, we still lack the ability to determine the level of harvest that could be considered sustainable.

Criterion 3

Maintenance of Ecosystem Health and Vitality

What is this criterion and why is it important?

Ecosystem health depends on the functionality of natural, nondegraded ecosystem components and processes. The underlying premise is that forest species and ecosystems have evolved to function within particular environmental conditions determined largely by geological and climatic forces. Humans, meanwhile, have historically (and prehistorically) adapted their economic and social activities to environmental conditions and to the resulting ecological processes. Substantial modification of environmental conditions therefore threatens species' adaptive capacities, ecosystems' functional capacities, and associated human economies and societies. For example, many local and regional U.S. economies depend on forests. To the extent that exotic species, air pollution, or diseases threaten the forests, socioeconomic values are also threatened.

What has changed since 2003?

The data—The indicators in this criterion have benefited from data improvements resulting from ongoing survey efforts undertaken by the Forest Service's Forest Health Protection program.

The indicator—The following table summarizes the revisions. Indicator reference numbers for 2003 and 2010 are provided to assist in comparisons with the previous report. A more detailed rationale for the revisions may be found at http://www.rinya.maff.go.jp/mpci/meetings/18_e.htm.

Criterion 3. Maintenance of Ecosystem Health and Vitality.

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
15	Area and percent of forest affected by processes or agents beyond the range of historic variation	Merge biotic components of 2003 indicators and change "historic variation" to "reference conditions"	3.15	Area and percent of forest affected by biotic processes and agents (e.g., insects, disease, invasive alien species) beyond reference conditions
16	Area and percent of forest land subjected to levels of specific air pollutants (e.g., sulfates, nitrate, ozone) or ultraviolet that may cause negative effects on the forest ecosystem	Merge abiotic components of 2003 indicators and change "historic variation" to "reference conditions"	3.16	Area and percent of forest affected by abiotic agents (e.g., fire, storm, land clearance) beyond reference conditions
17	Area and percent of forest land with diminished biological components indicative of changes in fundamental ecological processes (e.g., soil nutrient cycling, seed dispersion, pollination) and/or ecological continuity (monitoring of functionally important species, such as fungi, arboreal epiphytes, nematodes, beetles, wasps)	See above		

Indicator 3.15. Area and Percent of Forest Affected by Biotic Processes and Agents (e.g., Insects, Disease, Invasive Alien Species) Beyond Reference Condition

What is the indicator and why is it important?

Observed activity and effects from key biotic agents and processes measured by Indicator 15 show deterioration in forest ecosystem health and vitality and decline in forest sustainability. The "reference condition" is defined as the previous reporting period (1997 to 2002) used in the *National Report on Sustainable Forests—2003*. Current analysis of these agents and processes, systematically measured at regular intervals and contrasted with the reference condition provides information in support of practical forest health planning and management. The indicator is based on primary collection of insect and disease mortality and defoliation data (mainly through aerial survey) that are augmented by modeling and analysis techniques. The methodology is repeatable, and, with a growing database, increasingly reliable.

What does the indicator show?

Figure 15-1 shows areas of predicted risk of disturbance by biotic agents; risk is defined as 25 percent loss of standing volume over the next 15 years. Figure 15-2 shows areas with broadscale forest decline and tree mortality detected for this indicator during the past 5 years. Recently mapped effects show a three-fold increase in readily detectable damage, relative to the reference period, representing a significant departure from reference condition, deterioration in forest ecosystem health, and a threat to forest sustainability (fig. 15-3).

Within the broad context of this cursory report, evidence that biotic processes and agents are significantly out of range lies in what is directly observed and what is inferred (by extrapolating these results to account for understory effects not readily observed and to areas not regularly monitored, and by predicting risk into the future). Not described in detail within this report, yet detected and reportable at finer resolution are localized departures from reference condition. As predicted by risk modeling, and confirmed by site specific observations, actual effects at local or regional levels are often extreme.

Overall, the indicator shows a continuing and increasing trend in forest decline. Spikes in tree mortality during the reporting period are largely because of a combination of high stand density in unmanaged forests and drought, which both increase the likelihood of insect outbreaks. Cumulative effects of insects, disease and a complex of other environmental factors are occurring within previously surveyed areas and expanding into new areas.

Forest health damage detection (including both aerial and ground methods) results presented in this report cover a high proportion but not all of the total forested area. Annual aerial detection surveys cover approximately 70 and 20 percent of the total forested area in the lower 48 States and Alaska respectively. Consequently, the departure from reference conditions may be underestimated.

What has changed since 2003?

Annual mortality estimates within the past decade peaked in 2003 (fig. 15-4) then declined somewhat during subsequent years. The overall trend continues to increase, however. (A similar trend is evident for Alaska—see data report for details.) Mortality within any given year during the current period has not dropped below any given year during the reference period for the lower 48 States. Within the lower 48 States cumulative total forested area with mortality has increased to 37 million acres, compared to the reference condition of 12 million acres. Bark beetle, engraver beetle, gypsy moth-caused mortality, and mortality in the pinyon-juniper type because of complex factors, are leading contributors to increased mortality rates. Areas affected by root disease are documented as decreasing (see data report); however, it should be noted that currently reported insect-caused mortality often includes insect and disease complexes, so disease acreage is probably higher than recorded. Cumulative total forested area with defoliation has decreased by approximately 60 percent compared to reference conditions (see data report). Some of this decrease is attributable to gypsy moth suppression and eradication efforts and repeated defoliation events, moving those areas into the mortality category. The cumulative total forested area with mortality and defoliation since 2003 is approximately 50 million acres or 8 percent of the total hardwood and conifer forested area (considering all agents, not restricted to those specifically addressed in this report).

Do important regional differences exist?

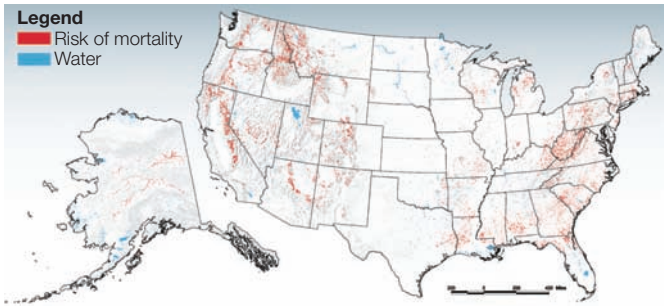
Cumulative effects from both native and nonnative pests are particularly evident at regional scales. Important regional effects from specific agents upon local ecosystems are often masked when these data are presented nationally.

Nonnative invasive plants, insects, and diseases include: sudden oak death and Port-Orford cedar root disease in the West; gypsy moth (fig. 15-5), hemlock woolly adelgid, sirex woodwasp, and emerald ash borer in the Northeast; salt-cedar in the Southwest, chestnut blight and butternut canker in the East; white pine blister rust, Dutch elm disease, tree-of-heaven, spotted knapweed and more. These often become established and readily spread within forested regions currently out of the range of natural variability. For example, stands becoming dominated by tanoak because of a variety of factors (shade

tolerant dominance resulting from fire exclusion, absence of harvest practices that increase age and species diversity, and so on) provide optimum conditions for the pathogen responsible for sudden oak death to become established and spread.

Native pest activity similarly threatens sustainability by affecting normal tree species distribution and the overall number and extent of live trees at regional scales. Examples include an insect complex in southern California in 2003, spruce beetles on Douglas-firs in the Northwest, and mountain pine beetle in the Rocky Mountains.

Figure 15-1. Predicted insect and disease risk equals 58 million acres (red) based on national 2006 composite.

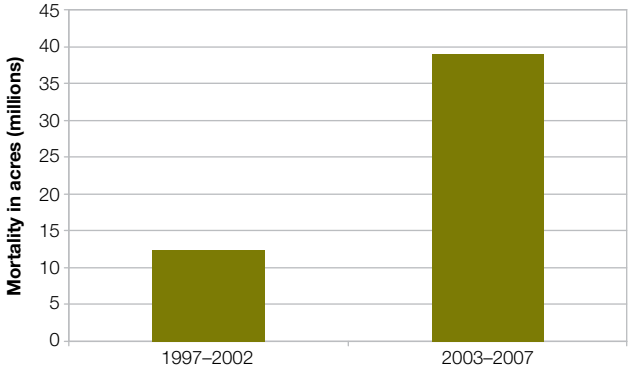


Source: USDA Forest Service, Forest Health Protection

Figure 15-2. Areas with mortality mapped from 2003–2007.

Source: USDA Forest Service, Forest Health Protection

Figure 15-3. Cumulative total area with mortality for select agents in the lower 48 States (cumulative effects occur where mortality continues in previously mapped areas and expands into new areas).

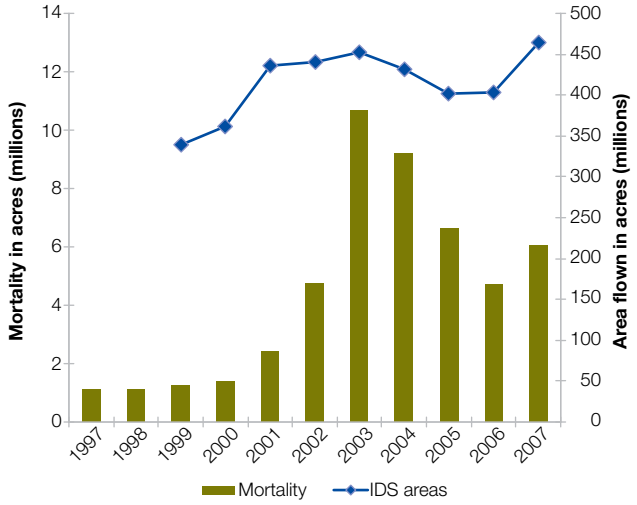


Source: USDA Forest Service, Forest Health Protection

Unique to Alaska is the issue of yellow cedar decline. The leading cause of yellow cedar decline appears to be freeze injuries to roots because of low snow pack. Cumulative acreage totals show a 24-fold increase in yellow cedar decline over reference condition.

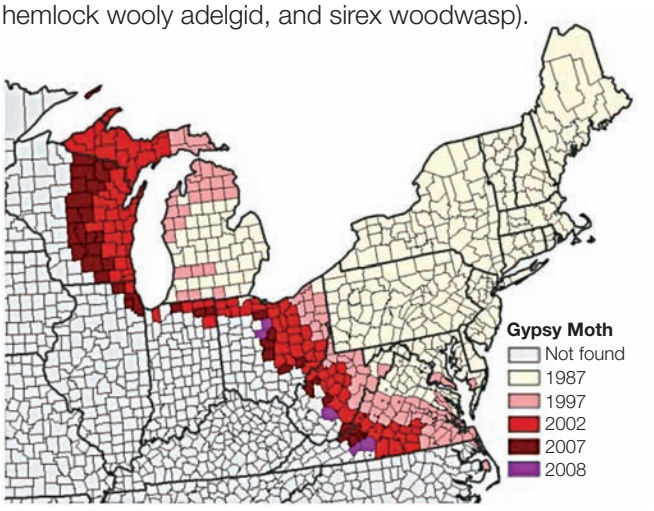
Monitoring regional effects is critical to early detection to apply management strategies for prevention and control within (1) affected areas, (2) areas currently in a predisposed condition, and (3) areas for which, without management, sustainability will soon be at risk.

Figure 15-4. Survey results for mortality and flown insect and disease survey areas within the lower 48 States; includes areas with pinyon, oak, and aspen mortality, select beetles, and root diseases for other tree species (reporting area flown began in 1999).



IDS = Insect and Disease Survey
Source: USDA Forest Service, Forest Health Protection

Figure 15-5. Gypsy moth effects and quarantine progression, 1987–2008; although geographic distribution varies, similar displays are available for counties confirmed with sudden oak death, emerald ash borer, hemlock wooly adelgid, and sirex woodwasp).



Source: USDA Forest Service, Forest Health Protection

Indicator 3.16. Area and Percent of Forest Affected by Abiotic Agents (e.g., Fire, Storm, and Land Clearance) Beyond Reference Conditions

What is the indicator and why is it important?

Various abiotic agents, both natural and human-induced, can change forest structure and species composition. Where such change goes beyond some critical threshold, forest ecosystem health and vitality may be significantly altered, and its ability to recover from disturbance is reduced or lost, often meaning a reduction or loss of benefits associated with that forest ecosystem. Monitoring the area and percent of forests affected by abiotic agents beyond reference conditions may provide information needed in the formulation of management strategies to mitigate risk.

What does the indicator show?

Of the abiotic agents that affect forested ecosystems, five were selected that have a dominant impact—fire, weather, pollution, land development, and climate change. Given the breadth of disturbance agents, it was not possible to treat any one of them in detail. Extended details are available in the supporting data report.

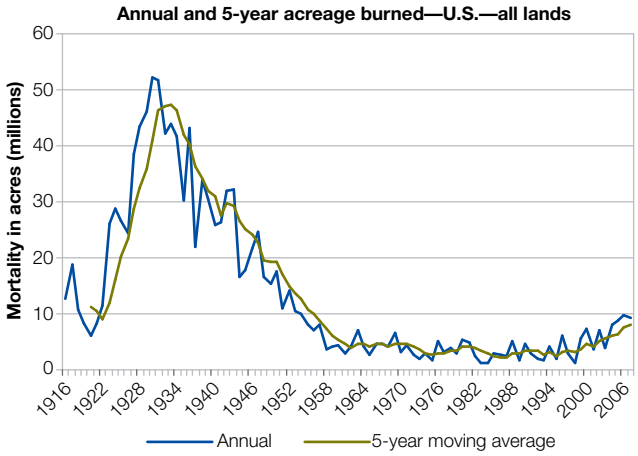
Fire is the most dominant abiotic agent in terms of area affected across the landscape, but is also an integral part of many forested ecosystems. Between 1945 and 2000, fire suppression substantially reduced annual acreage burned. Since 2000, an increase in area burned has occurred, although it has not yet reached the levels recorded between 1925 and 1960. Figure 16-1 summarizes acreage burned for all land cover types. Estimates of total affected area indicate a significant increase in fire damage in recent years, with the cumulative area affected for the 2003-to-2007 (40 million acres) period representing an increase of 1.5 times the area affected in the 1998-to-2002 period (25 million acres).

Forested lands accounted for 13.1 million acres of the burned area, equaling approximately 1.7 percent of all forest land. Although a significant increase in the extent of forest fires has occurred, concern over burn severity has prompted efforts to map the severity of large fires. Although complete data for the reference period is currently being developed, table 16-1 summarizes the total acreage burned for all forested lands for the current period.

Climate change may manifest itself with prolonged or more frequent drought. Drought-caused tree mortality is immediately noticeable; however, changes in productivity and regeneration success of species within their historic range would not be discernable at the 5-year reference period.

Drought can be measured by moisture deficit over a given time period. Perennial vegetation is affected by multiseasonal deficits. Figure 16-2 illustrates the predisposing drought conditions for the current period. Weather-related damage, caused by drought, flood, ice, hail, lightning, wind, and avalanche agents, is represented only in areas that have been aerial surveyed and, thus, may not represent all of the area affected by an agent. Forest Service's Aerial Survey Program measured 1.2 million acres of mortality attributable to drought (0.2 percent of the forested area) and an additional 0.5 million acres were affected by other weather-related events during the of 2003-to-2007

Figure 16-1. Total acreage burned.

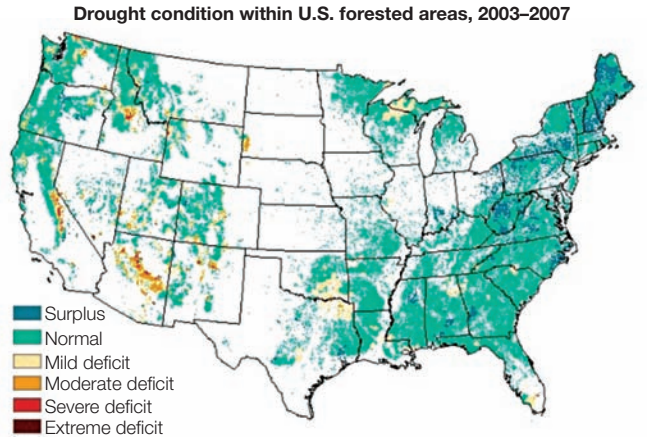


Source: USDA Forest Service, Forest Health Protection

Table 16-1. Acreage burned (thousands).

Fire	1998–2002	2003–2007
Total Burned Area—United States—All Lands	25,105	39,950
Forested lands:		13,131
High severity		2,724
Moderate severity		3,321
Low severity/other		7,086
Percent with high or moderate severity		46%

Figure 16-2. Drought conditions, 5-year period.



Source: USDA Forest Service, Forest Health Protection

period (0.1 percent of the forested area). All weather related damage is illustrated in figure 16-3.

Pollution effects on forests are indicated by Critical Acid Loading (CAL), which incorporates SO_4 and NO_3 and their relationship with soil properties. From 1994 to 2000, 74 million acres, or 17 percent of U.S. forest soils exceeded their CAL by more than 98.4 equivalents per acre per year. These areas are predominately located in the Northeastern United States (McNulty et al. 2007; see also Indicator 19). Surface ozone (O_3) is also an important air pollutant that affects vegetation. No evidence exists linking Forest Health Monitoring ozone bioindicator response data to a specific tree health problem or regional decline. Nevertheless, mapped data demonstrate that concentrations of plant damaging ozone air pollution are widespread in parts of the United States (Coulston 2005).

Figure 16-3. Surveyed weather damage.

Source: USDA Forest Service, Forest Health Protection

In 2000, 31 million forested acres existed in urban and suburban (less than 1.68 acres per residential housing unit) areas in the coterminous USA, but slightly more than seven times that (226 million acres) existed in exurban areas (between 1.68 and 39.98 acres per residential housing unit). From 1980 to 2000, the developed footprint has grown from 10.1 to 13.3 percent of forest land, roughly by 1.6 percent per year. This rate of land development outpaced the population growth rate (1.18 percent per year) by 25 percent. Based on model forecasts, urban and suburban housing densities will expand 2.2 percent by 2020, whereas exurban development on forest land will expand by 14.3 percent (Theobald 2005).

What has changed since 2003?

For burned area, the current period shows an increase over the reference period (table 16-2); however, both of these periods are substantially less than the historic 5-year period maximum that occurred in the late 1920s, as illustrated in figure 16-1.

Weather-related damage has increased during the past 5-year period (788,429 acres versus 1,760,885 acres) with drought exhibiting the largest proportion in acreage affected. Land clearing for urbanization continues to expand by 1.6 percent per year.

Are there important regional differences?

Burn severity data spanning from 1984 to 2007 has been tabulated for the Rocky Mountain and Pacific Regions. Over the past 24 years, the proportion of moderate and high burn severity on forested lands has increased from a proportion of 31 to 50 percent of the burned forested area (table 16-2). Burn severity for the Southern Region over the reference and current periods has declined (table 16-3).

Table 16-2. Burn severity (acres in thousands).

Fire	1983–1987	1988–1992	1993–1997	1998–2002	2003–2007
Burned Area—United States All Lands	10,535	16,482	16,635	25,105	39,950
Burn severity on forested lands—Western Region					
High	140	311	187	926	1,702
Moderate	211	229	244	929	1,476
Other	771	970	985	2,267	3,234
Percent with high or moderate severity	31%	36%	30%	45%	50%

Table 16-3. Burn severity (acres in thousands).

Burn Severity on Forested Lands—Southern Region		
	1998–2002	2003–2007
High	7	25
Moderate	31	144
Other	186	1,235
Percent with high or moderate severity	17%	12%

Criterion 4

Conservation and Maintenance of Soil and Water Resources

What is this criterion and why is it important?

Soil and water are primary stocks of natural capital in all terrestrial ecosystems. They constitute the foundation for the human economy and for the economy of nature with its birds, mammals, fish, reptiles, amphibians, invertebrates, and plants. Forest ecosystems differ from other types of ecosystems in that the soil and water resources support the growth of trees (which themselves constitute a form of natural capital). The amount of soil and water and their characteristics determine the capacity of ecosystems to sustain forests, forest economies, and forest-dependent societies.

What has changed since 2003?

The data—Indicator 4.17 was not reported in the 2003 report. Data for this indicator in the 2010 report were taken from the U.S. Environmental Protection Agency National Assessment Database. Indicators 4.18 and 4.20 are new in this report and data were taken from the National Association of State Foresters (NASF) survey. The FIA Soil Quality Indicator database used for Indicator 4.19 is greatly expanded since 2003. A different database (EPA National Assessment Database) than that used in the 2003 report has been used for Indicator 4.21 in this report.

The indicators—The following table summarizes the revisions. Indicator reference numbers for 2003 and 2010 are provided to assist in comparisons with the previous report. A more detailed rationale for the revisions may be found at http://www.rinya.maff.go.jp/mpci/meetings/18_e.htm.

The 2003 soils Indicators 18, 21, 22, and 25 were merged into the new soil conditions Indicator 4.19. The 2003 water Indicators 20, 23, and 24 were merged into the new water quality Indicator 4.21. New Indicators 4.18 and 4.20 report on the extent that best management practices are followed to protect soil and water resources. New Indicators 4.19 and 4.21 report on the actual condition of soil and water quality on forested lands.

Criterion 4. Conservation and Maintenance of Soil and Water Resources (1 of 2).

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
Protective Function				
19	Area and percent of forest land managed primarily for protective functions (e.g., watersheds, flood protection, avalanche protection, and riparian zones)	Wording change	4.17	Area and percent of forest whose designation or land management focus is the protection of soil or water resources
Soil				
18	Area and percent of forest land with significant soil erosion	Merge to new Indicator 4.19		
21	Area and percent of forest land with significantly diminished soil organic matter and changes in other soil chemical properties	Merge to new Indicator 4.19		
22	Area and percent of forest land with significant compaction or change in soil physical properties resulting from human activities	Merge to new Indicator 4.19		
25	Area and percent of forest land experiencing an accumulation of persistent toxic substances	Merge to new Indicator 4.19		
		NEW	4.18	Proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources
		NEW	4.19	Area and percent of forest land with significant soil degradation

Criterion 4. Conservation and Maintenance of Soil and Water Resources (2 of 2).

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
Water				
20	Percent of stream kilometers in forested catchments in which stream flow and timing have deviated significantly from the historic range of variation	Merge concept to new Indicator 4.21		
23	Percent of water bodies in forest areas (e.g., stream kilometers, lake hectares) with significant variance of biological diversity from the historic range of variability	Merge concept to new Indicator 4.21		
24	Percent of water bodies in forest areas (e.g., stream kilometers, lake hectares) with significant variation from the historic range of variability in pH, dissolved oxygen, levels of chemicals (electrical conductivity), sedimentation, or temperature change	Merge concept to new Indicator 4.21		
		NEW	4.20	Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water-related resources
		NEW	4.21	Area and percent of water bodies, or stream length, in forest areas with significant change in physical, chemical, or biological properties from reference conditions

Indicator 4.17. Area and Percent of Forest Whose Designation or Land Management Focus Is the Protection of Soil and Water Resources

What is the indicator and why is it important?

This indicator provides a measure of the extent to which soil and water resources in forested areas are protected by legislative or administrative designation or where their protection is the primary management focus. Such designations or management protections guard against degradation of soil resources, maintain soil quality, and prevent impairment of water supplies intended for public consumption.

Indicator 4.17 is also related to Indicators 18 and 20, which report on the overall use of forestry best management practices to protect soil and water resources. Forestry best management practices include a set of preventative measures designed to control or reduce movement of sediment, nutrients, pesticides, or other pollutants from soils to receiving water bodies.

What does the indicator show?

Every 2 years, States submit water quality reports to EPA under Section 305(b) of the Clean Water Act. The National Assessment Database summarizes the data submitted by the States (http://www.epa.gov/waters/305b/index.html). States designate water uses and assess water quality attainment in the National Assessment Database. Waters designated by the States as public water supplies are protected waters and are managed to protect soil and water resources in their watersheds. The total size of the watersheds containing assessed waters designated as public water supplies is unknown but will be directly proportional to the reported miles of rivers and streams and acres of lakes, ponds, and reservoirs.

In the United States, 3,589,765 miles of rivers and streams were reported by the States in the 2006 National Assessment Database (table 17-1). American Samoa, Northern Mariana Islands, Pacific Trust Territories, and the U.S. Virgin Islands provided no data. Of these, 822,340 miles have been assessed (22.9 percent of total). A total of 187,424 miles (5.2 percent of total) have been designated by the States as public water supplies and, thus, meet Indicator 17-protection criterion. Thirteen States and territories without an explicit public water supply or overall use designation include Florida, Hawaii, Maryland, Minnesota, Mississippi, Ohio, South Carolina, Wisconsin, District of Columbia, American Samoa, Northern Mariana Islands, Pacific Trust Territories, and the U.S. Virgin Islands. Thus, waters in those areas are not included in the protected total.

In the United States, 42,003,669 acres of lakes, ponds, and reservoirs were reported by the States in the 2006 National Assessment Database (table 17-1). Hawaii, American Samoa, Northern Mariana Islands, Pacific Trust Territories, and the U.S. Virgin Islands provided no data. Of the reported acres, 16,610,248 acres have been assessed (39.5 percent of total). A total of 7,801,087 acres of lakes, ponds, and reservoirs (18.6 percent of total) have been designated as public water supplies. Eight States and territories did not assess any lakes, ponds, or reservoirs (Arkansas, Hawaii, Ohio, Pennsylvania, American Samoa, Northern Mariana Islands, Pacific Trust Territories, and the U.S. Virgin Islands). These States and territories plus 10 additional States (Florida, Maryland, Michigan, Minnesota, Mississippi, New Jersey, Oregon, South Carolina, Wisconsin,

Table 17-1. Total estimated waters reported by States, total assessed waters, and condition of U.S. rivers/streams and lakes/ponds/reservoirs designated as public water supply use (U.S. Environmental Protection Agency 2006 National Assessment Database. http://www.epa.gov/waters/305b/index.html).

Type of Water Body	Estimated Total Waters in United States	Total Waters Assessed	Percent of Total Waters Assessed	Assessed Waters Designated as Public Water Supply	Percent of Total Waters Designated as Public Water Supply	Good (percent)	Threatened (percent)	Impaired (percent)
Rivers/streams (miles)	3,589,765	822,340	22.9	187,424	5.2	79.6	1.1	19.3
Lakes/ponds/reservoirs (acres)	42,003,669	16,610,248	39.5	7,801,087	18.6	78.6	1.9	19.5

and Wyoming), and the District of Columbia do not have separate public water supply use or overall use designations, and did not contribute to the total acreage.

Approximately 79.6 percent of the rivers and streams and 78.6 percent of the lakes, ponds, and reservoirs designated as public water supplies have attained good water quality status (table 17-1).

In addition to the specific protections associated with watershed management for public water supply, it should be noted that forest management regulations and practice involve soil and watershed protection measures. These involve a variety of Federal, State, and local regulations and voluntary stewardship practices, and they apply to varying degrees across different locations and across different forest ownerships.

What has changed since 2003?

No data were reported for this indicator in the previous report.

Are there important regional differences?

Because many key States did not report any data and many States do not have a separate use designation for public water supplies, it is not possible to determine whether regional differences exist in designation of protected water resources. Also, most water sources in each State have yet to be assessed.

Why can't the entire indicator be reported at this time?

This indicator implies that data will be reported in terms of forested land areas. The public database that most directly addresses this indicator, however, collects and reports data in terms of miles of streams and rivers and acres of lakes, ponds, and reservoirs. Although watershed land area is directly proportional to the size of the water bodies within the watershed, the forested portions of watersheds containing waters designated as public water supplies are unknown. Nevertheless, because these are waters designated as public water supplies, they are inherently protected through forest management and forest land will be the major land use classification in those watersheds.

The forested parts of hydrologic unit codes are known, but the necessary overlay of water use designation from the EPA database and the forest land use database for each watershed was not available for this report.

Indicator 4.18. Proportion of Forest Management Activities That Meet Best Management Practices or Other Relevant Legislation To Protect Soil Resources

What is the indicator and why is it important?

Forestry best management practices (BMPs) to protect soil resources are a set of preventive measures designed to control soil erosion caused by forest management activities. They are designed not only to avoid excessive loss of productive soils from the landscape but also to protect receiving water bodies from excess sediment loads from accelerated erosion.

What does the indicator show?

Indicator 4.18 is closely related to Indicator 4.20. Protection of soil resources leads to protection of water resources. The best way to protect water bodies from excess sedimentation is to protect the soil resource from excess loss via accelerated erosion caused by unsound forest management. Because BMPs were developed and are used to protect water resources, an assessment of BMPs to protect water resources automatically provides an assessment for protecting soil resources. Therefore, this indicator is reported under Indicator 4.20: Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water related resources such as riparian zones, water quality, quantity, and flow regulation.

What has changed since 2003?

This indicator did not exist in the 2003 report.

Are there important regional differences?

See brief for Indicator 4.20.

Indicator 4.19. Area and Percent of Forest Land With Significant Soil Degradation

What is the indicator and why is it important?

Underlying soil conditions directly control forest productivity and health. Soil conditions, as described by various physical and chemical properties, determine overall soil quality. Changes in soil conditions, as a result of disturbances or land use activities, may adversely affect forest productivity and health. The goal of this indicator is to quantify changes in soil quality resulting from climate changes, disturbances, or land use activities. The Forest Inventory and Analysis (FIA) Soil Quality Indicator was developed to assess the condition and trend of soil quality on all U.S. forest lands and therefore directly meets this indicator goal.

What does the indicator show?

Estimates of bare soil on FIA plots provide an indirect or surrogate measure of soil erosion potential, which is also related to precipitation amounts and distribution, slope steepness and length, soil texture, and types of disturbances (Elliot et al. 2000). Estimates of plot area showing evidences of soil compaction indicate the areal extent of disturbances that may change the physical properties of soils. This indicator estimates only the areal extent of visual evidences of compaction and does not measure compaction intensity. The affect of soil compaction on forest productivity is complex and depends on numerous factors, including soil texture, moisture content, and vegetation (Powers et al. 2005).

Most FIA plots have at least some bare soil, but only a very small percentage of plots (0.4 to 5.5 percent) have bare soil covering more than one-half the plot area (table 19-1). These plots are at highest risk of accelerated soil erosion, but cover only a very small fraction of all forested lands. Only 0.3 to 4.7 percent of all plots show evidences of compaction on more than one-half the plot area (table 19-1). Thus, soil compaction is not a widespread problem on forested lands and is largely confined to trails and forest harvest operations.

Soils develop in response to several interacting factors: parent material, topography (landscape position), organisms, climate, and time. In general, more highly weathered soils have lower levels of organic matter and nutrients and develop in warmer areas with ample precipitation. Over time, forests adapt to these local soil conditions, but forests developed on low productivity soils may have a higher risk of soil-related forest health decline when subjected to additional environmental stressors and may be more prone to accelerated soil degradation if forest cover is lost.

Nutrient-poor and acid forest soil conditions are found throughout the United States, but acidic soils with low Ca and high Al levels are concentrated in the Northeast and South, primarily in the Appalachian regions (table 19-2). The most serious soil-related emerging forest health threat is increasing soil acidity and associated decreasing soil Ca reserves along with increasing potentially toxic levels of exchangeable Al. This soil condition is strongly related to atmospheric acid deposition (Driscoll et al. 2001).

What has changed since 2003?

Because of changes to the Soil Quality Indicator and the more limited data set collected in 2003, direct comparisons between then and now are, for the most part, not possible. The 2003 report was based on only 2 years of FIA data. In the 2003 report, 1.6 percent of the plots (1999 to 2000) had evidence of compaction on more than one-half of the plot area. With 6,001 plots assessed from 1999 through 2005, that percentage has increased to just 2 percent of all plots. This increase is probably attributable to the assessment of a much wider geographic area of the United States.

Are there important regional differences?

The interior West tends to have more bare soil in forested areas than other regions, and is likely the result of more open tree canopies and less forest floor accumulation of organic matter during the sustained drought of recent years. The extent of bare soil can fluctuate during a growing season and depends on physiographic location and plant communities and their condition. The North Central Region tends to have more areas with evidence of soil compaction. The South has more highly weathered soils with lower organic matter and nutrients than other regions and the South and Northeast have a large percentage of strongly acidic soils with low Ca and high Al levels. The data in table 19-2 indicate a developing soils-related forest health threat. Continued loss of Ca and increases in Al throughout the northern and southern Appalachian Mountains puts Ca-sensitive tree species at risk of decline and mortality. Although southern forests are adapted to soil conditions in that region, the already low organic matter and nutrient status of these soils indicates that these forests may be more susceptible to influences from additional stressors (e.g., industrial inputs, drought, insects, and disease).

Table 19-1. Percent of Forest Inventory and Analysis P3 plots assessed from 1999 through 2005 with bare soil on more than 50 percent of plot area and showing evidences of compaction on more than 50 percent of plot area.

	Northeast[a]	North Central	South	Interior West	Pacific West	United States
Total plots (N)	1,716	1,424	857	1,461	543	6,001
Soil condition			**Percent of plots**			
Bare soil greater than 50% of plot area	0.4	1.6	1.6	5.5	1.8	2.2
Compaction greater than 50% of plot area	1.3	4.7	1.9	0.3	1.8	2.0

[a] Northeast: CT, DE, MA, MD, ME, NH, NY, NY, OH, PA, RI, VT, WV; North Central: IA, IL, IN, KS, MI, MN, MO, ND, NE, SD, WI; South: AL, AR, FL, GA, KY, LA, MS, NC, OK, SC, TN, TX, VA; Interior West: AZ, CO, ID, MT, NM, NV, UT, WY; Pacific West: AK, CA, HI, OR, WA; States in which the FIA Soil Quality Indicator is not yet implemented: MS, OK, NM, AK, HI.

Table 19-2. Percent of Forest Inventory and Analysis P3 plots (2000–2005) by region and soil depth with selected suboptimal soil conditions and with increased risk of soils-related forest health decline.

	Northeast[c]		North Central		South		Interior West		Pacific West	
	0–10 cm	10–20 cm	0–10 cm	10–20 cm	0–10 cm	10–20 cm	0–10 cm	10–20 cm	0–10 cm	10–20 cm
Soil condition						**Percent of plots**				
Organic C less than 1%	1.4	15.0	4.3	33.9	15.3	62.4	19.4	34.6	8.0	18.0
Total N less than 0.1%	6.3	29.7	14.1	50.1	47.0	82.8	31.0	52.2	22.7	41.9
Water pH less than 4.0	25.7	8.6	3.0	1.2	5.9	2.5	0.1	0.0	1.6	1.0
Exch[a] K less than 100 mg/kg	73.6	90.4	55.4	76.3	73.4	85.4	11.1	23.0	20.7	28.3
Exch Mg less than 50 mg/kg	58.3	73.2	19.9	35.3	45.9	61.6	6.3	10.0	17.9	28.3
Exch Ca less than 100 mg/kg	38.0	57.1	7.0	18.2	27.2	48.7	0.6	1.7	3.7	9.2
Exch Al greater than 100 mg/kg	73.7	73.0	23.2	27.1	30.9	35.2	6.8	7.6	20.0	21.6
Bray 1 P less than 15 mg/kg	81.7	83.8	63.8	67.7	83.8	89.2	39.3	53.4	31.3	41.5
Olsen P less than 10 mg/kg	34.8	60.0	24.9	52.8	87.9	92.6	47.9	63.5	29.2	45.4
SQI[b] less than 50%	**33.2**	**52.5**	**10.3**	**31.4**	**39.7**	**69.7**	**6.5**	**14.4**	**5.4**	**14.3**

[a] Exch = 1 M NH^4Cl exchangeable.

[b] SQI = soil quality index (less than 50 percent indicates increased risk of soil-related forest health decline).

[c] Regions same as defined in table 1 previously.

Indicator 4.20. Proportion of Forest Management Activities That Meet Best Management Practices, or Other Relevant Legislation, To Protect Water-Related Resources Such as Riparian Zones, Water Quality, Quantity, and Flow Regulation

What is the indicator and why is it important?

Forestry best management practices (BMPs) to protect water resources are a set of preventative measures designed to control or reduce movement of sediment, nutrients, pesticides, or other pollutants from soils to receiving water bodies. When properly implemented, forestry BMPs can prevent the impairment of water bodies from silvicultural practices and other forest management activities. Because the protection of water quality primarily involves the management of soil conditions, the information presented in this indicator can also be applied to Indicator 18, which assesses BMPs focused on soil protection.

What does the indicator show?

The Water Resources Committee (WRC) of the National Association of State Foresters (NASF) conducts periodic surveys of State nonpoint source (NPS) pollution control programs for silviculture. The fifth survey in the series was published in 2004 (NASF 2004). Responding to the survey were 45 States and two trust territories and the overall detailed results are tabulated in the survey report (NASF 2004). The term States in the NASF report and the report for this indicator refers to States, the District of Columbia, and trust territories. Development of BMPs for silviculture has occurred in 43 States, although 4 States do not have silviculture BMPs (NASF 2004).

Twenty-seven States reported on overall rates of use of forestry BMPs although 20 States responded unknown, nonapplicable, or did not respond to this survey question. Of the responding States, the median overall use of silvicultural BMPs is 91 percent with a range of 25 to 100 percent (table 20-1). Best management practice categories include preharvest, stream management, logging roads, stream crossings, site preparation, chemical use, roads to bed, and wetlands.

What has changed since 2003?

This indicator did not exist in the 2003 report.

Are there important regional differences?

Reported overall BMPs use is slightly higher in the West and South than in the East.

Table 20-1. Overall rates of forestry best management practice use in 2004 by State and National Association of State Foresters (NASF) regions.

NASF Northeastern Region		NASF Southern Group		NASF Western Council	
State	Overall rate of best management practices use (percent)	State	Overall rate of best management practices use (percent)	State	Overall rate of best management practices use (percent)
Connecticut	NA	Alabama	97	Alaska	92
District of Columbia	NA	Arkansas	89	Arizona	NA
Delaware	99	Florida	97	California	95
Iowa	25–50	Georgia	90	Colorado	80
Illinois	NA	Kentucky	NA	Guam	NA
Indiana	~80	Louisiana	93	Hawaii	NA
Massachusetts	85	Mississippi	89	Idaho	92
Maryland	NA	North Carolina	83	Kansas	NA
Maine	76	Oklahoma	90	Montana	95
Michigan	NA	Puerto Rico	NA	North Dakota	100
Minnesota	NA	South Carolina	94	Nebraska	NA
Missouri	Unknown	Tennessee	NA	Nevada	NA
New Hampshire	NA	Texas	92	New Mexico	NA
New Jersey	NA	Virginia	91.4	Oregon	96
New York	NA			South Dakota	NA
Ohio	80			Utah	NA
Pennsylvania	Unknown			Washington	NA
Rhode Island	NA			Wyoming	94
Vermont	70				
Wisconsin	86				
West Virginia	NA				
Northeast Region median	80	Southern Group median	91	Western Council median	95

NA = no response, no data available, or unknown.

Why can't the entire indicator be reported at this time?

Information for this indicator is dependent on State-level survey responses. Only 27 States provided responses that were applicable in constructing the indicator. Furthermore, BMPs are developed at the State level and may differ considerably both in their specific requirements and in their overall level of protection.

Indicator 4.21. Area and Percent of Water Bodies or Stream Length in Forest Areas With Significant Change in Physical, Chemical, or Biological Properties From Reference Conditions

What is the indicator and why is it important?

Water quality in forest ecosystems is controlled by climate and hydrology, catchment geology, natural disturbances, land management, and actual land use activities whether managed or not. Water quality in undisturbed forested catchments can serve as important baseline references for water quality in catchments with varying land use and management activities. Trends in physical, chemical, or biological properties can indicate effects of changing land use and management can be altered to preserve water quality.

What does the indicator show?

Every 2 years, States submit water quality reports to the EPA under Section 305(b) of the Clean Water Act. The National Assessment Database summarizes the data submitted by the States (http://www.epa.gov/waters/305b/ index.html). States designate water uses and assess water quality attainment in the National Assessment Database. States also determine the principal sources of impairment for both linear water bodies (rivers and streams) and area-based water bodies (lakes, ponds, and reservoirs).

The States reported 3,589,765 miles of rivers and streams in the 2006 National Assessment Database. Of these, 822,340 miles have been assessed for water quality attainment (22.9 percent of total). Sixteen States (Arizona, Alaska, Arkansas, California, Illinois, Kentucky, Louisiana, Montana, New Mexico, Ohio, Pennsylvania, Tennessee, Vermont, Virginia, West Virginia, Wisconsin) identified silvicultural activities as a source of impairment for 23,722 miles of rivers and streams (2.9 percent of total assessed miles—see table 21-1).

The various sources of impairment of rivers and streams identified by the States were grouped into eight broad impairment source categories (table 21-1): (1) physical changes to the water body, (2) crop production, (3) animal production and grazing, (4) forestry (including silviculture, forest roads, and fire), (5) resource extraction, (6) municipal and industrial sources, (7) natural sources, and (8) unspecified or unknown sources. Of these eight broad sources of impairment, forestry-related activities impaired the fewest miles of rivers and streams (2.9 percent of total assessed). In contrast, all agricultural activities (crop and animal production, including grazing) impaired about 8 times as many miles (about 24 percent of total assessed).

A total of 42,003,669 acres of lakes, ponds, and reservoirs were reported by the States in the 2006 National Assessment Database. Of these, 16,610,248 acres have been assessed for water quality attainment (39.5 percent of total). Just 11 States (Arizona, California, Illinois, Louisiana, Montana, New Mexico, North Dakota, Oklahoma, Utah, Vermont, and West Virginia) identified silvicultural activities as a source of impairment for 316,071 acres (0.8 percent of total acres, 1.9 percent of total assessed acres, 1.8 percent of all impaired acres) (table 21-1).

As in the case of rivers and streams, forestry-related activities impaired the fewest acres of aerial water bodies (1.9 percent of total assessed). In contrast, all agricultural activities related to crop and animal production impaired about 8 times as much water body acreage (about 15 percent of total assessed).

What has changed since 2003?

How this indicator is evaluated has changed since the 2003 report. In 2003, water quality data were reported as the percentage of counties with hydrologic unit code (HUC) watersheds with water quality parameters significantly different from other counties within each region. The 2003 report data could not be unambiguously analyzed solely for forested areas. On the other hand, States were able to identify silvicultural activities as a source of impairment for the National Assessment Database. Thus, it is not possible to directly compare the data in this report with that from the 2003 report.

Are there important regional differences?

Because many states do not specifically identify silviculture as a source of water quality impairment, and because many waters have yet to be assessed, it is not yet possible to determine regional differences.

Why can't the entire indicator be reported at this time?

Many other sources of water quality impairment are identified in the National Assessment Database. Some of these such as flow and habitat modification, sedimentation, riparian vegetation removal, grazing effects, resource extraction, and others occur in forested areas. Unfortunately, other than silviculture, the National Assessment Database does not separate sources

Table 21-1. Sources of water quality impairment for assessed U.S. rivers/streams and lakes/ponds/reservoirs. (U.S. Environmental Protection Agency 2006 National Assessment Database. http://www.epa.gov/waters/305b/index.html).

Source of Impairment*	Rivers/Streams		Lakes/Ponds/Reservoirs	
	Miles	Percent of total assessed	Acres	Percent of total assessed
Physical changes	164,498	20.0	1,849,582	11.1
Crop production	114,849	14.0	1,988,175	12.0
Animal production	80,269	9.8	555,054	3.3
Forestry	23,727	2.9	316,071	1.9
Resource extraction	41,916	5.1	599,280	3.6
Municipal/industrial	205,673	25.0	6,048,322	36.4
Natural	40,743	5.0	1,354,245	8.2
Unspecified/unknown	125,308	15.2	4,551,991	27.4
Total assessed	822,340		16,610,248	
Total United States	3,589,765		42,003,669	

*** Sources of impairment:**

- Physical changes: hydromodification, flow regulation, dams and impoundments, water diversion, channelization, dredging, bank destabilization, habitat changes, loss of wetlands and riparian areas, erosion, and sedimentation.
- Crop production: all agricultural sources related to irrigated and nonirrigated crop production.
- Animal production: all agricultural sources related to animal production, including confined animal feeding operations and upland and riparian grazing.
- Forestry: all silvicultural and forest industry activities, forest roads, and fire.
- Resource extraction: mineral resource development, mining, oil, gas, and coal production.
- Municipal and Industrial: all municipal, urban, and industrial point and nonpoint sources, including runoff; construction and development; and waste disposal.
- Natural: mineral deposits and ecosystem nutrient cycling.
- Unspecified or unknown: all unidentified or unknown point and nonpoint sources.

of impairment by land use. Thus, it is not possible to separate resource extraction impairments, for example, in forested areas from other land use classification areas.

Another problematic issue is sources of impairment may originate inside or outside of forested areas. Also, the National Assessment Database does not indicate the degree of impairment. Some impairments may be transitory, others more permanent. Although individual stressors and pollutants are identified, quantitative water quality data summarized by forested area across the entire United States are lacking. To fully report this indicator, quantitative water quality data summarized by land and water use, vegetative cover, sources and origins of impairments, and stressors and pollutants are needed. A full integration of EPA assessment and USGS water quality data by forested HUC would best meet the intent of the indicator.

Criterion 5

Maintenance of Forest Contribution to Global Carbon Cycles

What is this criterion and why is it important?

More than any other criterion, this one reflects the fact that forests exist within a context of the global environment and the world's economic and social activities. Criterion 5 embodies a direct link between the environment and the economy, because carbon cycling concerns result from the fossil fuel combustion that powers the human economy. The capacity of forests to sequester carbon may be—or may become—a primary factor for determining the capacity of fossil fueled economies. The global economy, in other words, may be a function not only of the global environment but also, particularly, of the forested environment.

What has changed since 2003?

The data—Most of this criterion's data continue to be based on greenhouse gas (GHG) inventories compiled by the U.S. Environmental Protection Agency, forest inventories conducted by the Forest Service, surveys of electricity generation by the U.S. Department of Energy, and models and simulations of carbon pools and fluxes based on said data sources.

The indicators—The following table summarizes the revisions. Briefly, the forest ecosystem and product pools have been separated into their own respective indicators, while a new indicator focused on avoided fossil fuel emissions through forest biomass use has been created. Indicator reference numbers for 2003 and 2010 are provided to assist in comparisons with the previous report. A more detailed rationale for the revisions may be found at http://www.rinya.maff.go.jp/mpci/meetings/18_e.htm.

Criterion 5. Maintenance of Forest Contribution to Global Carbon Cycles.

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
26	Total forest ecosystem biomass and carbon pool, and if appropriate, by forest type, age-class, and successional stages	Add fluxes, delete type and age	5.22	Total forest ecosystem carbon pools and fluxes
27	Contribution of forest ecosystems to the total global carbon budget (standing biomass, coarse woody debris, peat, and soil carbon levels)	DELETE		
28	Contribution of forest products to the global carbon budget	Add fluxes, delete global context	5.23	Total forest product carbon pools and fluxes
		NEW	5.24	Avoided fossil fuel carbon emissions by using forest biomass for energy

Indicator 5.22. Total Forest Ecosystem Carbon Pools and Fluxes

What is the indicator and why is it important?

The United States emitted a gross 6.0 billion metric tons of CO_2 in the year 2006. Because plants use carbon dioxide in the photosynthesis process, forests provide a primary vehicle to sequester carbon from the atmosphere. During this process, the carbon becomes part of the plant mass. Once forest biomass dies, carbon remains in the forest ecosystem and cycles through standing dead trees, downed dead wood, duff and litter, and finally soil carbon pools. Thus, managing forest ecosystems to sequester carbon reduces the net amount of carbon dioxide accumulating in the atmosphere. Less carbon dioxide in the atmosphere may help reduce the possibility and extent of human-induced climate change. In contrast, forests can also serve as a net emitter of CO_2 during years of extreme wildfires or widespread disturbance. In addition to showing current estimates of carbon pools, this indicator provides estimates of annual forest carbon storage changes (fluxes) that may be subtracted from the gross emissions to estimate net emissions.

What does the indicator show?

All carbon pools, with the exception of soil carbon, are estimated using the Forest Service's Forest Inventory and Analysis (FIA) measured data or imputed data, along with inventory-to-carbon relationships, developed using information from ecological studies. Thus, trends of volume and area in other indicators based on FIA data should be consistent with this information. Forest ecosystem carbon stocks in the United States continue to represent a substantial carbon pool of more than 156,000 Tg CO_2e (fig. 22-1), with live trees and organic soil carbon levels accounting for most of this stock. The forest carbon stock is equivalent to more than 25 years of CO_2 emissions in the United States. The live tree carbon stock is concentrated on the West coast, Rocky Mountains, Appalachian Mountains, and in other areas of the Eastern United States (fig. 22-2).

In terms of annual changes or carbon flux, both above- and below-ground forest ecosystem living biomass components account for most of annual carbon sequestration (fig. 22-3). These rates of sequestration have remained rather static since 2000. The spatial distribution of forest sequestration is evenly

Figure 22-1. Total carbon stocks by forest ecosystem component in the United States, 1990–2007 (Tg CO_2e).

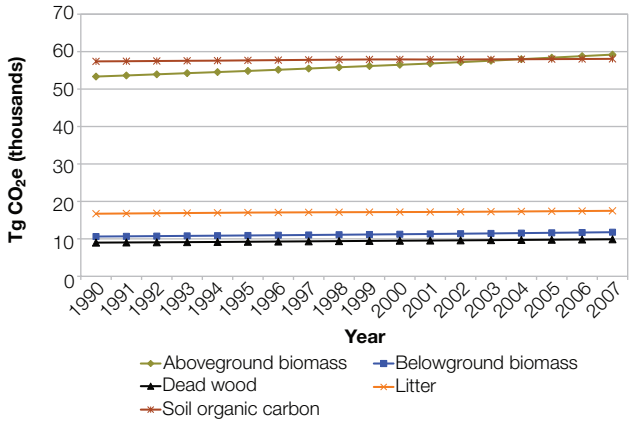
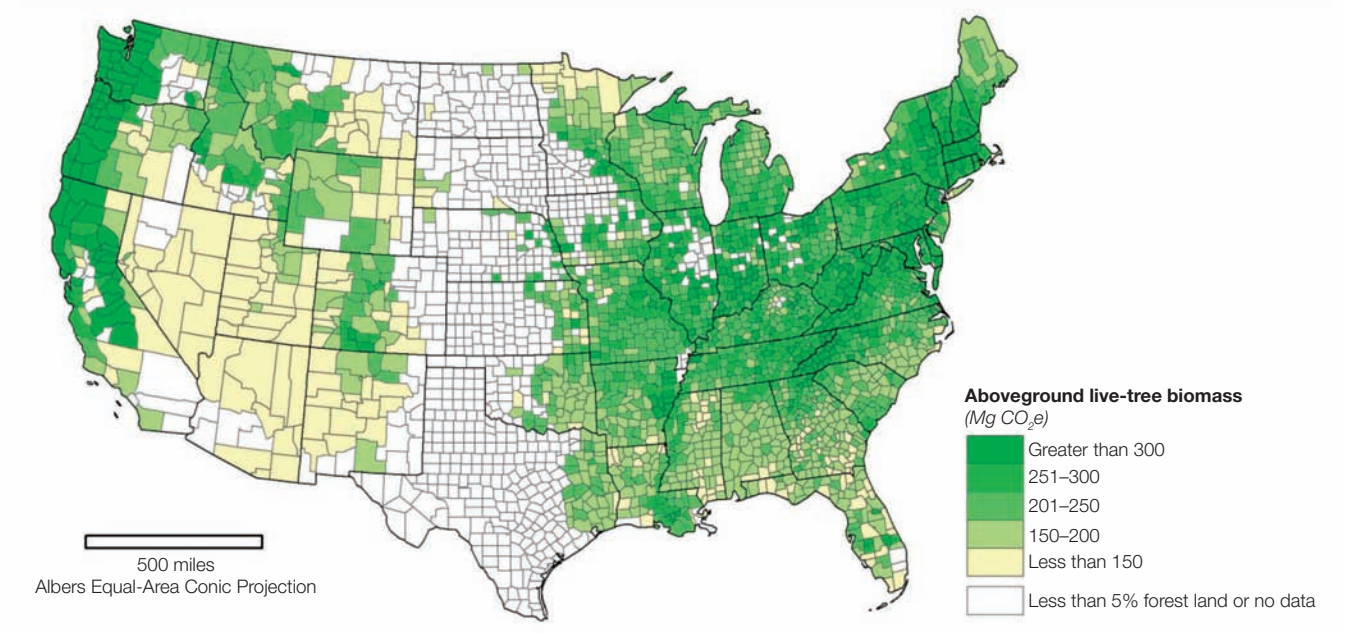


Figure 22-2. Forest aboveground live biomass carbon stocks by county for United States, 2006 (Mg CO_2e).



distributed within forested regions of the country (fig. 22-4). U.S. forests offset more than 11 percent of total U.S. CO_2 emissions in 2006. This rate of offset has remained relatively constant for the past two decades (fig. 22-5). Overall, the tremendous forest carbon stocks of the United States continue to gradually increase, increasing GHG emissions continue to greatly outpace what forests can sequester annually.

What has changed since 2003?

Total forest ecosystem carbon stocks were maintained with positive increases from forest area expansion and growth. Despite these increases, total U.S. GHG emissions still outpaced forest ecosystem gains.

Figure 22-3. Percent of total carbon stock by forest ecosystem component sequestered annually in the United States, 1990–2006.

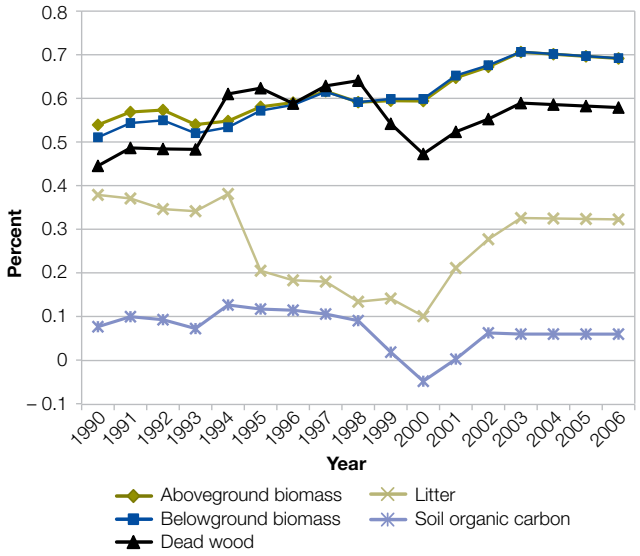


Figure 22-5. Total greenhouse gas emissions versus total forest ecosystem sequestration in the United States, 1990–2006 (Tg CO_2e).

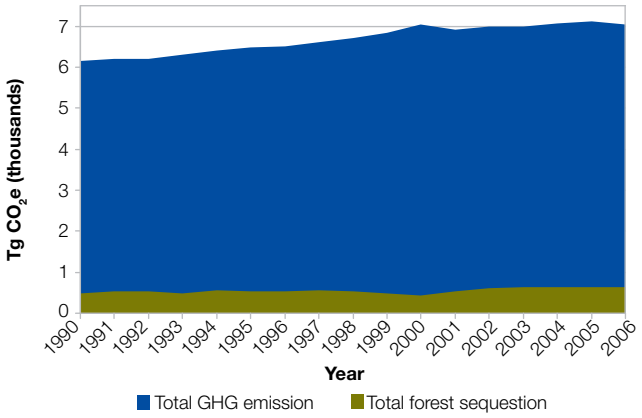
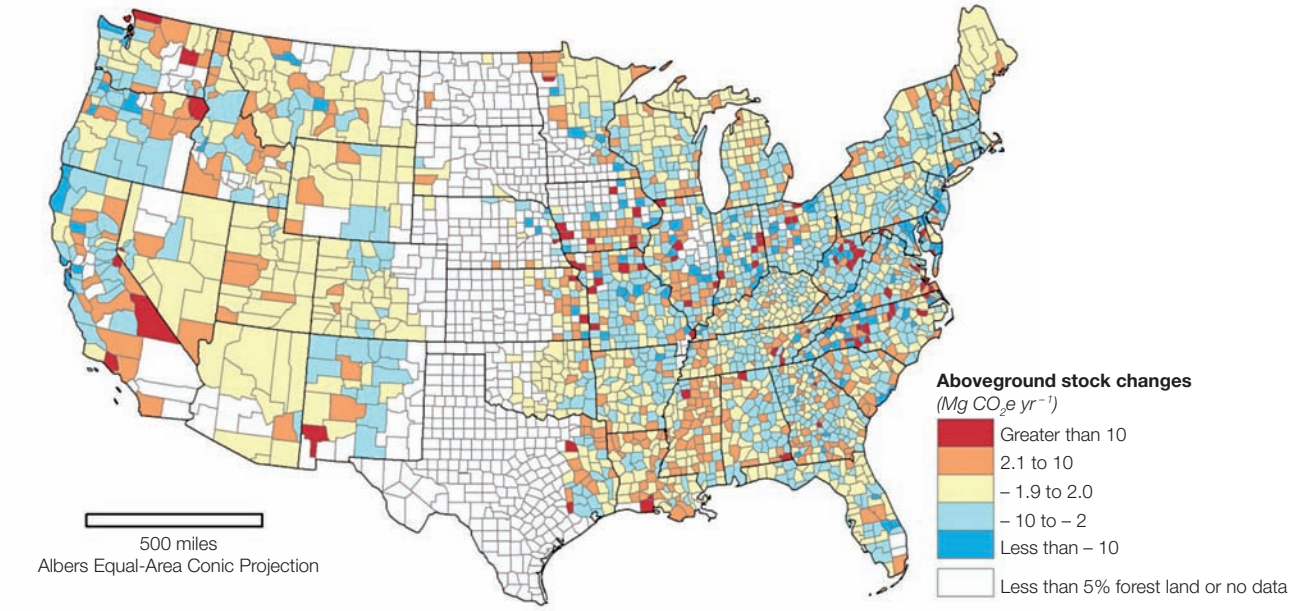


Figure 22-4. Total forest ecosystem carbon stock annual flux by county in the United States, 2006 (Mg CO_2e per year).



Note: In conformance with IPCC reporting protocols, carbon sequuestration is denoted by negative numbers (blue) while carbon emissions to the atmosphere are represented by positive numbers (red).

Indicator 5.23. Total Forest Product Carbon Pools and Fluxes

What is the indicator and why is it important?

Indicator 5.23 assesses the role that forest products play in the sequestration, cycling, or emission of carbon. Long-term storage of carbon in products and landfills delays or reduces carbon emissions. Use of wood products can also reduce emissions if they substitute for products with higher carbon emission processes. As domestic forest biomass is harvested carbon is shifted from forest ecosystems to forest products held in products and landfills. The rate of accumulation of carbon in products can be influenced by the mix of products and uses (e.g., the lumber used in housing versus the paperboard used in boxes) and by patterns of disposal, recycling, and landfill management. This indicator shows the harvested wood product (HWP) contribution to the combined system of annual CO_2 emissions and removals by forests and products. This indicator primarily uses the production accounting approach to track the HWP contribution. This approach tracks carbon levels in wood that was harvested in the United States, including carbon held products that are exported. The United States uses this approach to report the HWP contribution under the UN Framework Convention on Climate change. HWP contributions are also shown for the stock change approach which tracks carbon stock changes in the United States and the atmospheric flow approach which tracks net carbon exchange with the atmosphere. Estimates are made using methods recommended by the Intergovernmental Panel on Climate Change.

What does the indicator show?

In 2006, under the production approach, HWP contribution due to carbon additions to forest products in use and in landfills was 110 million tons CO_2 equivalent or about 17 percent of the value of annual carbon additions to forest ecosystems. In 2006 this contribution offset emissions equal to about 34 percent of the CO_2 emitted by fossil fuel combustion in residential housing. The annual contribution is now less than the contribution in 1990 due, in part, to the decreasing amount of U.S. timber harvested and to the replacement of products from domestic harvest products by imported products. Under the stock change accounting approach, HWP contribution has increased notably since 1990 because of increases in imports. Annual contributions under the atmospheric flow approach are about the same as for the production approach (fig. 23-1).

Under the production approach, additions to carbon storage have been increasing for solidwood products in landfills, and decreasing for solidwood in uses, and for paper in uses and landfills. Annual additions to paper in uses were negative for the 2001-to-2003 period. (fig. 23-2).

The annual amount of HWP contribution as a percent of total forest carbon stock has decreased since 1990 (fig. 23-3).

Figure 23-1. Harvested wood product contribution to CO_2 removals under the three accounting approaches, 1990 to 2006 (Tg CO_2e).

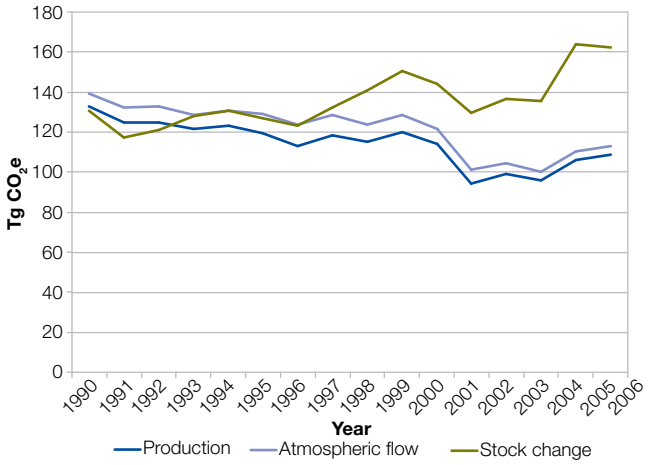


Figure 23-2. Cumulative annual harvested wood product contribution by location of storage—wood and paper products in use and wood and paper product in landfills, 1990–2006 (Tg CO_2e).

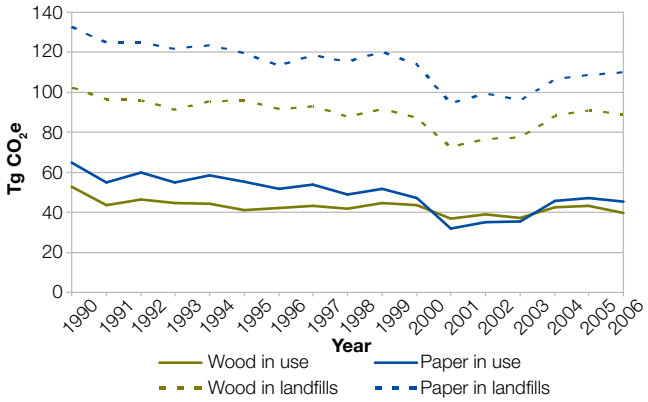
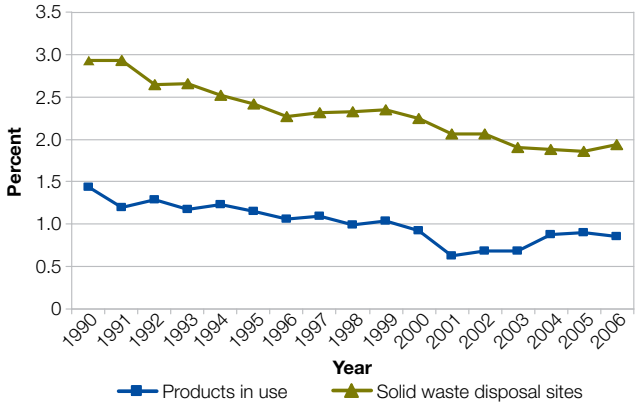


Figure 23-3. Annual harvested wood product carbon additions as a percent of total forest plus product carbon stock in the United States, 1990–2006.



In 2007, total carbon stored in forest products in use and in landfills under the production approach equaled more than 8,000 Tg CO_2 equivalent or more than 1 year worth of CO_2 emissions in the United States.

A rough estimate of the GHG emission savings because of building wood framed single-family detached homes in 2005 instead of building homes using example designs that use steel or concrete walls is 1.7 million tons of CO_2 equivalent. This potential savings is because of lower Greenhouse Gas emissions associated with production of wood products. The emission savings associated with using wood in single-family detached homes is only part of the total savings, which would also include wood framed single-family attached and multifamily houses. Single-family detached houses provided about 54 percent of the total housing floor area build in 2005.

What has changed since 2003?

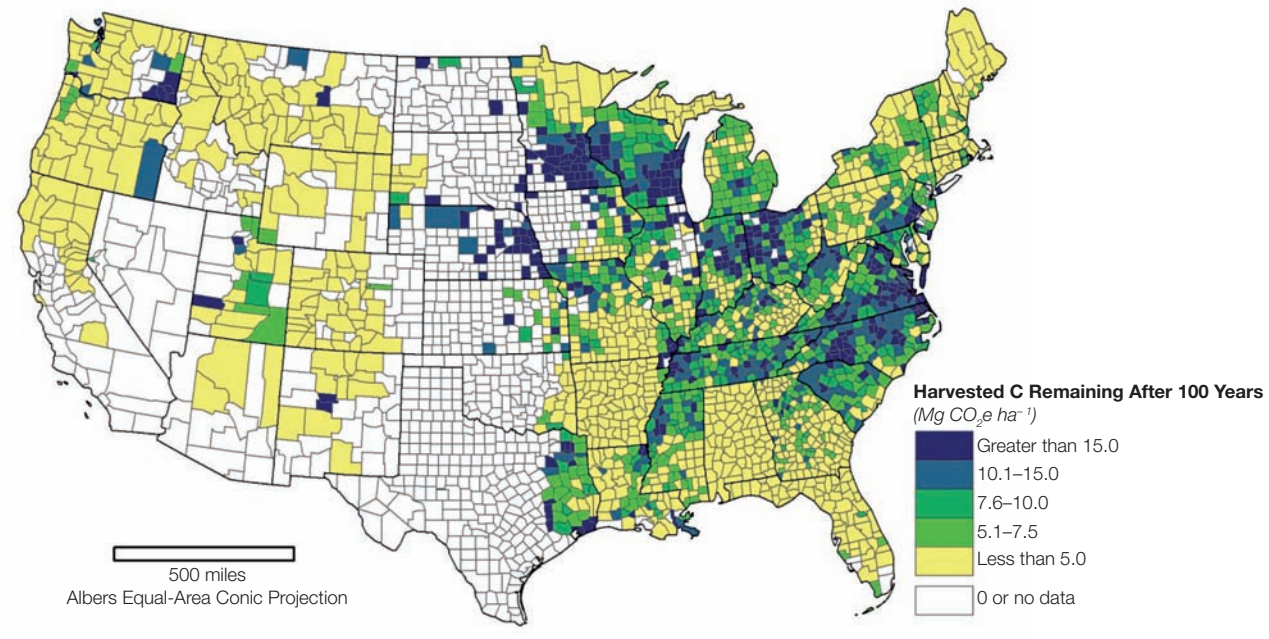
The estimates of HWP contribution to forests and products emissions and removals have been improved and now better track effects of changes in product production, use and disposal. It is now estimated that the HWP contribution to carbon storage has decreased since 1990 under the production and atmospheric flow accounting approaches.

Are there important regional differences?

Regional differences in contribution to carbon storage in products were identified by estimating the contribution each county makes to wood carbon storage. The objective is to estimate the portion of carbon harvested in 2006 that is still stored after 100 years. To do this we estimate the wood harvest in each county, estimate the wood products that are produced (lumber, panels, and paper), the end uses where those products are used (e.g., housing and paper products), the rate of discard from use, the rate of disposal to landfills, and their decay from landfills. The amount still stored after 100 years has offset an equivalent CO_2 emission for 100 years.

Figure 23-4 shows the estimated amounts of carbon still stored in products from 2006 harvest in U.S. counties after 100 years in tons of carbon storage per hectare of timber land. Carbon storage per hectare is highest for timber land in Midwest and Mid-Atlantic States. The amount of carbon stored per hectare after 100 years is influenced by the harvest per hectare and by the mix of sawlogs or pulpwoods and softwoods or hardwoods produced. About 30 percent of carbon from both hardwood and softwood sawlogs is stored after 100 years along with about 20 percent from hardwood pulpwood and 10 percent from softwood pulpwood.

Figure 23-4. Estimated amount of carbon still stored in 100 years from wood harvest in 2006 by county (Mg CO_2e per hectare of timber land).



Indicator 5.24. Avoided Fossil Fuel Carbon Emissions by Using Forest Biomass for Energy

What is the indicator and why is it important?

Nearly 80 percent of the gross 7,054.2 Tg of CO_2 equivalents emitted by the United States in 2007 came from the combustion of fossil fuels for energy. If the combustion of forest biomass for energy occurs in lieu of burning fossil fuels, then fossil fuel emissions may be reduced. If 100 percent of the removed/harvested forest biomass is eventually regenerated and, then there will be a net reduction in greenhouse gas (GHG) emissions because the burning of nonrenewable fuels (e.g., coal) was avoided. If forest sources of wood are used, the net offset of emissions is attained slowly over time and the pace of attaining offsets depends on what would have happened to the wood source (growth, decay) if it was not used for energy.

What does the indicator show?

In 2007, more than 2,100 trillion BTUs (British Thermal Units) were generated in the United States from the combustion of wood in the form of fuelwood logs, wood chips, mill wastes, and black liquor at pulp mills (fig. 24-1). This amount is about 2 percent of all energy consumed in 2007. Burning fossil fuels is the primary remaining source for generating BTUs. Most wood energy was consumed in industrial applications (67 percent), followed by residential (21 percent), electric utility (8 percent) and commercial applications (3 percent). The energy generated by burning wood has decreased from a high level in 1989, but the wood used for electric power production has increased about 90 percent from a low level in 1989. Because the burning of wood may potentially avoid GHG emissions over a period of time given sustainable forest management, the avoided CO_2 emissions may be stated in terms of offsetting the burning of several alternate fossil fuels. The burning of wood for energy in 2007 avoided the emissions of approximately 59, 35, or 48 Tg CO_2e if coal, natural gas, or fuel oil was the fossil energy source, respectively (fig. 24-2). A great variety of electric utility applications have used wood as a source of energy across the United States in 2007 (fig. 24-3), often through co-generation at wood processing facilities. Most of the electric utility sites are located near sources of forest biomass, such as the West coast, Lake States, Northeast, and Southeast. Currently, hundreds of electric utility plants use wood derived as waste from forest product industries for power generation and, thus, avoid GHG emission. However, the amount of power produced from wood residue burning is a small fraction of the power produced by fossil fuel electric utility plants nationwide.

What has changed since 2003?

The use of wood as an energy source and thereby avoidance of fossil fuel emissions has been decreasing since the mid-1990s. Although widespread use of, and access to, wood as an energy source exists in the United States, it still represents less than 1 percent of power generation nationwide.

Figure 24-1. Total energy produced through burning of wood in United States, 1990–2007 (BTUs, trillions).

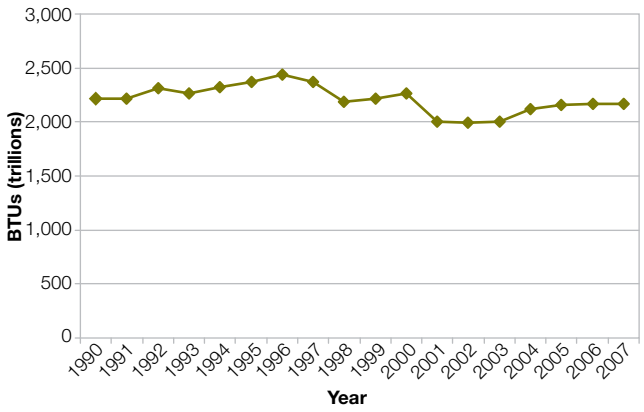


Figure 24-2. Avoided greenhouse gas emissions in terms of coal, natural gas, or fuel oil through burning of wood by industrial and residential users for heat/electricity in United States, 2007 (Tg CO_2e).

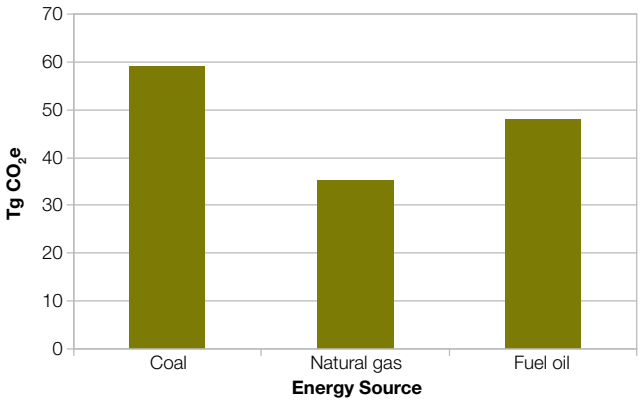
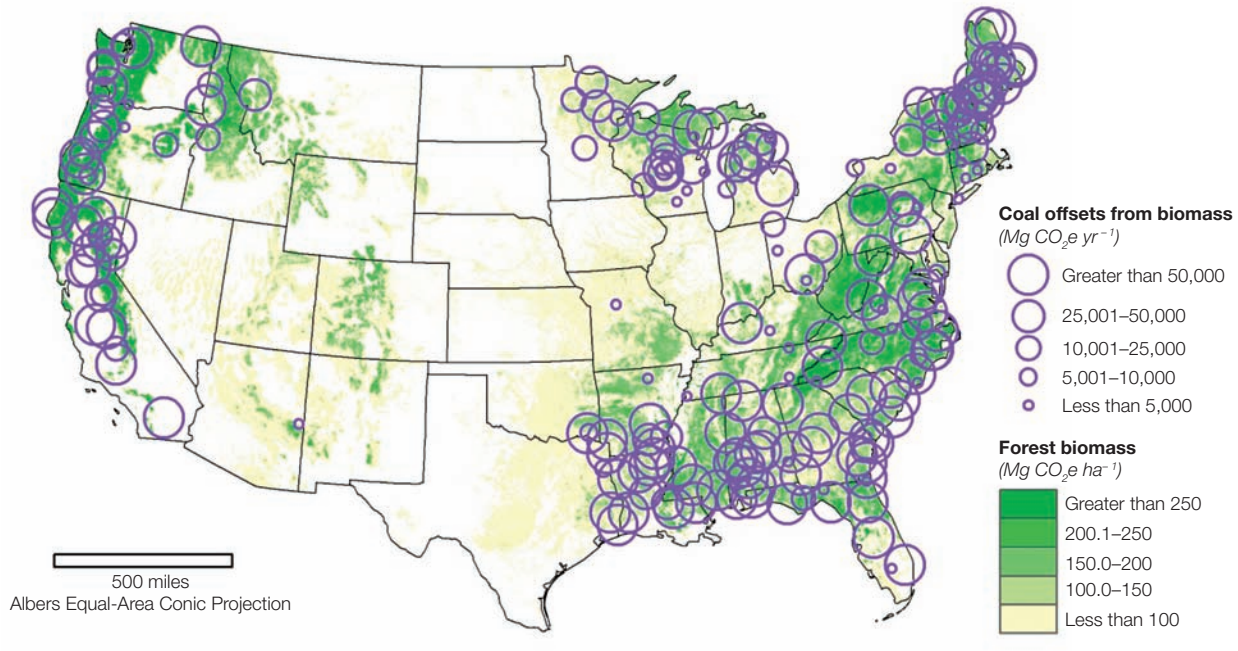


Figure 24-3. Location and avoided emissions (Tg CO_2e) of public electric utilities using wood as a power generation source in lieu of burning coal in relation to aboveground forest biomass (Mg/ha), 2007.



Criterion 6

Maintenance and Enhancement of Long-Term Multiple Socioeconomic Benefits To Meet the Needs of Societies

What is this criterion and why is it important?

Although the first five criteria are centered in the environmental sphere of sustainability (with the exception of Criterion 2, which clearly overlaps the economic sphere), Criterion 6 is centered firmly in the economic sphere. As the sole criterion with an economic focus, it has more (20) indicators than any of the environmental criteria. Its first two subcategories reflect the basic economic breakdown of goods (e.g., wood products) and services (e.g., tourism). The investment subcategory provides indicators of society's attention to forest maintenance. The cultural subcategory includes the most social of the socioeconomic indicators, and the employment subcategory provides indicators of the forests' capacity to provide work, wages, and subsistence.

What has changed since 2003?

The data—Significant data changes have occurred since 2003, including (1) addition of new indicators with new data, particularly on environmental services, distribution of revenue, resilience of communities and importance of forests, (2) expansion of time trends related mostly to forest products and nonwood products, and (3) expansion of data on regional differences in amounts and trends for more indicators, including forest products, nonwood products, and recreation. Coverage for some data has changed because one time studies done for 2003 were not repeated the same way, for example updates of employment in forest based recreation in tourism for 2010 are for more limited categories of employment.

The indicators—The following table summarizes the revisions. Indicator reference numbers for 2003 and 2010 are provided to assist in comparisons with the previous report. A more detailed rationale for the revisions may be found at http://www.rinya.maff.go.jp/mpci/meetings/18_e.htm.

Criterion 6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies (1 of 2).

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
Production and Consumption				
29	Value and volume of wood and wood products production, including value added through downstream processing	Improve wording, restrict value added to secondary products	6.25	Value and volume of wood and wood products production, including primary and secondary processing
30	Value and quantities of production of nonwood forest products	Improve wording	6.26	Value of nonwood forest products produced or collected
			6.27	Revenue from forest-based environmental services
31	Supply and consumption of wood and wood products, including consumption per capita	Improve wording	6.28	Total and per capita consumption of wood and wood products in roundwood equivalents
32	Value of wood and nonwood products production as a percentage of GDP	DELETE		
34	Supply and consumption/use of nonwood products	Improve wording	6.29	Total and per capita consumption of nonwood forest products
		NEW	6.30	Value and volume in roundwood equivalents of exports and imports of wood products

Criterion 6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies (2 of 2).

2003 Reference	2003 Indicator	Revision Action	2010 Reference	2010 Indicator
		NEW	6.31	Value of exports and imports of nonwood products
		NEW	6.32	Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption
33	Degree of recycling of forest products	Include percent of total consumption	6.33	Recovery or recycling of forest products as a percent of total forest products consumption
Investment in the Forest Sector				
38	Value of investment, including investment in forest growing, forest health management, planted forests, wood processing, recreation, and tourism	Include annual expenditure	6.34	Value of capital investment and annual expenditure in forest management, wood and nonwood product industries, forest-based environmental services, recreation, and tourism
39	Level of expenditure on research and development and on education	Confine to "forest-related" only	6.35	Annual investment and expenditure in forest-related research, extension and development, and education
40	Extension and use of new and improved technologies	DELETE		
41	Rates of return on investment	DELETE		
	Employment and community needs			
44	Direct and indirect employment in the forest sector and the forest sector employment as a proportion of total employment	Improve wording	6.36	Employment in the forest products sector
45	Average wage rates and injury rates in major employment categories within the forest sector	Restrict to forest sector	6.37	Average wage rates, annual average income, and annual injury rates in major forest employment categories
46	The viability and adaptability to changing economic conditions of forest-dependent communities, including indigenous communities	Broaden context	6.38	The resilience of forest-dependent communities
47	Area and percent of forest land used for subsistence purposes	No change	6.39	Area and percent of forests used for subsistence purposes
			6.40	Distribution of revenues derived from forest management
Recreation and Tourism				
35	Area and percent of forest land managed for general recreation and tourism in relation to the total area of forest land	Improve wording	6.41	Area and percent of forests available and managed for public recreation and tourism
36	Number and type of facilities available for general recreation and tourism in relation to population and forest area	Merge to new 6.42		
37	Number of visitor days attributed to recreation and tourism in relation to population and forest area	Merge with above to new 6.42	6.42	Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available
	Cultural, social, and spiritual needs and values			
42	Area and percent of forest land managed in relation to the total area of forest land to protect the range of cultural, social, and spiritual needs and values	Improve wording	6.43	Area and percent of forests managed primarily to protect the range of cultural, social, and spiritual needs and values
43	Nonconsumptive use forest values	DELETE		
		NEW	6.44	The importance of forests to people

Indicator 6.25. Value and Volume of Wood and Wood Products Production, Including Primary and Secondary Processing

What is the indicator and why is it important?

The value and volume of wood and wood products indicates the relative importance of forests as a source of raw material for a wide variety of uses. Tracking the values and volumes of goods and services through the production process from the forest to the end of secondary processing explains a key dimension of the economic contribution that forests make to local and national economies.

What does the indicator show?

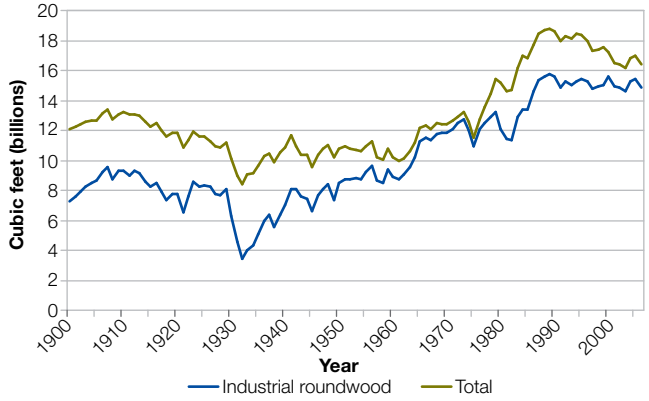
The volume of total roundwood harvest (including fuelwood) in the United States increased fairly steadily from about 10 billion cubic feet in the 1930s to 18.8 billion cubic feet in 1989. Since 1989, harvest has declined, reaching a level of 16.4 billion cubic feet in 2006 (fig. 25-1), a figure equivalent to about 25 percent of world harvest. Industrial roundwood production increased steadily between the mid-1930s and 1989 and has since been roughly constant.

The amount of primary wood and paper products produced in the United States increased relatively steadily from 82 million tons in 1950 to 203 million tons in 1999 and has since then declined to 191 in 2006 (fig. 25-2). In comparison, in 2006, the United States produced 9.5 million tons of steel and 142 million tons of Portland cement.

The decline since 1999 is due primarily to declines in production of pulp and paper, hardwood lumber and softwood plywood. These declines offset an increase of 29 percent in oriented strandboard (OSB) production. In 2006 the largest share of production, by weight, was for pulp and paper (51 percent) followed by softwood and laminated veneer lumber (LVL) (21 percent), hardwood lumber (10 percent), nonstructural panels (6 percent), OSB (5 percent), softwood plywood (4 percent) and other industrial products (3 percent) (fig. 25-2).

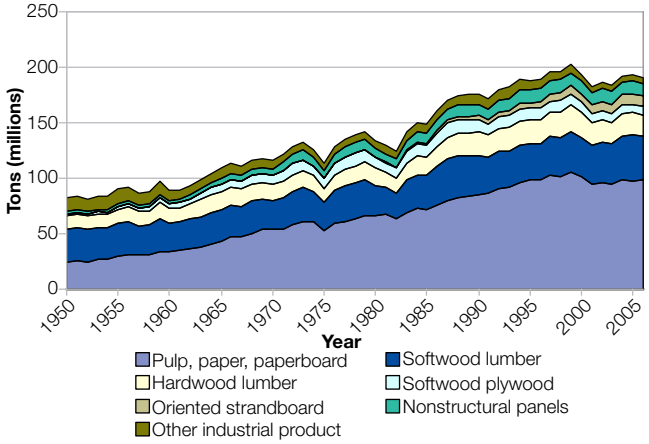
Wood energy use was 2.2 quadrillion BTUs (British Thermal Units) (Quad) in 2006 (roughly 2.4 percent of U.S. consumption), down from 2.7 Quad in 1983. Industrial use (primarily in forest products firms) was 1.5 Quadrillion in 2006 which is somewhat lower than highs in 1983 and 2000. Residential wood energy use has also declined but wood use for electric power has increased from 0.10 Quad in 1989 to 0.18 Quad in 2006 (fig 25-3). (see Indicator 24). Wood pellet fuel production increased from about 0.5 million tons (6 percent moisture content) (0.01 Quad) in 2003 to 1.8 million tons in 2008 (0.03 Quad). In 2008 about 20 percent of production was exported. Most domestic use was for residential heating.

Figure 25-1. Volume of U.S industrial roundwood and fuelwood production (harvest), 1900–2006 (billion cubic feet) (Total line includes industrial roundwood plus fuelwood).



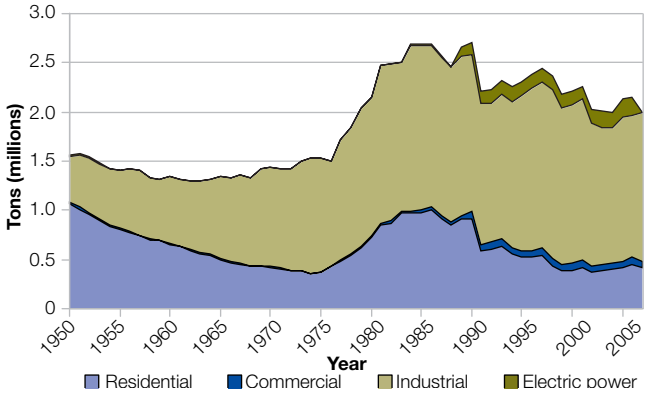
Source: USDA Forest Service

Figure 25-2. Weight of wood and paper products produced by product 1950–2006 (million tons).



Source: USDA Forest Service and other sources

Figure 25-3. Wood energy produced, by consumer, 1950–2006 (10^15 BTUs).



Source: U.S. Department of Energy

Total value of shipments for wood, paper, and furniture industries, using SIC (Standard Industrial Classification) industry codes, increased between 1973 and 1996 from $288 to $356 billion (all values adjusted for inflation and presented in 2005 dollars). Between 1997 and 2006, using U.S. Census (NAICS (North American Industry Classification System)) industry codes, shipments decreased from $322 billion to $309 billion (fig. 25-4). The decrease was due to a 10 percent decline for paper industries. Furniture industries increased 13 percent and wood products industries were nearly constant.

What has changed since 2003?

The volume of roundwood harvest and total weight of primary products production remained relatively stable between 2000 and 2006, although the weight of production has increased for softwood lumber, OSB and miscellaneous products and declined for other primary products—pulp and paper, hardwood lumber, softwood plywood, and nonstructural panels.

The value of paper industry shipments decreased 12 percent between 2000 and 2006 from $187 to $165 billion, but values were stable between 2000 and 2006 for wood products and wood furniture shipments (fig. 25-4).

Are there important regional differences?

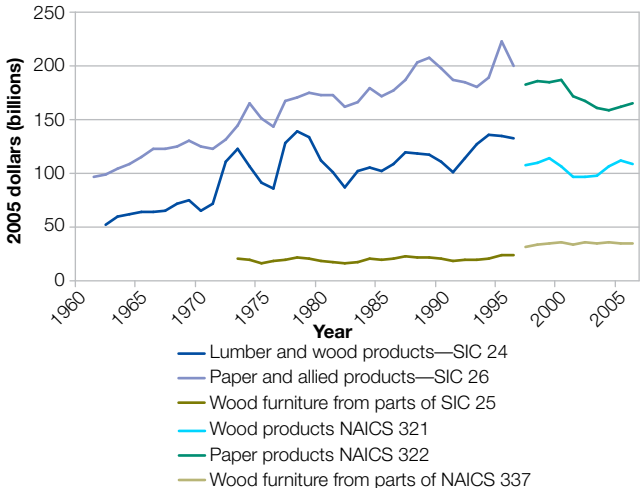
A marked increase in roundwood harvests occurred in the South along with concurrent reductions in the North and Pacific Coast Regions. Industrial roundwood harvest volume increased 80 percent in the South between 1970 and 2006, accounting for 62 percent of the United States total in 2006. In 2006, the North provided 18 percent of the roundwood harvest, followed by the Pacific Coast at 16 percent, and the Rocky Mountains at 3 percent. Harvest decreased between 1991 and 2006 in all regions except the South (fig. 25-5).

Percent changes in harvest are not fully reflected in the value of final product shipments, which have remained much more stable across the regions (fig. 25-6). Although the South had the largest volume of harvest in 2006, the value of shipments for the wood and paper industries was highest for the North, at $108 billion, followed by the South, at $104 billion. Value of shipments has declined since 1997 in the North, South and Pacific Coast, and has increased in the Rocky Mountain Region. State level data on the value of wood furniture production were not available but may alter these results.

Relation to other indicators

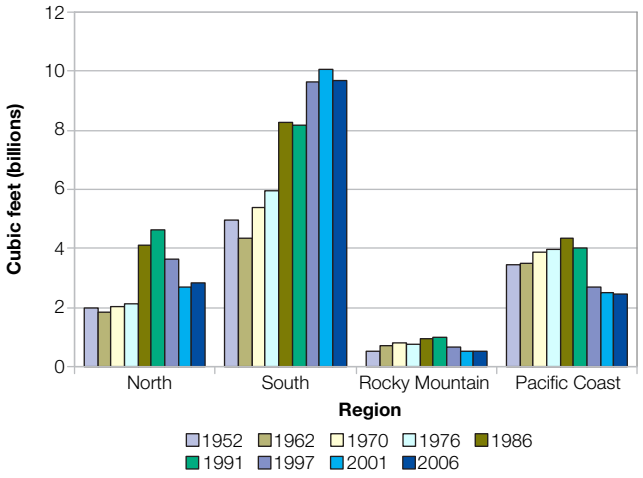
The level and trend in this indicator are factors in sustaining benefits from forests employment and wages (Indicators 6.36 and 6.37), distribution of revenues (Indicator 6.40), and community resiliency (Indicator 6.38). The level of wood and paper production is determined by the competitiveness of U.S. industries compared to foreign industries which, in turn, is influenced by capital investment in new technology (Indicator 6.34), by levels of research and education (Indicator 6.35), and by productivity of forests (Indicator 6.11).

Figure 25-4. Value of shipments for forest products industries by SIC (Standard Industrial Classification) code, 1961–1996, and by NAICS (North American Industry Classification System) code, 1997–2006 (billions of 2005 dollars) (each line is added to the line below).



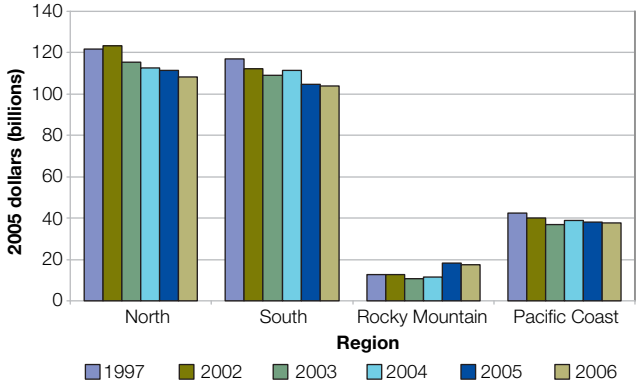
Source: U.S. Department of Commerce, Bureau of Census

Figure 25-5. Volume of all industrial roundwood harvested by region, 1952–2006 (billions of cubic feet).



Source: USDA Forest Service

Figure 25-6. Value of shipments in wood and paper products industries (NAICS 321, 322) by region (billions of 2005 dollars).



Source: U.S. Department of Commerce, Bureau of Census

Indicator 6.26. Value of Nonwood Forest Products Produced or Collected

What is the indicator and why is it important?

Nonwood forest products are items harvested or gathered from forests that are not traditional wood products. Nonwood forest products are important components of the economic value of forests and their collection and processing makes an important contribution to economic activity. Many of these products also are important to indigenous people and others for their contribution to cultural values and subsistence activities.

In this indicator we cover nontimber forest products (NTFP), which includes both (1) nonwood products that do not include the main stem of trees, and (2) selected secondary wood products—fuelwood, posts and poles, and Christmas trees that do include the main stem of trees. The secondary wood products are included because we estimate their value using the same methods as for nonwood products. We also include the value of game animals taken by hunting and trapping.

What does the indicator show?

The value of permit and contract sales of nontimber forest products (NTFP) from Forest Service and BLM land declined overall by about 30 percent between 1998 and 2007, from $9.5 to $6.5 million (all dollar figures adjusted for inflation and reported in 2005 dollars). Nonwood products decreased 18 percent and secondary wood products decreased 36 percent (table 26-1). These fluctuations are expected with products that fruit better in some years than others, such as fungi or pine nuts. The nonwood products value declined from $2.6 to $2.1 million and the secondary wood products value declined from $6.9 to $4.4 million.

Nonwood products include many plants, lichens, and fungi from forests, including understory species used in floral markets, for seasonal greenery, as wild foods, for medicinals, as plant extracts, and for transplants.

Secondary wood products include fuelwood, posts and poles, and Christmas trees. Production of these items is significant in many regions.

Although annual or regularly collected data on domestic production and prices for NTFPs are generally not available, permit and contract data from the Forest Service and the Bureau of Land Management (BLM) can serve as a benchmark to assess use and value for many NTFPs. Information about game animal and fur-bearer populations and harvest is collected by State and Federal agencies, but national information is not generally available for all species. Prices for many NTFPs in the United States are influenced by international supply and demand, by seasonal fluctuation in availability, and by rising domestic demand. Forest Service and BLM sales data are used to assess NTFP first point of sales value by several categories, including landscaping uses; crafts and floral uses; regeneration and silvicultural seeds and cones; edible fruits, fungi, nuts, and saps; grass, hay, and forage; herbs and medicinals; and for three categories of secondary wood products, including fuelwood, posts and poles, and Christmas trees.

Table 26-1. Receipts for wild-harvested nontimber resources from Forest Service and Bureau of Land Management permits and contracts, 1998–2007 (millions of 2005 dollars).

Product Category	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landscaping	0.8	0.6	0.5	0.5	0.4	0.4	0.3	0.3	0.2	0.2
Crafts/floral	1.1	0.9	0.7	1.0	1.2	1.1	1.0	0.8	0.8	1.2
Seed/cones	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0
Edible fruits, nuts, sap	0.5	0.3	0.4	0.5	0.4	0.4	0.5	0.4	0.3	0.4
Grass/forage	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.2
Herbs, medicinals	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	2.6	2.1	1.8	2.2	2.4	2.2	2.1	1.8	1.6	2.1
Fuelwood	4.0	3.7	3.1	3.1	3.2	3.1	2.9	2.7	2.7	3.0
Posts and poles	0.9	0.7	0.7	0.4	0.3	0.4	0.3	0.3	0.3	0.2
Christmas trees	2.0	1.7	1.7	1.8	1.7	1.7	1.4	1.5	1.2	1.2
Total	9.5	8.1	7.3	7.5	7.7	7.5	6.8	6.3	5.8	6.5

It is possible to make a very rough estimate of total national wholesale value for those types of NTFPs that are provided from Forest Service and BLM land. First, assuming that the value per unit that the Forest Service and BLM receive is 10 percent of value per unit received at the first point of sales. Second, we assume that the Forest Service and the BLM provide particular proportions of total national production depending on the category. As a general guide about proportions we note that the national forest land constitutes about 20 percent of total forest land in the United States, and the BLM about 1.5 percent. Sometimes particular products are harvested more on Federal land than elsewhere, and sometimes less. The third step is to assume the first point-of-sale values are 40 percent of wholesale values. First point of sale value refers to the initial transaction by which a product enters the marketplace. It is comparable to farm values, which commonly run about 40 percent of wholesale value.

The resulting estimate in 2007 for national wholesale value of nonwood products produced was about $232 million (down 19 percent since 1998) and for secondary wood products was about $391 million (down 35 percent since 1998) for a total of about $622 million (down 30 percent since 1998) (table 26-2).

These are very rough estimates, and actual values may be quite different. For example, alternate estimates of national first sale value for moss production value (part of the Crafts/ Floral category) have ranged from $6 million to $165 million compared to our estimate of first sale value of about $55 million for that entire Crafts/Floral category in 2007.

What has changed since 2003?

NTFP appraisal methods and monitoring of commercial harvesting have improved considerably on Forest Service land as a result of the Federal Pilot Program of Charges and Fees for Harvest of Forest Botanical Products established in 2000. The law defines botanical products as florals, mushrooms, and so on removed from Federal forests (excluding wood products), defines fair market value, and requires that permit fees be based on a determination of fair market value and sustainable harvest levels.

Why can't the entire indicator be reported at this time?

More complete data on sources and values of NTFPs are needed beyond those presented from the Forest Service and BLM. The assumptions used to expand those estimates to total wholesale value cannot be defended as a continuing means to make complete estimates on the level and trend for this indicator. Prominent data gaps include personal use of NTFPs, and production and value from private lands. No single source of data exists for NTFPs, nor is it expected that there ever will be. It is unclear how consistent or comparable data sources are in terms of value and scale.

Table 26-2. Estimated wholesale value of wild-harvested nontimber resources in the United States, assuming Forest Service and Bureau of Land Management sales receipts are 10 percent of first point of sales value; Forest Service sales represent approximately 20 to 30 percent and Bureau of Land Management sales represent approximately 2 to 15 percent of total supply; and first point of sales value is 40 percent of wholesale price (millions of 2005 dollars).

Product Category	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landscaping	89	73	56	54	51	44	37	35	28	28
Crafts/floral	119	105	83	112	134	126	118	87	89	138
Seed/cones	6	2	5	5	12	6	3	5	3	3
Edible fruits, nuts, sap	56	38	41	56	47	49	58	46	35	42
Grass/forage	15	14	16	19	20	19	17	24	19	19
Herbs, medicinals	1	2	2	0	3	3	2	2	1	2
Subtotal	285	234	202	246	267	247	236	199	175	232
Fuelwood	397	367	306	312	323	310	294	271	273	302
Posts and poles	89	65	67	35	33	40	29	33	26	24
Christmas trees	114	94	96	102	97	96	80	82	66	65
Total	885	760	671	695	720	693	639	585	540	622

Indicator 6.27. Revenue From Forest-Based Environmental Services

What is the indicator and why is it important?

Although many studies estimate the value of environmental services to society, this indicator focuses on how much society is actually paying landowners for those services. These payments represent the financial incentives landowners actually face in managing their lands to enhance environmental services. Therefore, tracking the actual payments to landowners is essential for designing effective policies for environmental service production, improving forest policy and management decisionmaking, and for assessing the overall contribution of forests to economies and well-being. Note, however, that the results presented here are simply a measure of the amount of revenues landowners actually receive for producing environmental services rather than a measure of underlying values.

What does the indicator show?

The results presented here reflect incentive payments from Federal and State agencies, payments by developers to private wetland mitigation and conservation banks, sales of carbon offsets produced on U.S. forest lands in the voluntary carbon market, purchases of conservation easements by nongovernmental organizations, and payments for leases and entrance fees to hunt and view wildlife on private forest lands. Data were not available for Federal, State, and local tax incentives; water quality trading and watershed source protection; price premiums paid by consumers for sustainable harvested timber and wood products; and incentive payments by forest industry or forest professional associations. Therefore, these results should be considered a lower bound.

Payments for forest-based ecosystem services to U.S. landowners from all sources for which data are available totaled $1.9 billion in 2007, with private sources accounting for $1.5 billion (81 percent) and government agencies providing $366 million (19 percent) (table 27-1). In 2007, sales of forest wetland mitigation credits amounted to $727 million, conservation bank credits were $34 million, sales of carbon offsets were $1.7 million, conservation easements were $315 million, hunting leases and entrance fees were $410 million, and wildlife viewing entrance fees were $34 million. Wetland mitigation accounted for the largest percentage of forest-based ecosystem service payments, with 39 percent of all payments in 2007. These payments were received by only about 173 private forest mitigation banks, however, accounting for only a miniscule proportion of all private forest landowners in the United States. Hunting leases and entrance fees represented about 22 percent of all payments, conservation easements were 17 percent, wildlife viewing and conservation banks each accounted for 1.8 percent, and carbon offsets were 0.001 percent of all forest-based payments for environmental services in 2007.

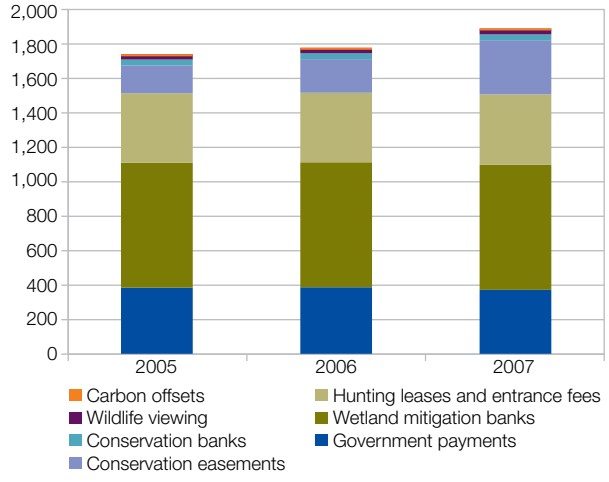
Table 27-1. Total payments for environmental services by source (in thousands of constant 2005 dollars).

Payor	2005	2006	2007
Government payments	378	381	366
Wetland mitigation banks	727	727	727
Hunting leases and entrance fees	405	405	410
Conservation easements	162	195	315
Conservation banks	34	34	34
Wildlife viewing	31	32	34
Carbon offsets	0.6	1.6	1.7
	1,737	1,775	1,887

What has changed since 2003?

This indicator is new for 2008 and, therefore, was not reported in 2003. We, however, report changes in payments for environmental services from 2005 to 2007. Figure 27-1 shows the change in payments made to landowners by category from 2005 to 2007. Available data for wetlands mitigation and conservation banking did not allow calculation of annual changes; average values were used for all 3 years. Government payments increased from $378 million in 2005 to $380 million in 2006, but then fell to $365 million in 2007, resulting in an average annual decline of 1.6 percent. In contrast, payments by nongovernment sources grew from $1.6 billion in 2005 to $1.8 billion in 2007. Estimated payments for forest carbon offsets increased by an average of 99 percent annually, conservation easements were 47 percent, and hunting and wildlife viewing revenues were 5 percent, between 2005 and 2007.

Figure 27-1. Total payments by category (carbon offsets, wildlife viewing, and hunting) (millions of constant 2005 dollars).



Are there important regional differences?

Figure 27-3 shows the distribution of payments between States from all sources in 2007. Payments per State increased from an average of $34 million (median equals $19 million) in 2005 to $38 million (median equals $18 million) in 2007. Wide variation existed between States, however. In 2007, the States receiving the lowest total payments were Alaska ($428,000), Hawaii ($615,000), and North Dakota ($0.95 million). The highest payments occurred in Georgia ($173 million), Florida ($158 million), and Louisiana ($114 million).

These results differ, however, when accounting for the overall amount of forest land in each State. Figure 27-4 shows the total ecosystem service payments per acre of forest land for each State. Average payment per acre for all sources and all States was $5.22, with a median of $3.34 per acre of forest land. These payments were lowest in Alaska ($0.003 per acre) followed by West Virginia ($0.16 per acre) and Hawaii ($0.32 per acre). The States with the highest revenues per acre of forest land were Illinois ($23 per acre), Colorado ($18 per acre), and Nebraska ($19 per acre).

Why can't the entire indicator be reported at this time?

Lack of available data limits our ability for complete accounting. Many payments occur in one-off deals between public and private entities, for example, payments by municipalities and regional water authorities for watershed management and protection. Quantifying these requires a national survey, which is beyond the scope and budget of this effort. Data are not available to track tax incentives landowners receive (e.g., donations of conservation easements and local and State property taxes). In addition, we were not able to allocate payments to specific environmental services, because most of the available data does not specify which service was purchased.

Figure 27-2. Total payments by type of service between 2005–2007 (thousands of constant 2005 dollars).

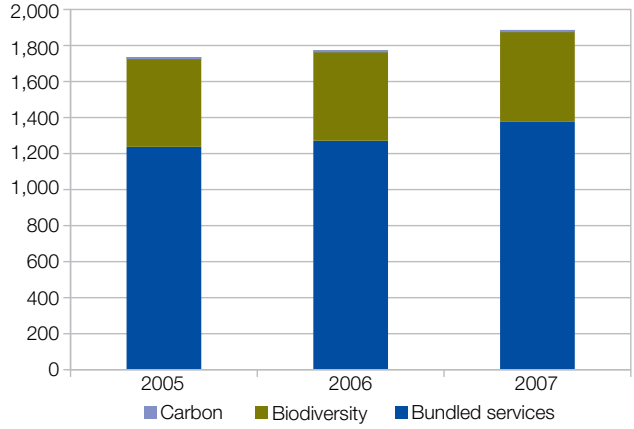


Figure 27-3. Total payments for environmental services in 2007 (thousands of constant 2005 dollars).

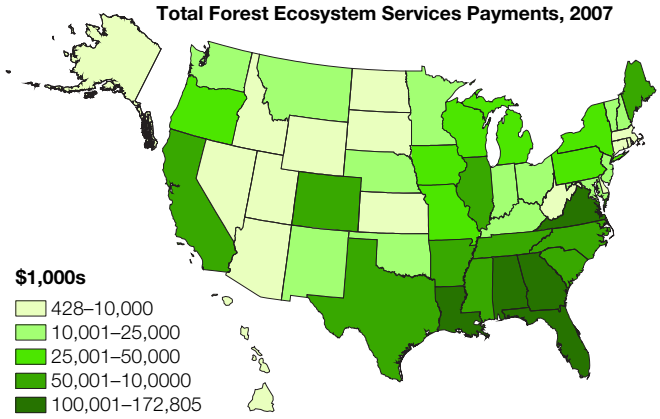
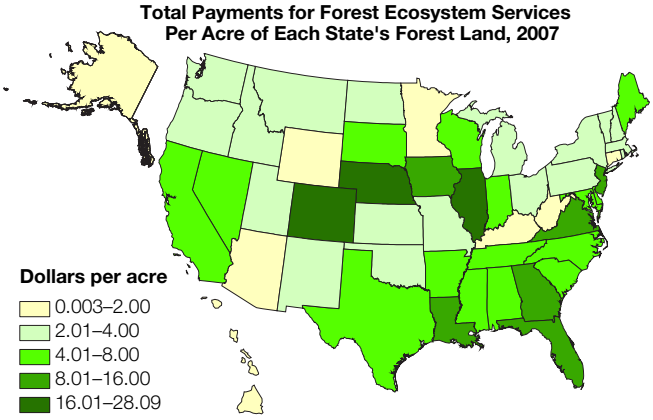


Figure 27-4. Total payments per acre of forested land in 2007 (constant 2005 dollars).



Indicator 6.28. Total and per Capita Consumption of Wood and Wood Products in Roundwood Equivalents

What is the indicator and why is it important?

The quantity of wood and wood products consumed is an indicator of the relative importance of forests as a source of raw materials. Information on the consumption of forest products, especially when compared to production levels, helps to illustrate the balance between supply and demand. When demands for consumption are not balanced by supplies—net domestic production plus imports—the imbalance creates price pressures that often have repercussions in the forest sector or elsewhere in the economy and society that may call into question long-term forest sustainability.

Consumption per capita is an indication of the value people and businesses place on wood products, given their prices, prices of substitutes; their perceived use qualities; and environmental benefits and costs. It is also integrally linked to timber harvest and the many factors that influence it, including investment, management, regulation, and owner objectives. These, in turn, change timber productivity and ecosystem conditions in various regions. Harvest of wood for imports to the United States and export of U.S. products influences forestry and the forest industry in other countries.

What does the indicator show?

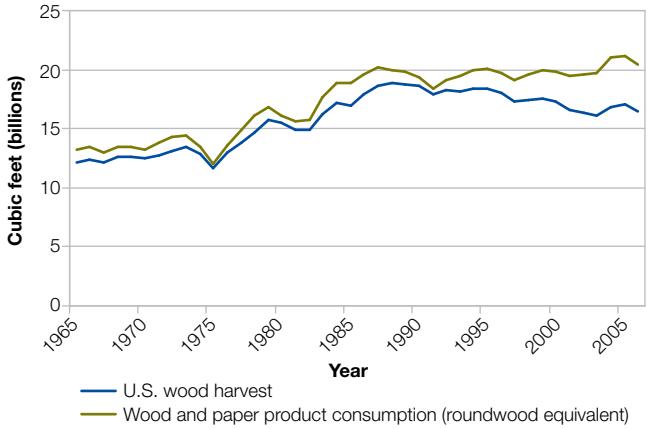
Total consumption of wood and paper products and fuelwood, in roundwood equivalents, increased between 1965 and 1988 from 13.2 to 18.9 billion cubic feet. Since 1988, total consumption has been between 19 and 21 billion cubic feet per year (fig. 28-1). Although, over this same period, U.S. wood harvest declined.

Excluding fuelwood, wood and paper products consumption, in roundwood equivalents, increased steadily between 1965 and 2006, from 12.3 to 18.8 billion cubic feet (fig. 28-2). During this same period, use of softwood and hardwood roundwood increased 53 and 56 percent, respectively. Fuelwood consumption increased to a high of 3.6 billion cubic feet in 1984 and had declined to 1.6 billion cubic feet in 2006. Most of the increase in wood and paper products consumption occurred between 1965 and 1988. The rate of growth in consumption was significantly less between 1988 and 2006.

Per capita consumption of wood and paper products and fuelwood, in roundwood equivalents, increased between 1965 and 1987, from 68 to 83 cubic feet per year. From 1987 through 2006 per capita consumption has declined by 18 percent to 68 cubic feet per year (fig. 28-3).

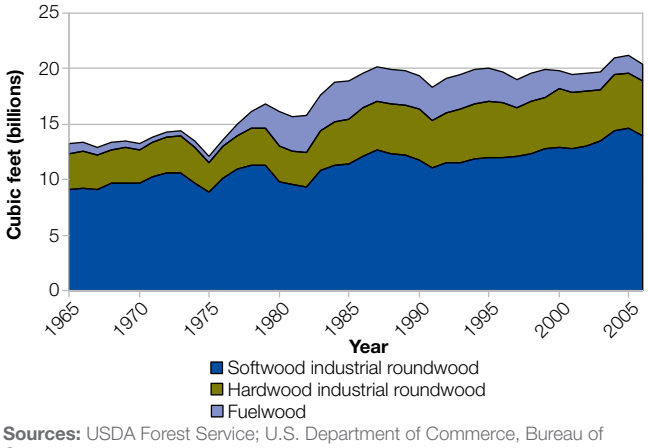
Excluding fuelwood, per capita consumption of wood and paper products, in roundwood equivalents, has been relatively stable,—averaging 63 cubic feet per year. So, in roundwood equivalents, wood and paper products consumption has been increasing at roughly the pace of population (fig. 28-4). Fuelwood use per capita increased to 15.3 cubic feet in 1984 and has declined to 5.2 cubic feet in 2006. With increasing net imports to meet consumption needs, per capita harvest declined 28 percent between 1987 and 2006.

Figure 28-1. U.S. wood production (harvest, including fuelwood) and wood and paper product consumption (including fuelwood), in roundwood equivalents, 1965–2006.



Source: USDA Forest Service

Figure 28-2. U.S. wood and paper product consumption—subdivided into softwood, hardwood, and fuelwood in roundwood equivalents—1965–2006 (each line is added to the line below).



Sources: USDA Forest Service; U.S. Department of Commerce, Bureau of Census

What has changed since 2003?

Trends have not changed markedly since 2003 despite 3 years of robust construction and economic growth in the United States. Total consumption of wood and paper products (including and excluding fuelwood) have continued to increase although at a slower rate. Per capita consumption of wood and paper products alone has remained at about 63 cubic feet. Per capita, and fuelwood consumption has continued to decline.

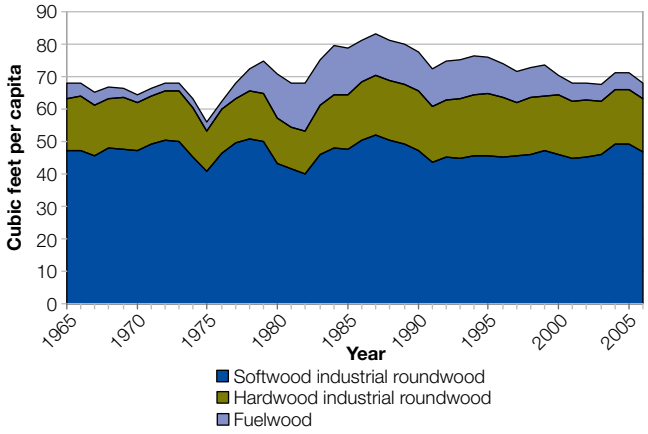
Are there important regional differences?

The data available for this report does not support the calculation of different rates of per capita consumption for different regions in the United States. Given an assumption of uniform per capita consumption rates, total regional consumption will depend directly on population, with the greatest consumption occurring in the populous east, followed by the South, the Pacific Coast, and lastly, by the Rocky Mountain Region, as shown in figure 28-5. In reality per capita use of wood and paper will vary by region. For example, use of wood for structures is higher in the northwest and lower for the southwest than the U.S. average.

Relation to other indicators

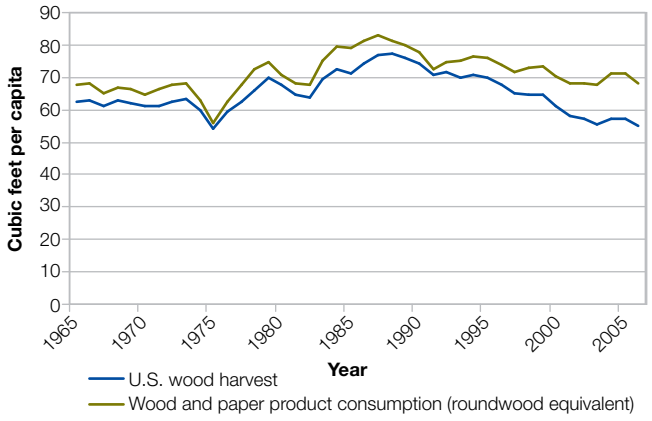
Data from this indicator are being constructed to be consistent with indicators on consumption (Indicator 6.31), recycling (Indicator 6.33), employment (Indicator 6.44), and injury rates (Indicator 6.45) by using consistent data sources and data categories to allow comparisons.

Figure 28-4. Per capita U.S. wood and paper product consumption—subdivided into softwood, hardwood, and fuelwood in roundwood equivalents—1965–2006 (each line is added to the line below).



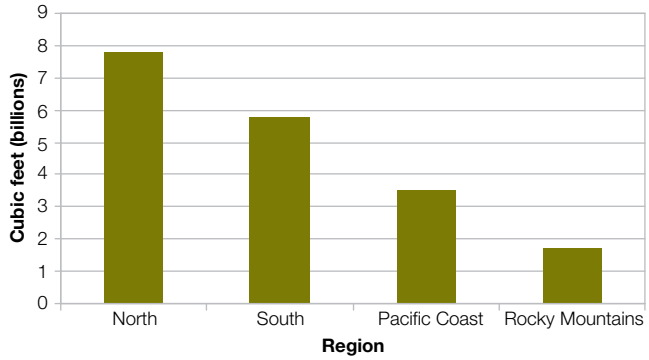
Sources: USDA Forest Service; U.S. Department of Commerce, Bureau of Census

Figure 28-3. Per capita wood production (harvest, including fuelwood) and wood and paper product consumption (including fuelwood) in roundwood equivalent, 1965–2006.



Sources: USDA Forest Service, U.S. Department of Commerce, Bureau of Census

Figure 28-5. Estimated wood and paper products consumption by Resource Planning Act region assuming uniform per capita consumption, in roundwood equivalent, 2006.



Sources: USDA Forest Service, U.S. Department of Commerce, Bureau of Census

Indicator 6.29. Total and per Capita Consumption of Nonwood Forest Products

What is the indicator and why is it important?

Nonwood forest products are items harvested or gathered from forests that are not traditional wood products. The quantity of nonwood forest products consumed indicates the relative importance of forests as a source of products other than wood and wood products. Information on the consumption of nonwood forest products, especially when compared to sustainable production levels, helps to illustrate the balance between supply and demand. When consumption and available supplies are not balanced, price changes are likely to occur that cause economic effects in the forest sector or elsewhere in the economy. Estimates are provided for nontimber forest products and nonwood forest products. See definitions for these terms under Indicator 26.

The products considered in this indicator are the same as those presented in Indicator 26. They follow the same definition of nontimber forest products (NTFPs), including both nonwood products and selected secondary wood products.

Although annual or regularly collected data on domestic production and prices for NTFPs are generally not available, permit and contract data from the Forest Service and the Bureau of Land Management (BLM) can serve as a benchmark to assess use and value for many NTFPs. Nonwood forest products specifically included in U.S. export data generally have long traditions of international trade. There is also evidence of emerging significance in international trade of some crops from native species, such as American matsutake (mushrooms). For purposes of estimating consumption for this indicator, production data (Indicator 26) were adjusted by known trade (Indicator 31) and the result was assumed to be equivalent to consumption.

What does the indicator show?

From Indicator 26 we have estimates of wholesale value of production for nonwood products and for nontimber forest products. The estimate in 2007 for the national wholesale value of nonwood products produced was about $232 million 2005 dollars, down 19 percent since 1998 (all values adjusted for inflation and presented in 2005 dollars). For secondary wood products (fuelwood, post and poles, and Christmas trees), it was about $391 million (down 35 percent since 1998) for a total of about $622 million (down 30 percent since 1998) (fig. 29-1).

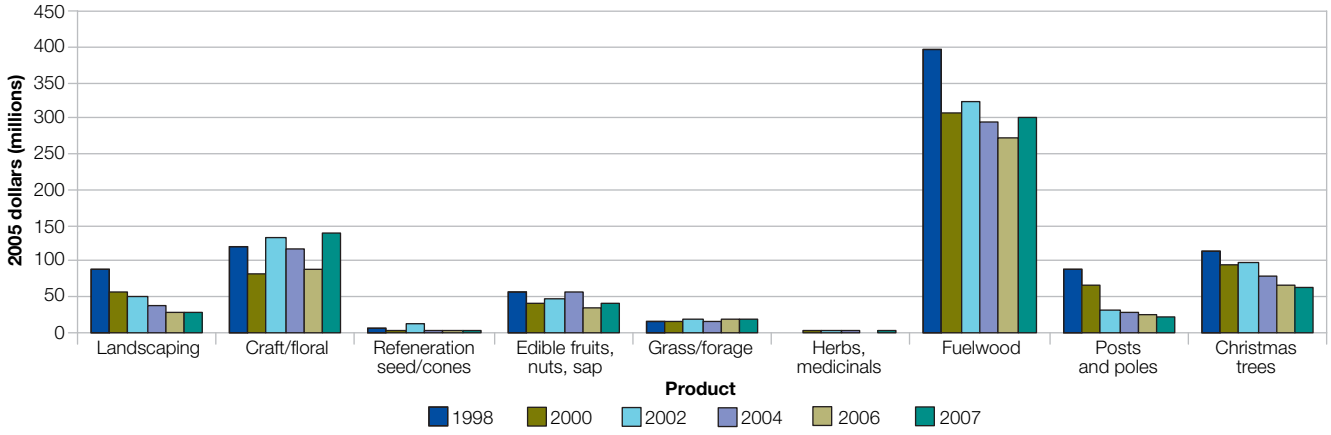
To estimate value of consumption we first estimate the value of net imports of selected nonwood and secondary wood products and then add these estimates to wholesale production estimates. We divide these consumption values by population to obtain the value of consumption per capita.

We obtained value of imports and exports for selected nonwood and secondary wood products using Harmonized Trade Data codes. It was assumed that these selected import and exports are representative of all nonwood forest product trade. This assumption is imperfect, because nonwood forest products may be included under many different trade codes, but it is not possible to split nonwood forest products out of all categories.

Under these assumptions we estimated that the United States is a net importer of nonwood forest products. Estimated net imports decreased between 2003 and 2007 from $157 to $113 million or 28 percent.

The net value of U.S. nonwood forest product trade (imports minus exports) is heavily influenced by vanilla, most of which is imported. Vanilla beans come primarily from Madagascar, and imports of vanilla beans from that country have dropped precipitously since cyclone Hudda in 2003 devastated Madagascar's vanilla-growing regions.

Figure 29-1. A rough estimate of national wholesale value for selected nontimber forest products, 1998–2007 (millions of 2005 dollars).



After adding net imports to production we estimate that total consumption of nonwood products decreased between 2003 and 2007 from $404 to $345 million or 15 percent (table 29-1). These consumption values should be considered a lower bound estimate as they do not include personal use, undocumented harvest, and certain products that cannot be differentiated in the trade data.

In 2007, the value of net imports of nonwood forest products was about 33 percent of consumption.

Per capita consumption of nonwood forest products has decreased between 2003 and 2007 from $1.4 to $1.1 per person (table 29-1).

If we add the net imports of nonwood products to production of all nontimber products, we find that total consumption has increased between 2003 and 2007 from $748 to $815 million; per capita consumption has increased from $2.6 to $2.7.

These consumption estimates are quite uncertain because error in any of a several assumptions could strongly influence the result.

Trade in nonwood forest products has been a small but regionally important part of the U.S. economy for generations. International trade in species native to North America is subject to many different influences, including globalization of labor markets, movement of processing to countries with competitive advantages, and changes in taste and style. International trade in nonwood forest products, in turn, influences sustainable forest practices, or the lack thereof, throughout the world.

What has changed since 2003?

NTFP appraisal methods and monitoring of commercial harvesting have improved considerably on Forest Service lands as a result of the Federal Pilot Program of Charges and Fees for Harvest of Forest Botanical Products, established in 2000. The law defines botanical products as florals, mushrooms, and so on removed from Federal forests (excluding wood products), defines fair market value, and requires that permit fees be based on a determination of fair market value and sustainable harvest levels.

Why can't the entire indicator be reported at this time?

See data limitations noted for Indicator 26. Results do not include consumption for personal use. Regional or national data on both harvest and price of nontimber forest products is not available, other than ginseng.

Indicator 6.30. Value and Volume in Roundwood Equivalents of Exports and Imports of Wood Products

What is the indicator and why is it important?

For many countries, international trade is a significant factor in the commercial use of forests. Exports are, in some cases, a significant source of value for regional and national economies. Imports may either supplement or be a substitute for production from domestic sources. The values and volumes of wood product exports and imports are important because of the increasing importance of global markets in determining economic developments in our domestic forest sector and in influencing the sustainability of forest ecosystems both domestically and throughout the world.

What does the indicator show?

Between 1990 and 2006 the overall value of forest products imports increased 73 percent—from $24 to $41 billion (all dollar values adjusted for inflation and reported in 2005 dollars), but increases have been small since 1999. At the same time, the value of exports increased 15 percent—from $20 to $24 billion with most of the increase occurring in the early 1990s and subsequent declines in more recent years (figs. 30-1 and 30-2). In 2006, import value was about 71 percent higher than export value. A factor influencing the competitive position of U.S. products versus those in other countries (and trends in imports and exports) is the trend in the value of the U.S. dollar relative to other currencies.

Table 29-1. Total wholesale value of consumption and per capita consumption of nonwood (not including secondary wood products) and nontimber forest products (including selected secondary wood products), adjusted for trade, (millions of 2005 dollars).

	2003	2004	2005	2006	2007
Nonwood forest products consumption	404	396	270	301	345
Nontimber forest products consumption (includes nonwood products)	748	746	656	701	815
U.S. population in millions	290	293	296	299	302
Nonwood forest products consumption per capita	1.4	1.4	0.9	1.0	1.1
Nontimber forest products (includes nonwood products) consumption per capita	2.6	2.5	2.2	2.3	2.7

Import value for all groups of forest products increased between 1990 and 1999. Since 1999, the value of imports of wood and paper products has not increased, and the import value in the other wood and log and chip categories have continued to rise (though the log and chip import value is extremely small relative to the other categories).

Wood products include lumber, veneer, and panels. Other wood includes poles and piling, fuelwood, wood charcoal, cork, wood containers, wood doors, and other miscellaneous products. Paper products include paper, paperboard, pulp, and recovered paper.

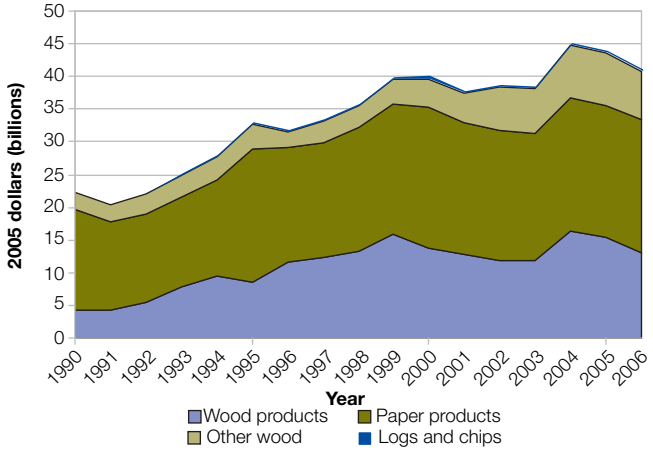
In 2006, the largest share of import value was for paper products (49 percent), followed by wood products (32 percent), other wood products (18 percent), and logs and chips (1 percent).

Export value increased a small amount overall between 1990 and 2006. The export value for paper and other wood increased modestly during the first half of the 1990s but has remained steady since then. In contrast, the export value for both wood products and logs and chips declined steadily between 1990 and 2006. (fig. 30-2)

We now shift to data on imports and exports in terms of **roundwood equivalent**—the amount of wood needed to make various products. These estimates do not include roundwood equivalent of imports and exports of recovered paper.

Between 1990 and 2006, overall imports increased 67 percent—from 2.6 to 4.3 billion cubic feet, and exports decreased 53 percent—from 1.8 to 0.8 billion cubic feet. Note that export volume has decreased and export value has increased. In 2006, import volume is more than 400 percent larger than export volume (figs. 30-3 and 30-4). This margin is much greater than the margin of import value over export value.

Figure 30-1. Value of forest products imports by product group, 1990–2006 (2005 dollars) (each lines value is added to the line below).



Source: U.S. Department of Commerce, Bureau of Census.

Import volume increased for all forest product groups between 1990 and 2005, and declined for all groups in 2005 and 2006 (fig. 30-3). The strong increase in volume through 2004 is in contrast to the limited increase in import value during the same period.

The product groups used when estimating roundwood equivalent of imports and exports are lumber, plywood, and veneer, pulpwood based products (including OSB) and logs and chips.

In 2006, the largest share of import volume—in roundwood equivalent—was for lumber (76 percent), followed by pulpwood based products (18 percent), plywood and veneer (4 percent) and logs and chips (2 percent). The actual shares of product volume imported are lower for lumber and plywood because about one-half of the roundwood used to make these products would be left in the exporting country.

Export volume declined for all product groups between 1990 and 2006. Exports of lumber, plywood and veneer, and logs and chips all decreased by more than 65 percent and pulpwood based products decreased 1 percent. These declines occurred after increases from 1965 to 1990 (fig. 30-4).

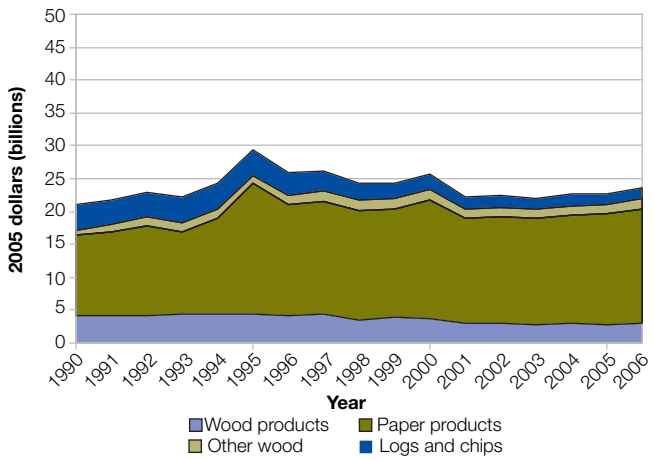
What has changed since 2003?

Trends in imports and exports evident before 2003 have continued. Import value is stable to higher, export value is level to declining, import volume is higher, and export volume is trending lower.

Are there important regional differences?

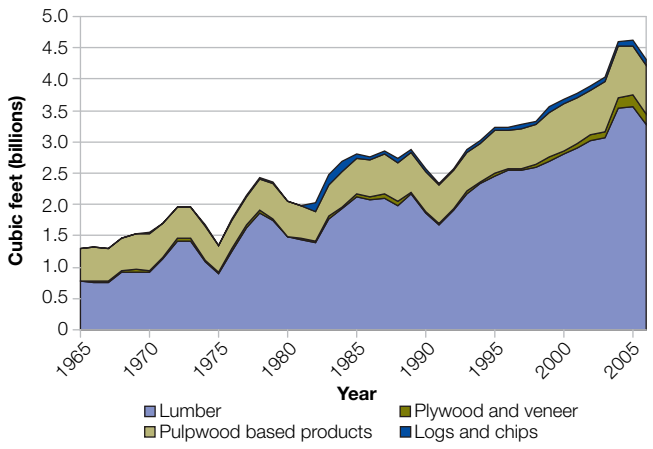
In 2005, the largest share of export value of forest products (fig. 30-5) was from the South (44 percent), followed by the North (31 percent), Pacific Northwest (13 percent), and other West (12 percent).

Figure 30-2. Value of forest products exports by product group, 1990–2006 (2005 dollars) (each lines value is added to the line below).



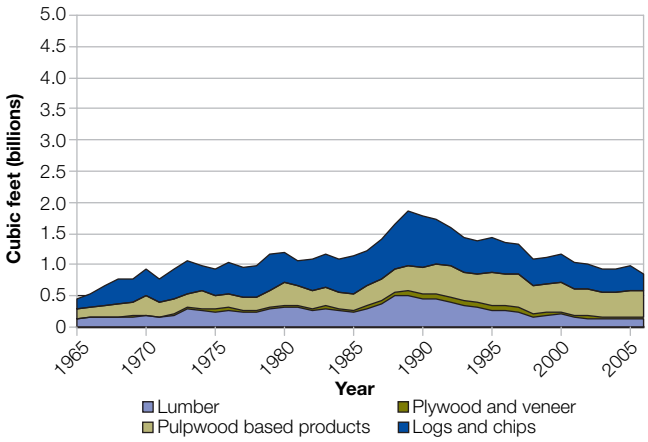
Source: U.S. Department of Commerce, Bureau of Census.

Figure 30-3. Imports of forest products in roundwood equivalent (excluding pulp and recovered paper), 1965–2006 (each line's value is added to the one below).



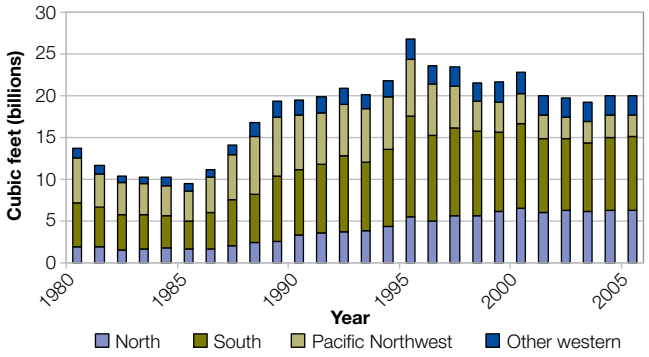
Source: USDA Forest Service

Figure 30-4. Exports of forest products in roundwood equivalent (excluding pulp and recovered paper), 1965–2006 (each line is added to the one below).



Source: USDA Forest Service

Figure 30-5. Value of forest products exports by region of customs districts, 1980–2005 (2005 dollars).



Source: USDA Forest Service

Between 1990 and 2005:

- Value for the North increased then stabilized above $6 billion (2005 dollars) after 1999,
- Value for the South peaked in 1995 and has since declined,
- Value for the Pacific Northwest declined steadily, and
- Value for the other West increased until about 1997 then stabilized at above $2 billion (2005 dollars).

Relation to other indicators

The levels and trends in this indicator are factors in sustaining benefits from forests—employment and wages (Indicators 6.36 and 6.37), distribution of revenues (Indicator 6.40), and community resiliency (Indicator 6.38). Exports and exports also influence level of harvest (Indicator 2.13). The level of exports and imports are determined by the competitiveness of U.S. industries compared to foreign industries which, in turn, is influenced by capital investment in new technology (Indicator 6.34), research and education (Indicator 6.35), and productivity of forests (Indicator 2.11).

Indicator 6.31. Value of Exports and Imports of Nonwood Products

What is the indicator and why is it important?

For many countries, international trade is a significant factor in commercial use of forests. Exports are, in some cases, a significant source of value for regional and national economies. Imports may either supplement or be a substitute for production from domestic sources. The values and volumes of wood product exports and imports are important because of the increasing importance of global markets in determining prices in domestic markets, the sustainable use of domestic resources, and the profitability of domestic industries.

What does the indicator show, and what has changed since 2003?

The value of 12 types of exported nonwood forest products (fig. 31-1) increased from $332 to $457 million between 2003 and 2007 (all values adjusted for inflation and reported in 2005 dollars). The value of imports of the same products decreased from $757 to $650 million between 2003 and 2007. Export values may be underestimated as discussed below.

The nonwood forest products included in U.S. export data have long traditions of trade. Products that have become important in export markets recently include wild edible fungi, mosses, and lichens. For some species a distinction in data exists between wild and cultivated species. Pecans and cranberries are mostly

cultivated. Blueberries and ginseng maintain separate trade markets for wild and cultivated crops, with the wild crop being smaller and more valuable per unit of production. Some exports such as American matsutake (*Tricholoma magnivelare*), appear to arise more from international demand than from U.S. marketing efforts.

All internationally traded goods are classified with a six-digit Harmonized Trade Code (HTC) number. Each Nation can then add four additional digits to track goods that are of special interest to that country. National export data can be used to help assess domestic harvest and total trade for products where little other data are available.

For some products additional local export data exist that differ notably from national export data. The harvest and trade figures for moss are a case in point. For moss harvests from the Pacific Northwest and the Appalachian regions there is a difference between moss harvests reflected in land management agency permit data, and national moss and lichen export data. The Forest Service and Bureau of Land Management issued permits for moss from 1997 to 2002 that averaged about 100,442 air-dry kg per year, with average annual permit revenues of about $19,650. An examination of export permit data from 1998 to 2003 showed 4.6 to 18.4 million air-dry kg per year were exported, with a value between $6 and $165 million per year. These values are considerably higher than the national export values of $4.2 million for 2003 and $0.8 million for 2007. In fact, the upper bound of the export value estimate ($165 million) would place moss at the top of the list of export earners as opposed to the relatively minor position it holds in the current export statistics.

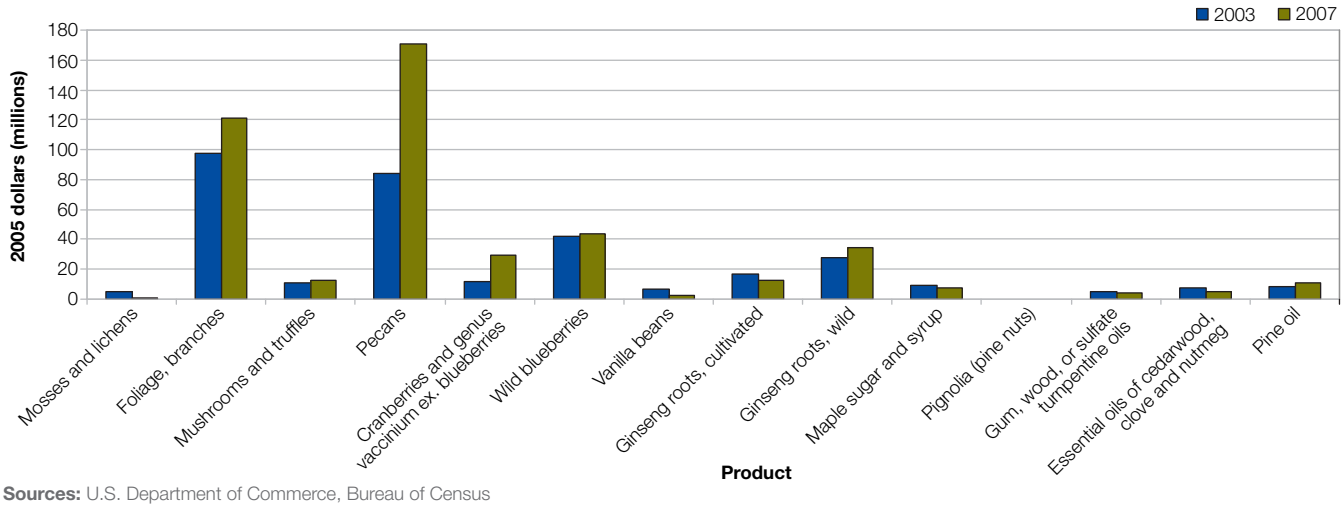
The discrepancies and range in the estimates illustrate how little is known about the moss trade. Policymakers and land managers lack critical information about inventories and response to disturbances on which to base resource management decisions. This lack of knowledge has been noted about other wild-harvested nonwood products traded in commercial markets, such as floral greens and mushrooms.

Figures 31-1 and 31-2 show the value of nonwood forest products exported from and imported to the U.S. exports listed in this report focus on nonwood products from species native to North America, Included are native species growing wild in forests, forest openings, and woodlands, products from select native species grown agriculturally, and select products from native species growing in nonforest environments, whether wild or domesticated. Some trade codes are so broad that it is impossible to describe trade in specific species. For example, fresh foliage and branches (HTC 0604.91.0000) covers many species, wild and domesticated, from forests and agricultural lands. Some codes may include products that are grown in agroforestry environments, intentionally sown but allowed to grow in wild simulated environments, such as wild ginseng (HTC 1211.20.0040). A few codes are exclusive to wild-harvested nonwood forest products, such as fresh wild blueberries (HTC 0810.40.0024).

The U.S. mushroom trade data since 2002 has split out the most commonly domesticated mushrooms, including the white button mushroom common in grocery stores (*Agaracus* spp.), wood ears (*Auricularia* spp.), and jelly fungus (*Tremella* spp.). Mushroom trade data in Figures 31-1 and 31-2 do not include these domesticated species, and can be assumed to be highly influenced by amounts of wild-harvested fungi such as morels (*Morchella* spp.), chanterelles (*Cantharellus* spp.), American matsutake (*Tricholoma magivelare*), and various truffle species.

The top four exported nonwood forest products, in both 2003 and in 2007 were (1) pecans, (2) foliage and branches, (3) wild blueberries, and (4) wild ginseng. Values for all four increased from 2003 to 2007.

Figure 31-1. Value of exports of selected nonwood forest products, 2003 and 2007 (millions of 2005 dollars).



Sources: U.S. Department of Commerce, Bureau of Census

The top four imported nonwood forest products in 2003 were (1) vanilla beans, (2) pecans, (3) maple syrup products, and (4) foliage and branches. The top four imports in 2007 were (1) pecans, (2) maple syrup products, (3) wild blueberries, and (4) foliage and branches. Vanilla beans come primarily from Madagascar, and imports from that country dropped precipitously since cyclone Hudda in 2003 devastated Madagascar's vanilla-growing regions. Imports for the other top imports increased between 2003 and 2007.

Commerce in nonwood forest products has been small but regionally important for the U.S. economy for generations. International trade in species native to North America are influenced by a number of factors, including globalization of labor markets, movement of processing to countries with competitive advantages in processing, and changes in taste and style. When one country experiences an event that puts it at a disadvantage, such as the cyclone in 2003 that affected Madagascar's vanilla bean growing areas, other regions or countries will hurry to fill the gap, particularly if prices rise because of the shortage. International trade in nonwood forest products likewise help determine sustainable forest practices. Trade information must be used along with other data, such as estimates of domestic consumption, to assess effects on regions or countries.

Indicator 6.32. Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption

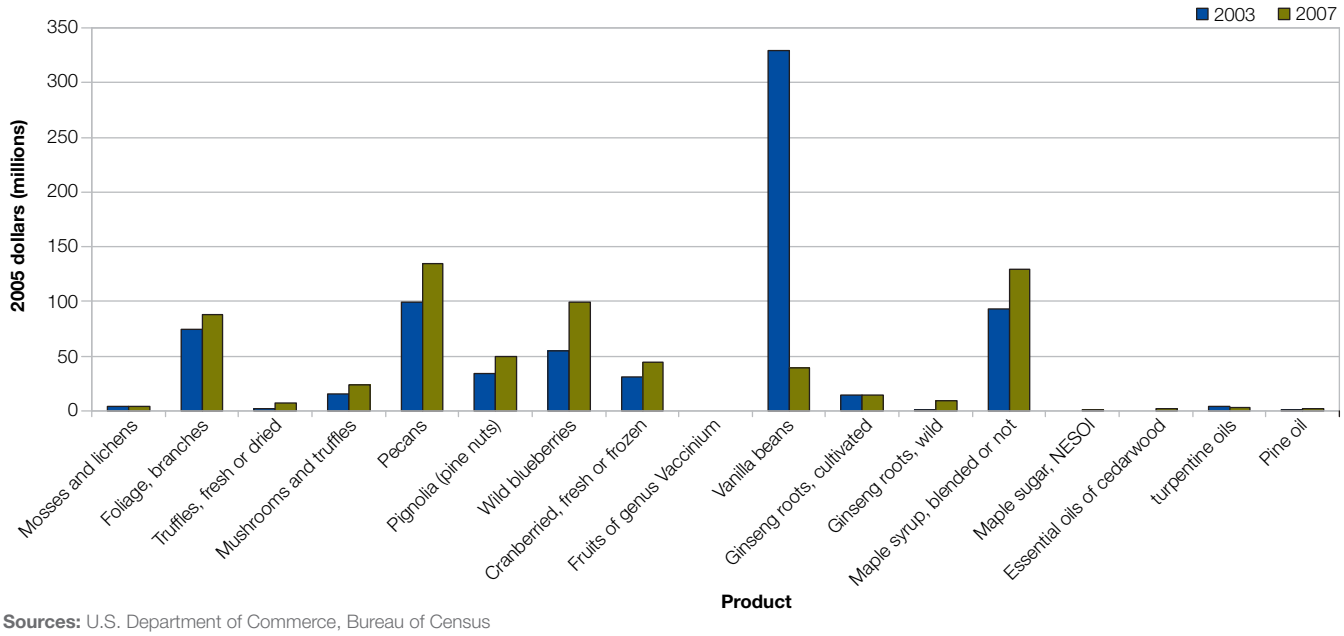
What is the indicator and why is it important?

This indicator provides information on the relative importance of international trade in wood and wood products to domestic production and consumption. This indicator is used to evaluate the role of trade in the forest sector and thereby its effect on forest sustainability across social, economic, and ecological dimensions.

What does the indicator show?

The United States has become progressively more reliant on imports to meet consumption needs. In terms of roundwood equivalents, imports of wood and paper products as a share of consumption increased from 13 to 30 percent between 1965 and 2005. During this same period there was initially a concurrent trend toward increasing exports as a share of production, which reached a high in 1991, but these exports have since declined. Exports as a share of production increased from 5 percent in 1965 to a high of 16 percent in 1991 then decreased to 10 percent in 2006 (fig. 32-1).

Figure 31-2. Value of imports of selected nonwood forest products, 2003 and 2007 (millions of 2005 dollars).



Sources: U.S. Department of Commerce, Bureau of Census

The sustained increase of the overall import share to the historically high level of 30 percent is due largely to growth in the softwood lumber import share, which reached a level of 38 percent in 2006. The overall import share is up from 15 percent in 1965. The import share for other products was relatively stable between 1965 and the 1990s, but has since also increased (figs. 32-2 and 32-3).

The trend in overall export share of production, an increase then a decline, is because of initial increases and subsequent declines for softwood lumber, softwood plywood, and paper and paperboard. For hardwood lumber the share has continued to increase, and for pulp the share increased then leveled off after the mid-1990s. (figs. 32-4 and 32-5).

What has changed since 2003?

The overall trends in import share (increasing) and export share (decreasing) that appeared before 2003 have continued through 2006.

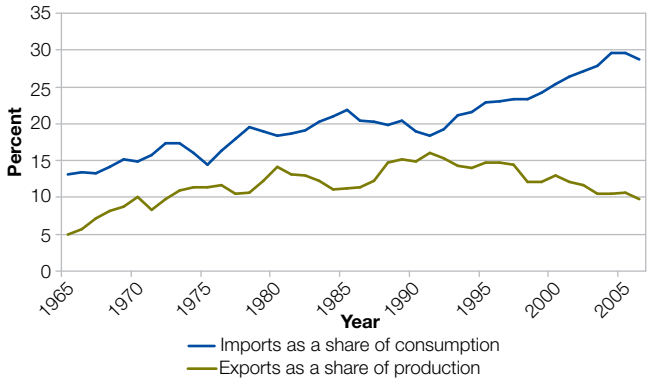
Are there important regional differences?

Data are not available for interstate imports and exports for U.S. regions, so import and export shares cannot be provided by U.S. regions. It is possible, however, to roughly estimate which regions are net importers of wood and paper products, in roundwood equivalent, if we assume that consumption per capita is uniform across regions. In terms of roundwood equivalent, of the four Resource Planning Act (RPA) Regions, only the U.S. South is a net exporter of wood and paper products (fig. 32-6).

Why can't the entire indicator be reported at this time?

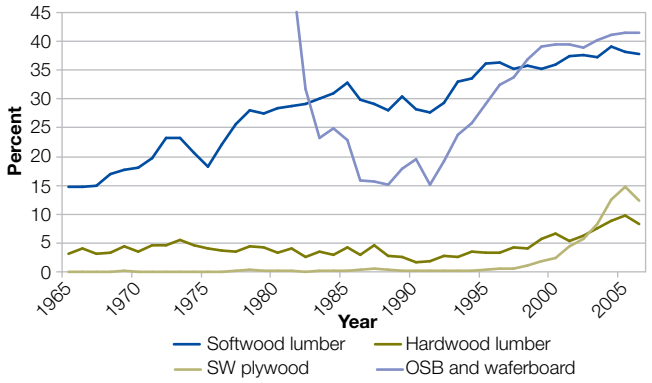
It is not clear if data on value of wood and paper industry shipments covers the same range of products as the value of wood and paper imports and exports, so import and export shares on a value basis have not been provided.

Figure 32-1. Wood and paper products imports as a share of consumption, and exports as a share of production, 1965–2006 (on volume basis in roundwood equivalents).



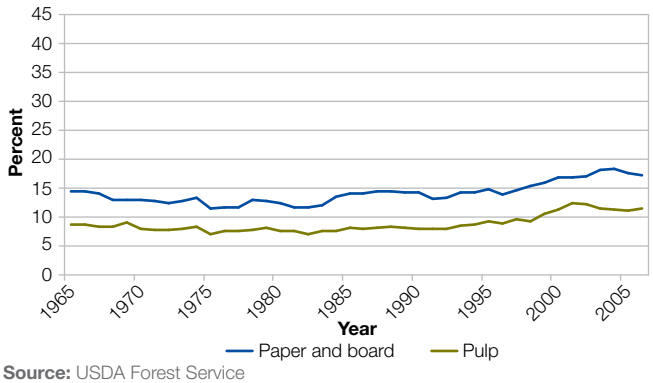
Source: USDA Forest Service

Figure 32-2. Wood products imports as a share of consumption, 1965–2006 (cubic units imported per cubic unit consumed).



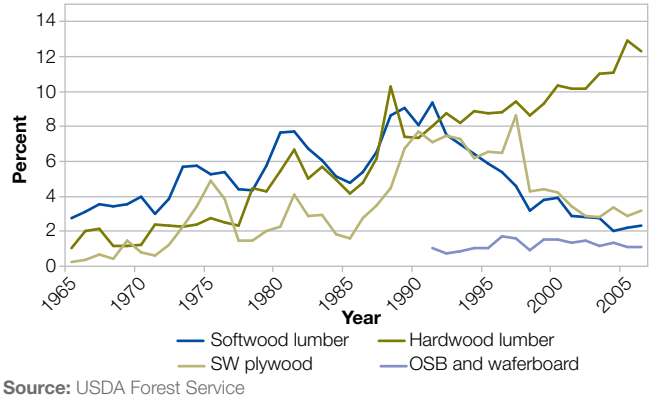
Source: USDA Forest Service

Figure 32-3. Pulp, paper, and board imports as a share of consumption, 1965–2006 (tons imported per ton consumed).



Source: USDA Forest Service

Figure 32-4. Wood products exports as a share of production, 1965–2006 (cubic units exported per cubic unit produced).

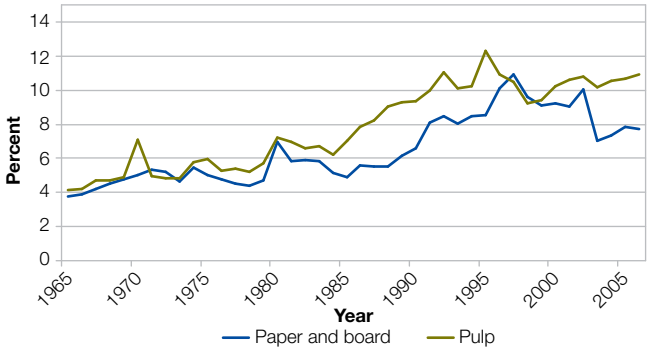


Source: USDA Forest Service

Relation to other indicators

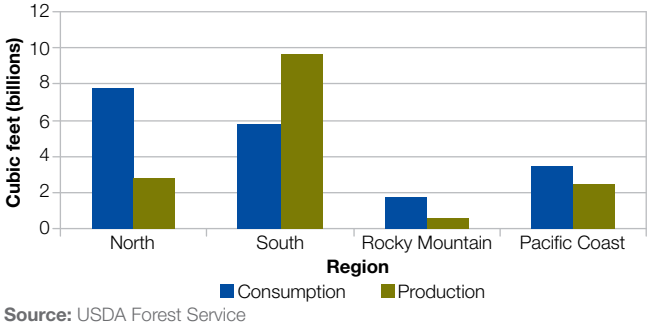
The level and trend in wood and paper export share of consumption are a key factor in sustaining certain benefits from forests—benefits of employment and wages (Indicators 6.36 and 6.37), benefits in revenue to various groups (Indicator 6.40), and contribution to community resiliency (Indicator 6.38). Level and trend in import share of production also has an influence on the same indicators but in a direction opposite from export share. For example—for a given level on wood products consumption in the United States increased export share would increase employment and wages and increase import share would decrease employment and wages. The level of export and import shares are determined by the competitiveness of U.S. industries in relation to foreign industries which, in turn, is influenced—in the long run—by the level capital investment in new technology (Indicator 6.34), by levels of research and education in the United States (Indicator 6.35), and by the productivity of U.S. forests (Indicator 6.11).

Figure 32-5. Paper and paperboard, and pulp exports as a share of production, 1965–2006 (tons exported per ton produced).



Source: USDA Forest Service

Figure 32-6. Wood and paper products consumption and production by region in roundwood equivalents, 2006 (billions of cubic feet) (Regional consumption is estimated by assuming national per capita consumption of 63.5 cubic feet is uniform across regions).



Source: USDA Forest Service

Indicator 6.33. Recovery or recycling of forest products as a percent of total forest products consumption

What is the indicator and why is it important?

This indicator identifies the extent to which forest products are recycled or reused and provides a measure of the national efficiency of forest products usage. Recovered products are an important raw material for many forest products industries and some industries outside the wood products sector. Recycling forest products reduces the quantity of waste deposited in land fills or incinerated and enables a country to increase consumption of wood products without an increase in timber harvesting. With increased recycling and stable exports timber harvest and timber prices would decrease.

Key sources of post-consumer wood and paper materials that are recovered for reuse in products include paper and paperboard, wood pallets, construction waste, demolition waste, and wood and paper in municipal solid waste. For this indicator recovered amounts do not include amounts of waste wood and paper that are used for energy.

Two basic measures are used for this indicator:

- The recovery rate is the amount of wood or paper recovered for reuse in products (includes exports) divided by the amount of source products consumed in a year.
- The utilization rate is the amount of wood or paper recovered divided by the amount of products produced in a year.

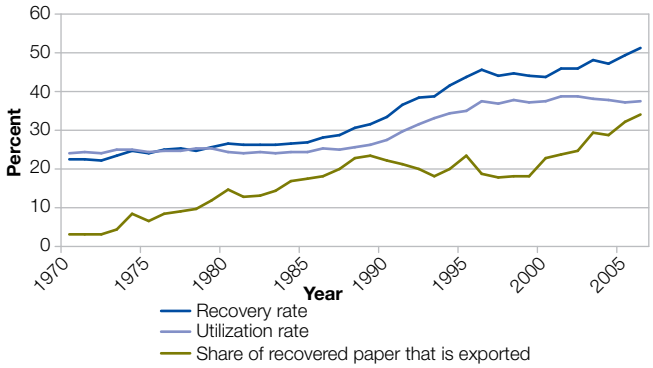
The utilization rate indicates the degree to which use of recovered wood or paper holds down or substitutes for use of virgin wood in U.S. production of wood and paper products.

What does the indicator show?

The recovered paper utilization rate increased from 22 to 38 percent between 1970 and 1996, but then stabilized at 37 to 38 percent between 1996 and 2006 (fig. 33-1). In contrast the recovery rate for paper and paperboard increased from 22 percent in 1970 to 45 percent in 1999 and then continued to rise to 51 percent in 2006. In the past decade, the recovery rate has continued to increase although the utilization rate has leveled off because almost all the increase in recovery since 1996 has gone to exports. Exports of recovered paper increased from 3 percent in 1970 to 18 percent and then nearly doubled since 1999, rising to 34 percent in 2006. For the purpose of comparison, in 1999 the total consumption of paper and paper products by all developed countries was 252 million tons annually, and their average recovery rate was 43 percent.

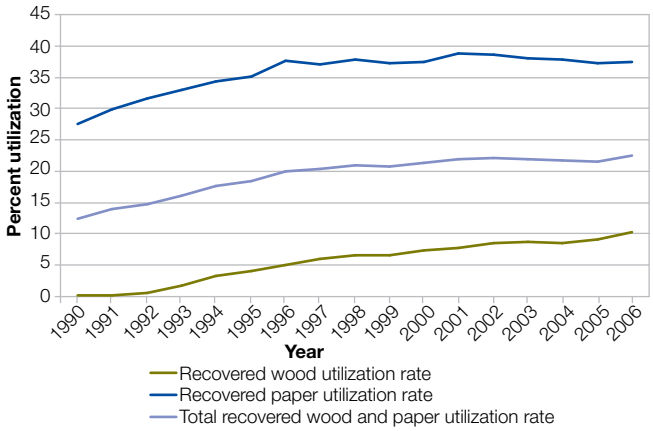
The utilization rate of recovered wood products (for reuse as wood products) is uncertain because of incomplete data. We estimate the amount of recovered wood that is reused for products to include all recycled wood pallets and one-half of the wood recovered from municipal solid waste. We further assume that: (1) the other half of wood from municipal solid waste (MSW) is used for fuel or uses that do not displace wood products use; (2) wood recovered from demolition and construction sites goes for uses (e.g., fuel or mulch) that do not displace wood products use; (3) the amounts of wood recycled via deconstruction are still small; and (4) recovered amounts are all used in the United States with no exports. With these assumptions the estimated recovered wood utilization rate has increased from an insignificant amount in 1990 to 10 percent in 2006 (fig. 33-2). The recovered wood utilization rate for wood pallets alone has increased from 2 percent in 1993 to 34 percent in 2000 and 38 percent in 2006.

Figure 33-1. Paper and paperboard recovery rate, utilization rate, and share of recovered paper that is exported, 1970–2006.



Sources: USDA Forest Service and American Forest and Paper Association

Figure 33-2. Recovered wood and paper utilization rates, separately and combined, 1990–2006.



Sources: USDA Forest Service and American Forest and Paper Association

What has changed since 2003?

U.S. recovery of paper is has increased from 45 percent in 1999 to 51 percent in 2006 with virtually all of the increasing recovery share going for exports.

Are there important regional differences?

Total U.S. recovered paper consumed at U.S. mills increased by 2 percent between 2003 and 2006, from 33.7 to 34.5 million tons. Industry reported data indicate recovered paper consumption increased in mills in every region except the North. In 2006 the South had the highest recovered paper consumption (15.4 million tons) but the lowest recovered paper utilization rate (29 percent). The next highest level of consumption was in the North (13.4 million tons) where the utilization rate was (50 percent), followed by the Pacific Coast (4.8 million tons and a 49 percent utilization rate) and the Rocky Mountains (1.2 million tons, where utilization rate was highest [59 percent]) (fig. 33-3).

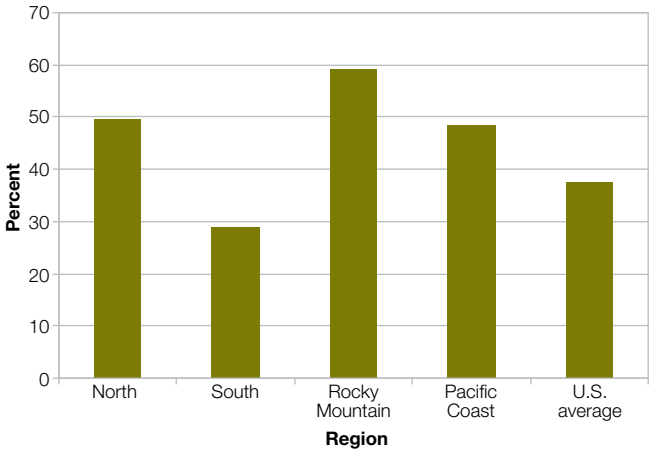
Why can't the entire indicator be reported at this time?

Data are not available on the amount of wood reused for products from demolition and construction sites and from deconstruction of building. We have assumed amounts are currently small. Value of recovered material, except for grades of recovered paper, are not available on a national scale.

Relation to other indicators

The recycling rates (utilization rates) for wood and paper influence the amounts and kinds of wood that is harvested in the United States (Indicator 2.13) and the effect of the harvest

Figure 33-3. Recovered paper utilization rate by region, 2006.



Sources: USDA Forest Service and American Forest and Paper Association

treatments on forest growth (Indicator 2.11). To the extent that recycling decreases harvest jobs, income, and revenue to landowners is affected (Indicator 6.36, 6.37, and 6.40). These rates also influence the amounts of carbon stored in forests (Indicator 5.22), the length of time carbon is stored in products (Indicator 5.23), and the energy that is obtained by burning post-consumer wood and paper (Indicator 5.24). The degree to which recovered paper is recycled in the United States rather than being exported depends on price competiveness. This competitiveness is determined in part by the amount of U.S. investment in capital (Indicator 6.34) and in research and education (Indicator 6.35).

Indicator 6.34. Value of capital investment and annual expenditure in forest management, wood and nonwood product industries, forest-based environmental services, recreation, and tourism

What is the indicator and why is it important?

This indicator measures investments made to maintain and enhance the ability of forests to produce goods and services for the benefit of a Nation's economy and people. Sustainable forest management is not possible in the long run without regular investments. When capacities to protect, manage, and use forests erode, through lack of funding, the benefits that forests provide also decline.

What does the indicator show?

Capital investment toward protecting and managing forests includes investment in facilities, roads, and trails by the Forest Service, which was $501 million in 2005 and $390 million in 2007 (adjusted for inflation and expressed in 2005 dollars). Annual expenditures for Forest Service programs for national forests and grasslands decreased between 2004 and 2007 from $3.0 to $2.7 billion and expenditures for wildfire management increased from $1.7 to $2.1 billion (all in 2005 dollars).

Total annual expenditures for State forestry agency programs have been about the same in 1998, 2002, and 2004 at $2.0 to $2.2 billion (2005 dollars) (fig. 34-1). During this time State expenditures increased for States in the Pacific Southwest and Pacific Northwest Regions by 27 percent after inflation, primarily in California, and decreased in the Northern Region mostly as a result of an urban forestry expense in 1998 in New Hampshire not present in 2002 or 2004.

Capital investment in forest recreation and tourism are made by a variety of entities on both public and private land, and for infrastructure for businesses that provide the goods and services that make forest recreation possible. On the national level, investments into public recreation facilities include those made by the Forest Service and the U.S. Department of the Interior National Park Service (NPS). For 2009 the Forest Service budgeted $405 million in capital improvement and maintenance costs, which is an 8-percent decrease from 2008 ($474 million). NPS expenditures on facility maintenance increased from $389 million in 2006 to $393 million in 2007, and are budgeted for $461 million in 2008.

Private capital investment in forest recreation infrastructure was estimated for businesses that provide forest recreation services and those that provide the equipment, which makes forest recreation possible. In 2006, total capital expenditures within the forest recreation sector were an estimated $1.47 billion, with $1.03 billion toward structures and $442 million in equipment expenditures. These expenditures are approximately 8.5 percent of total expenditures in the leisure industry.

In 2006, NPS concessions provided an estimated $48.3 million in the form of franchise fees paid to NPS and in the form of facility improvements for national parks, with $21.6 million of this being solely dedicated to facility improvements. As much as 90 percent of the fees and improvements may support forest-based recreation.

Capital investment in wood products industries decreased from $3.4 billion in 1997 to $2.2 billion in 2003 but increased to $3.5 billion in 2006 (all in 2005 dollars) (fig. 34-2). Capital investment in paper products industries declined more—from $10.2 billion in 1997 to $5.3 billion in 2004 but increased to $7.4 billion in 2006 (all in 2005 dollars). Capital investment in the wood furniture industry was $837 million in 1997 and $873 million in 2002. Capital investment in logging industry was $0.9 billion in 1997 (2005). More recent data from U.S. Bureau of Census is not available.

Annual expenditures for payroll and materials by the wood products industries decreased between 1997 and 2003 about 9 percent from $82 to $75 billion then increased to $84 billion in 2006 (2005 dollars). Annual expenditures for payroll and materials for paper product industries decreased 15 percent from 1997 to 2003 from $121 to $104 billion then increased to $107 billion in 2006 (in 2005 dollars).

What has changed since 2003?

Annual capital investment in wood and paper industries declined 40 percent between 1997 and 2004 and increased 34 percent between 2004 and 2006. In contrast annual expenditures for payroll and materials remained relatively stable between 1997 and 2006 (in 2005 dollars).

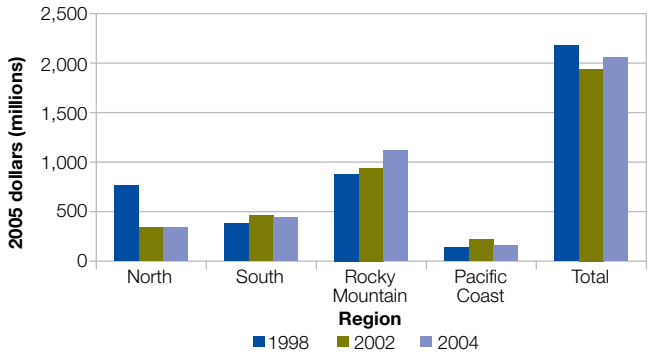
In recent developments, during 2007 and early 2008, the U.S. Department of Energy (DOE) announced grants of up to $585.3

million for capital costs to build 13 commercial or demonstration cellulosic liquid biofuels plants. Six of the plants—with DOE capital funding up to $230.3 million—will use wood biomass or wood pulp extract as feedstock. Additional funds will be invested by individual businesses. In addition to the DOE funded plants, three other wood based biofuels plants are being prepared. All together these wood-based plants expect to use 2,300 tons per day or more of wood biomass (720,000 tons per year).

Are there important regional differences?

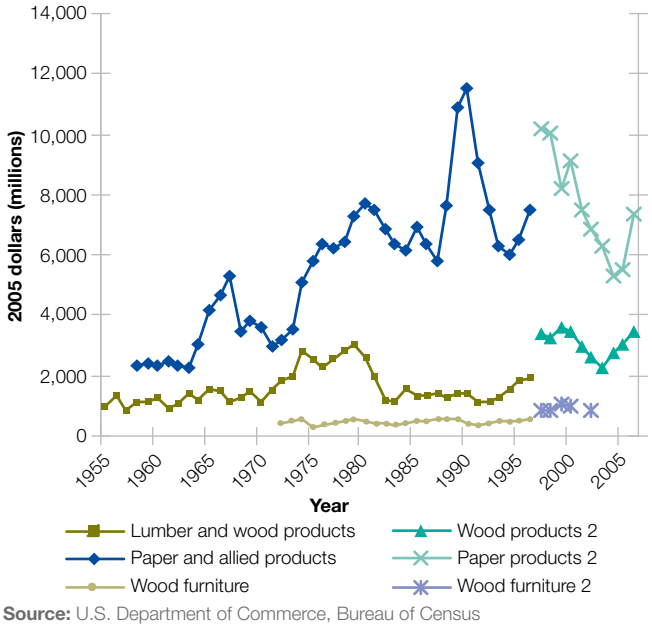
The regional share of U.S. expenditures for State forestry agency programs in 2004 is highest for the Pacific Coast (54 percent), followed by the South (21 percent), North (16 percent), and Rocky Mountains (8 percent). Between 1997 and 2006 the share of total U.S. annual capital investment in wood and paper product industries ranged from 35 to 49 percent in the North, 36 to 43 percent in the South, 11 to 15 percent in the Pacific Coast, and 3 to 9 percent for the Rocky Mountain Region (fig. 34-3). The share increased from 11 to 15 percent for the Pacific Coast Region and decreased for the North and South Regions. The regional shares of annual payroll and material expenses have been a little more stable and are highest in the North and South, 39 percent, 38 percent, respectively, followed by the Pacific Coast (15 percent), and Rocky Mountains (7 percent) (fig. 34-4).

Figure 34-1. Annual State forestry program expenditures and costs by region, 1998, 2002, 2004 (millions of 2005 dollars).



Source: National Association of State Foresters

Figure 34-2. Capital expenditure in forest products industries, 1955–2006 (millions of 2005 dollars) (data after 1996 use NAICS (North American Industry Classification System) industry codes).

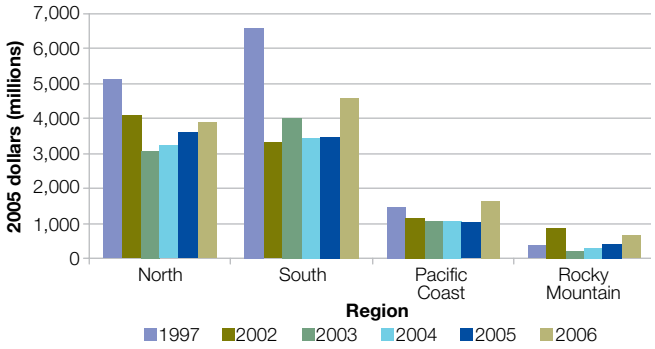


Source: U.S. Department of Commerce, Bureau of Census

Why can't the entire indicator be reported at this time?

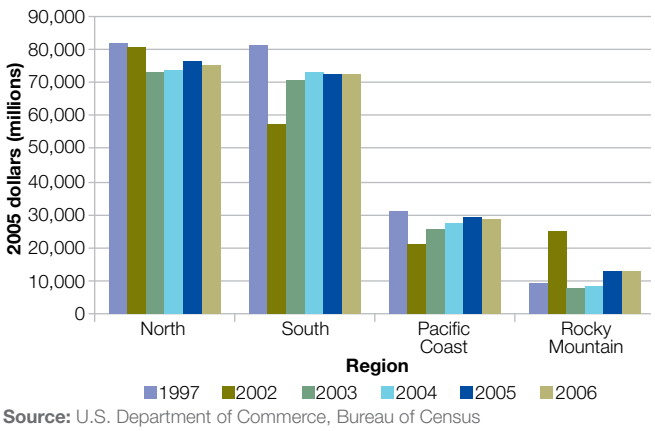
Capital expenditure and annual expense data are not available for a number of entities that protect and manage forests, including county and local governments, conservation organizations, and certain corporate land owners (e.g., TIMOs, REITs).

Figure 34-3. Capital expenditure in wood products and paper products industries by region, 1997, 2002–2006 (millions of 2005 dollars).



Source: U.S. Department of Commerce, Bureau of Census

Figure 34-4. Payroll and material costs for wood and paper products industries by region, 1997, 2002–2006 (millions of 2005 dollars).



Source: U.S. Department of Commerce, Bureau of Census

Capital and annual expense data are not available by region for forest based recreation and tourism. Data specifically on capital and annual expenses for providing forest-based environmental services are not available although some cited total expenses by the Forest Service and State forestry agencies support these services.

Relation to other indicators

The levels and trends in capital investment and annual operating expenses are key factors in sustaining benefits of all types from forests—from wood products (Indicators 6.25 and 6.28), from nonwood products (Indicators 6.26 and 6.29), from recreation (Indicators 6.41, 6.42, and 6.43), and for environmental services (Indicator 6.27). Levels of capital investment and operation expenses also influence the competitiveness of U.S. wood and nonwood products firms in comparison to foreign firms (Indicators 6.30, 6.31, and 6.32). Levels of capital investment also influence levels of employment (Indicator 6.36), wages (Indicator 6.37) and community resilience (Indicator 6.38).

Indicator 6.35. Annual investment and expenditure in forest-related research, extension and development, and education

What is the indicator and why is it important?

Capital investments and annual operating expenditures on forest-related education, research and development increase human capital. Funds invested in communicating the results of research and development to practitioners and the public build awareness, and hopefully support, for sustainable forest management. These investments and expenditures increase knowledge and skills and, over time, increase a country's ability to practice sustainable forest management.

Research and development, extension, and education areas include all disciplines that influence forest resource management decision making. Forests in the United States are threatened by fragmentation, invasive species, the effects of climate change, and the disconnect of our children and increasingly urban populations from the natural world. Forest related education and extension, and the communication of research and development to both forestry practitioners and the general public can build awareness and support for sustainable forest management. Thus, it is critical to examine the level of funds invested annually toward forest-related education, extension, and research and development.

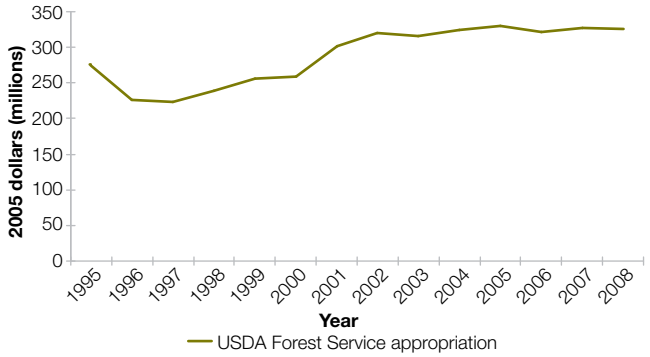
What does the indicator show?

Forest resource management-related research and development efforts are centered in the Forest Service, in universities, and in industry, with additional efforts by other agencies and nongovernmental organizations. Forest Service funding for research, including construction, and net of inflation, has increased from $259 million in 2000 to $326 million in 2008 (both in year 2005 dollars) although funding has been relatively constant above $300 million per year (2005 dollars) since 2002 (fig. 35-1).

Forest Service publications (including those in peer reviewed journals) have increased from 1,886 in 1981, to 2,718 in 1998, and most recently to 3,182 in 2007.

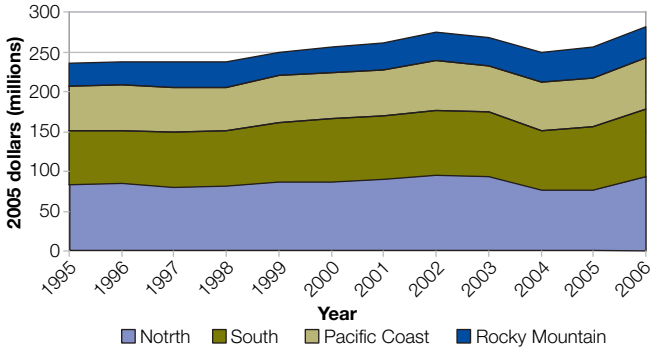
Funding available for forestry research at universities that receive Federal funding increased from $256 million in 2000 to $282 million in 2006 (2005 dollars). Funding in 2006 was highest in the North ($92 million), followed by the South ($84 million), Pacific Coast ($65 million), and the Rocky Mountains ($39 million) (fig. 35-2).

Figure 35-1. USDA Forest Service Research and Development appropriations, 1995–2008 (millions of 2005 dollars).



Source: USDA Forest Service

Figure 35-2. Forestry research funding at U.S. universities that are partially funded by the USDA National Institute of Food and Agriculture by Resource Planning Act Region, 1995–2006 (millions of 2005 dollars).



Source: USDA National Institute of Food and Agriculture

Forest industry also provides funding for both internal and external research. The Agenda 2020 is a key Federal and industry partnership that provides funds from the Federal Government and industry for research on a wide range of topics, including improved fiber recovery and use, decreasing capital costs, reducing environmental effect, the forest biorefinery, and improved housing systems. Funding for 2003 was about $30 million each from industry and the Federal Government.

Additional sources of funding for forestry research are available, from other Federal sources and nongovernmental organizations (NGOs).

Baccalaureate, masters, and doctorate degrees awarded in forest science programs decreased 20 percent from 2,263 in 2001 to 1,810 in 2006. During that period, the number of baccalaureate degrees decreased 28 percent, doctorate degrees decreased 15 percent, and master's degrees increased almost 4 percent.

In 2007, funding appropriated through the Renewable Resources Extension Act for forest stewardship and health extension programs, resulted in 1,495 education events nationwide, the development of 1,574 stewardship plans, and affected more than 12 million acres.

Forest Service Conservation Education activities and programs, which are funded from numerous sources within and external to the Forest Service, reached 4,400,000 people in FY 2006. 35 percent of those reached came from urban areas, 10 percent were underserved, and 33 percent were youth and their educators. FY 2006 data indicate a significant increase over previous years for the number of activities conducted, audiences reached, partnerships developed and improved, and total dollars spent, although these data are collected from a voluntary, self-reporting database (table 35-1).

Forest resource education is also provided by public schools, and by a wide range of nongovernmental organizations (NGOs).

What has changed since 2003?

The amount of funds available for forest research since 2003 has increased both for Federal and university research. In the same time period, the amount of forest science degrees awarded has decreased by 20 percent.

Table 35-1. Level of Forest Service Conservation Education activities and dollars spent, 2004–2006.

	2004	2005	2006
Number of activities	655	1,007	1,335
Audience reached	2,100,000	982,000	4,400,000
Number of partnerships	641	825	1,578
Total spent (millions of 2005 dollars)	8.3	9.7	17.9

Why can't the entire indicator be reported at this time?

Investment in forest education for primary school-aged children is important for this indicator but a forestry-specific, nationwide data set was not found. Information is not available on funding for forestry related research and education from other Federal sources, such as U.S. Department of the Interior or National Aeronautics and Space Administration, nor are data available funds for research done by many NGOs.

Indicator 6.36. Employment in Forest Products sector

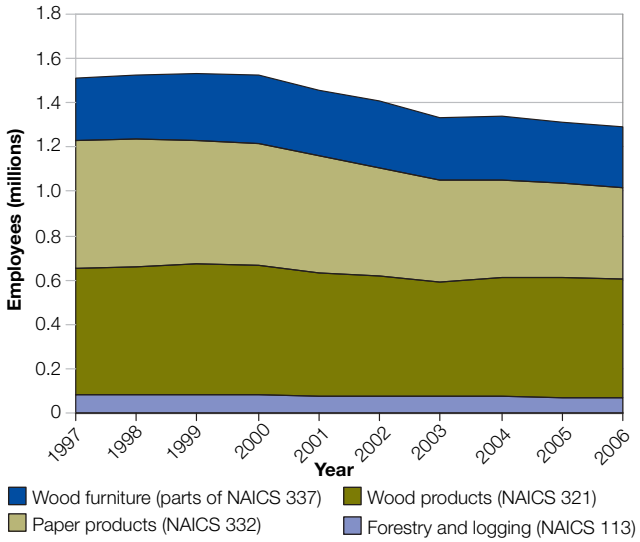
What is the indicator and why is it important?

Employment attributable to forests is one measure of the social and economic importance of forests. It includes employment that is both forest-based and forest-related. Employment is a tangible and widely understood measure of economic and social well being.

What does the indicator show?

Jobs in the forest products industries decreased by about 15 percent between 1997 and 2006, falling from 1.51 to 1.29 million jobs. Job declines included 21 percent for forestry and logging, 6 percent for solidwood products, 28 percent for pulp and paper, and 3 percent for wood furniture (fig. 36-1). Within the furniture category nonupholstered wood furniture decreased 44 percent from 127,703 to 71,544 jobs and architectural

Figure 36-1. Number of employees in forest products industries, 1997–2006.



NAICS = National American Industry Classification System.
Source: U.S. Department of Commerce, Bureau of Census

woodwork and millwork increased 31 percent from 24,390 to 32,033 jobs. Forestry and logging jobs had been relatively constant between 1986 and 1996.

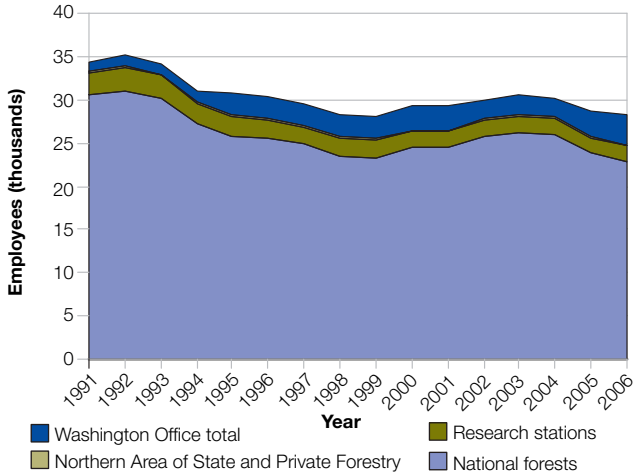
In 2006, 74 percent of forest industry jobs noted above were in the wood products and paper products industries (536,094 and 414,049 jobs, respectively). Combined, they were 1.1 percent of all U.S. jobs and 7.1 percent of manufacturing jobs. This number of jobs is down from 824,000 and 485,000 jobs in 1950 when combined they were 2.5 percent of all jobs and 8.6 percent of manufacturing jobs.

Jobs in forest management and protection include:

- Permanent Forest Service, National Forest System jobs, which have declined from 30,632 jobs in 1991, to 24,605 jobs in 2000, and 22,867 jobs in 2006 (fig. 36-2);
- Permanent employees in State forestry agencies—which has been about constant between 1998 (15,836) and 2004 (15,455) (fig. 36-3);
- Total State agency employees which have increased by about 2000 after including temporary employees—22,269 in 1998 to 24,507 in 2004;
- Employees in Department of Interior agencies that manage forests was about the same level in 2007 (43,085) as in 1998 (44,003); and
- An undetermined number in county and municipal governments, private land management organizations, private consultants, and private forest-resource related organizations.

Nationwide, firefighting and support jobs during fire season have ranged between 12,000 to 15,000 jobs in recent years. Many such jobs are temporary and excluded from the number of permanent employees in figures 36-2 and 36-3.

Figure 36-2. USDA Forest Service permanent employees by branch, 1992–2006.



Source: USDA Forest Service

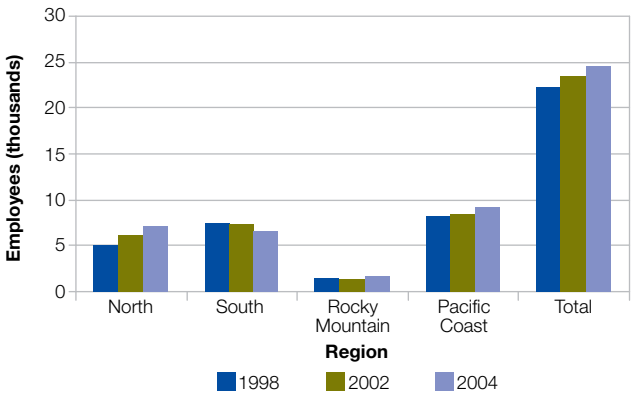
The number of jobs associated with forest-based recreation is uncertain. For 2006, we estimate about 551,000 forest-based recreation jobs. An increase may be inferred by the increase in participation in U.S. forest recreation. To underscore the uncertainty of this estimate, we note that the estimate for the 2003 report made using different methods was 1.1 million direct forest-based recreation jobs. For 2005, direct jobs associated with recreation on national forests are estimated to be 97,600 jobs.

Jobs in producing nonwood forest products, including medicinals, food and forage species, floral and horticultural species, resins and oils, arts and crafts, and game animals and furbearers probably number in the tens of thousands. Many, if not most jobs, are in informal businesses whose characteristics are not recorded in Bureau of Census surveys. Two exceptions. The sector Forest Nurseries and gathering of forest products included 231 businesses in 2006 with 2,098 employees. The sector hunting and trapping included 348 establishments with 1,875 employees in 2006. These jobs have decreased from 2,702 in 2002.

Jobs in forest related education and research include those at colleges and universities and research jobs include those in the Forest Service. For the 2003 report, we estimated 1,361 jobs in forest related education and research for 2001. Jobs at Forest Service research stations have decreased from 2,469 in 1991, to a low of 1,708 in 2000, and were 1,760 in 2006. For the 2003 report, we estimated 124 industry research jobs for 2001. In addition there are an undetermined number of forest resource education jobs within private associations and organizations.

Total forest-related direct jobs are estimated to be close to 3 million or about 2 percent of all U.S. employment. This number does not include indirect jobs generated by expenditures of government agencies, businesses, or others.

Figure 36-3. Permanent and temporary State forestry agency employees, by region, 1998, 2002, and 2004 (State data missing: 2002—PA and NV; 2004—OH, ME, IL, and AR).



Source: National Association of State Foresters

What has changed since 2003?

Jobs in forest products industries have declined considerably—by 167,995 or 12 percent between 2001 and 2006.

Are there important regional differences?

In 2006, forest products industry employment (number of jobs excluding wood furniture) was highest in the North (400,000), followed by the South (341,000), Pacific Coast (130,000), and Rocky Mountains (73,000) (fig. 36-4). Between 2001 and 2006 these jobs decreased in the North, South, and Pacific Coast but increased in the Rocky Mountain Region. Forestry and logging jobs in 2006 were highest in the South (36,013), followed by the Pacific Coast (14,538), North (11,839) and Rocky Mountains (3,914).

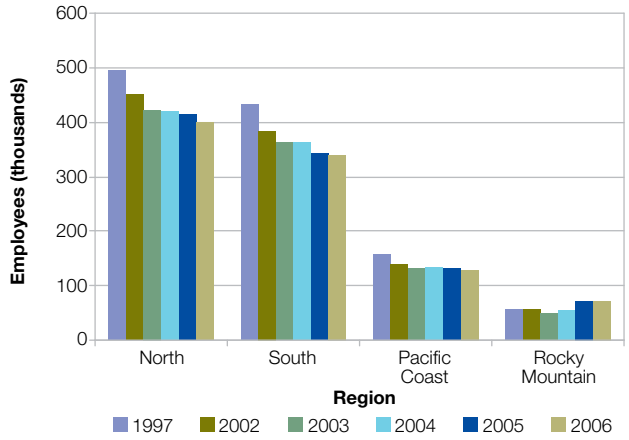
In 2004, total employment in State forestry agencies was highest in the Pacific Coast (6121 permanent and 3109 temporary) followed by the North (2,791 permanent and 4,320 temporary), the South (5492 permanent and 1,043 temporary), and Rocky Mountains (1,051 permanent and 581 temporary). Between 1998 and 2004 State forestry agency seasonal and temporary jobs increased for the North (more than doubled), and for the Pacific Coast and Rocky Mountains, but declined for the South.

Why can't the entire indicator be reported at this time?

Little data are available on jobs in producing nonwood forest products because many businesses are very small and part of the informal economy, which has casual hiring practices and nonreported income.

Data are not available on jobs related specifically to the provision of environmental services such as carbon storage, biodiversity, or water supply. Updated data are likewise not available on forest-related education and research jobs at colleges and universities nor for forest related jobs in county and municipal governments, private land management organizations, private consultants, and private forest-resource related organizations.

Figure 36-4. Employees in wood and paper products industries (NAICS [North American Industry Classification System] 321, 322) by region, 1997, 2002–2006.



Source: U.S. Department of Commerce, Bureau of Census

Relation to other indicators

The levels of employment are a factor in the resilience of forest-based communities (Indicator 38) and in the importance of forests to people (Indicator 44). Employment levels are influenced by capital investment (Indicator 34) and education and research (Indicator 35). Employment levels in forest products industries are also influenced by competition from imported forest products, as indicated by trends in imports as a proportion of U.S. consumption (Indicator 32).

Indicator 6.37. Average wage rates, annual average income, and annual injury rates in major forest employment categories

What is the indicator and why is it important?

Wages, income and injury rates are measures of the quality of employment. Wages and income are indicators of the economic returns to workers in forest-based and forest-related enterprises. Decreasing injury rates may reflect improved occupational health and safety and employment quality, which provide both personal and community social benefits.

What does the indicator show?

Average annual incomes related to forest management and protection employment includes the salaries of full time permanent employees of the Forest Service which have increased from a median of $41,300 in 1992 to $48,200 in 2000, and to $50,500 in 2006 (all figures are adjusted for inflation and expressed in 2005 dollars).

Salaries of full-time permanent employees in State forestry agencies in 1998, for entry-level foresters, ranged from a high of $48,000 for the Pacific Coast, $39,000 in the North, $35,000 for the Rocky Mountains and $28,000 for the South. Values for district foresters for the same regions were $62,000, $63,000, $43,000, and $50,000, respectively. Salary data are not available for more recent years.

In the forest products industries annual income per full-time equivalent employee is higher and has increased more for workers in the paper products industries than those in the wood products industries. For paper products, annual income increased from $39,954 to $52,572 between 1975 and 2006 and wood products annual income increased from $30,866 to $34,239 (fig. 37-1). Annual income for paper products

continues to be above the average for all manufacturing and below the average wood products. Production worker wages for forestry and logging, including timber tract operations, nurseries, and logging, ranged from $33,000 to $34,620 in 2008.

Average annual income for persons working in the forest recreation and tourism sector during 2006 was estimated to be $22,782, which is only a slight increase from the $21,939 figure estimated for 2003. This amount is about 37 percent less than the 2006 national average per capita annual income of $36,276. One likely reason for the lower income is that jobs offered in this sector tend to be lower wage and seasonal jobs.

Injury and illness rates for forest products industries have steadily declined since the early 1990s with rates for wood products and furniture industries being somewhat higher than for all manufacturing, and paper products industries being somewhat lower (fig. 37-2). In 2006 injury and illness cases per 100 employees were 5.3 for forestry and logging, 8.5 for wood products, 7.1 for wood furniture, 4.3 for paper products, and 6.0 for all manufacturing.

Are there important regional differences?

Hourly wages for wood products industries production workers are slightly higher than the national average for the Pacific Coast and slightly lower for the South (fig. 37-3). Wages for paper products industries are slightly higher in the South, Pacific Coast and North than in the Rocky Mountains.

Average income in forest-based recreation and tourism in 2006 was highest for the Pacific Southwest and Pacific , $24,566 and lowest for the Rocky Mountains, $17,620 (both in 2005 dollars) (fig. 37-4). Although these differences could be a function of forest-based recreation and tourism demand driving labor markets, fluctuations in regional economies are likely to be the major drivers of these rankings.

Why can't the entire indicator be reported at this time?

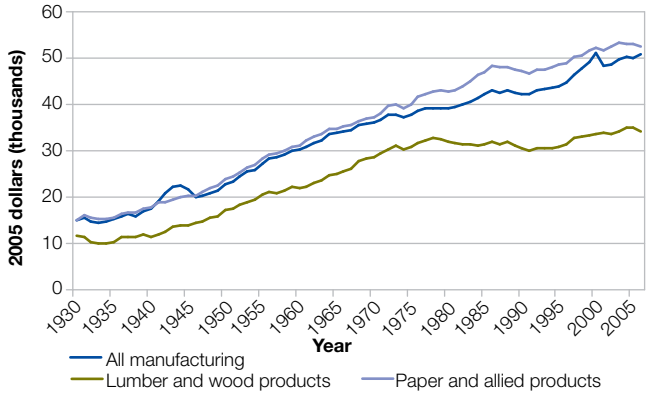
Wage and annual income estimates are not available for State forestry agencies, nonwood products industries, forestry schools in colleges and universities or for local governments and NGOs that contribute to forestry. Special surveys would be required to collect this information.

Injury rate information is not available for most forest management jobs nor are they available for the nonwood forest products sector or jobs in forest recreation and tourism jobs. Injuries for some forest management jobs are included in wood and paper industry data. Although nonwood forest products workers operate in the informal economy (not covered by traditional surveys), gathering products in the forest can be dangerous, and there are reports in the media of people becoming lost or injured every year.

Relation to other indicators

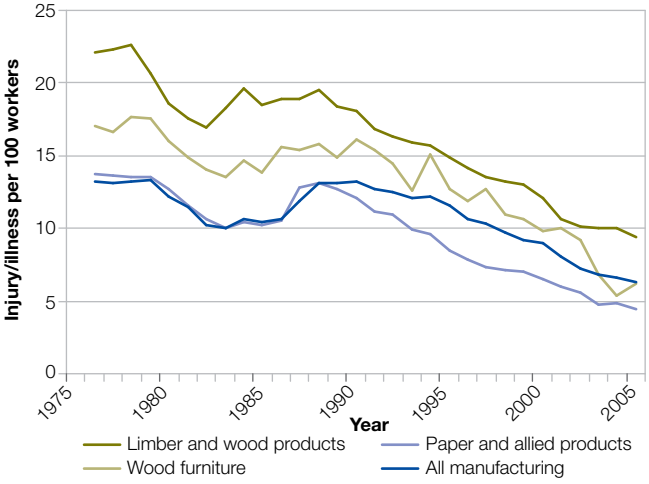
The level of wages and income and level of injuries are a factor in the resilience of forest-based communities (Indicator 6.38) and a factor in the importance of forests to people (Indicator 6.44). The level of wages is influenced by the levels of capital investment (Indicator 6.34) and by the levels of education and research (Indicator 6.35). The level of wages in forest products industries may also be influenced by competition with other countries to provide products for the United States as indicated by trends in imports as a proportion of U.S. consumption (Indicator 6.32).

Figure 37-1. Wage and salary accruals per full-time equivalent employee for all manufacturing, lumber, and wood products industries and paper and allied product industries, 1930–2006 (thousands of 2005 dollars).



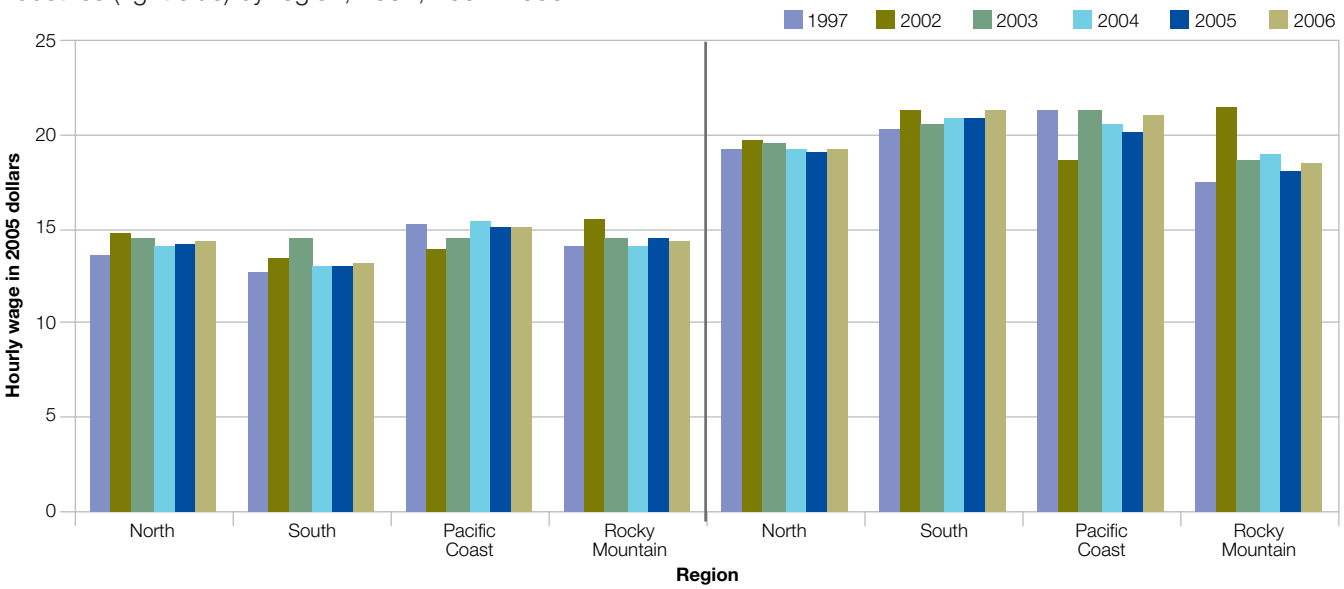
Source: U.S. Department of Commerce, Bureau of Economic Analysis

Figure 37-2. Rate of injury and illness cases per 100 full-time workers for lumber and wood products, paper and allied products, and all manufacturing industries, 1976–2006.



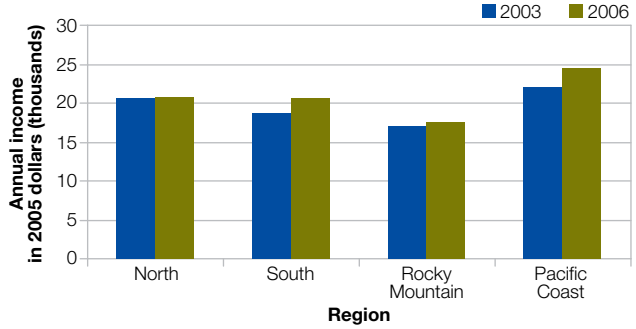
Source: U.S. Bureau of Labor Statistics

Figure 37-3. Wage per hour for production workers in wood products industries (left side) and paper products industries (right side) by region, 1997, 2002–2006.



Source: U.S. Department of Commerce, Bureau of Census

Figure 37-4. Annual average income for persons employed in the forest recreation and tourism sector by region, 2003 and 2006.



Sources: USDA Forest Service analysis, multiple data sources

Indicator 6.38. The Resilience of Forest-Dependent Communities

What is the indicator and why is it important?

Resilience of Forest Dependent Communities is a new indicator of social sustainability. In the development of this indicator, the Montréal Process Technical Advisory Committee suggested that countries provide definitions and select approaches to measurement that best reflect their national experiences. The resultant methodology should enable reporting on the health of forest-dependent communities and trends over time. The definition, operationalization, and data gathering protocol presented herein emerged from research commissioned by the U.S. Roundtable. Additional information on the concepts and techniques underlying this work can be found in the supporting documentation on the project Web site (http://www.fs.fed.us/research/sustain/) and in Magis (2004).

Community resilience (CR) is defined as the existence, development, and engagement of community resources by community members to thrive in an environment characterized by change, uncertainty, unpredictability, and surprise. Members of resilient communities intentionally develop personal and collective capacity that they engage to respond to and influence change, to sustain and renew the community and to develop new trajectories for the community's future.

The contribution of community resilience to the MP C&I is a deeper understanding of social sustainability, specifically as it relates to a community's ability to thrive in contexts of change. A community's resilience will determine its ability to successfully mobilize and respond to societal stress, making it integral to social sustainability. Further, human societies are intimately interconnected with ecological systems. Hence, the resilience of forest-communities will influence their capacity to act as forest stewards, thus, affecting the forest's sustainability.

Eight dimensions operationalize CR into actionable, observable, and measurable elements; *Community Resources, Development of Community Resources, Engagement of Community Resources, Active Agents, Collective Action, Strategic Action, Equity,* and *Impact.* The *Community Resilience Self Assessment* (CRSA) was developed to provide a comprehensive portrayal of a community's resilience via its performance along the eight dimensions. From it, information is gleaned regarding: the community's resources; how the resources are developed and

used; the participation and collective involvement of community members in community endeavors; and the effect of those collective efforts.

What does the indicator show?

The goal of this ongoing research project is to depict a national picture of the extent to which communities dependent on forests for their wellbeing, livelihoods, subsistence, quality of life, or cultural identity are able to respond and adapt to change.

The CR definition and dimensions emerged from multidisciplinary research to understand and describe the well-being and resilience of communities. The Community Resilience Self Assessment (CRSA) and sampling protocol were developed to measure a community's resilience along the eight CR Dimensions. The CRSA contains 66 questions arranged across the eight dimensions. Respondents were chosen through a purposive sampling method involving key informants, and responses to the CRSA were gathered via the Internet.

The next stage in this project is to establish and administer a sampling process to periodically gather resilience data from forest-based communities across the United States. These data will provide a national picture of community resilience as it relates to forest sustainability, thereby accomplishing the intent of Indicator 6.38.

Initial Results

Administration of the CRSA generates data that describes conditions prevailing in particular communities. Key informants rank the community's resilience along each CR Dimension. Their answers are tallied to generate dimension scores. The CRSA uses a scale of 1–6. A score of 1 equates with very low resilience; 2—low resilience; 3—low to medium resilience; 4—medium resilience; 5—low and high resilience; and 6—high resilience. The following graphics exemplify one way to display the CR data. A radar chart is used in the first four figures to display CR scores for the pilot communities (figs. 38-1 and 38-2).

Six communities were sampled as a proof of concept for this report. Because this sample is very small, generalizations cannot be made. With a broadened sampling base, however, data can be compared across communities and relationships between dimensions and forest sustainability can be demonstrated. Figure 38-3 shows comparisons between three of the sample communities, that is, Alberton, Superior, and St. Regis.

What has changed since 2003?

Indicator 6.38 is essentially a new indicator, although it is related to Indicator 46 in the 2003 report, which measured the viability and adaptability of forest-dependent communities. The approach taken in 2003 relied on nationally available data on county level conditions, and was therefore restricted in terms of spatial specificity and the sorts of variables it could measure. The CRSA generates community-scale data, which portrays a community's resilience from the perspective of key informants. Key informants are individuals whose active engagement in the community gives them broad knowledge regarding social, political, economic, cultural and ecological conditions and trends in their community. The CRSA and key informant methodology enable direct measurement of CR, but with some costs in terms of breadth of coverage. Given these changes, it is impossible to draw direct comparisons to the results displayed in 2003.

Figure 38-1. Sample radar plot showing Community Resilience Self Assessment (CRSA) scores for Alberton, MT (sampled in 2009–2010).

Figure shows CRSA index scores (1 = lowest, 6 = highest)

Figure 38-2. Sample radar plot showing Community Resilience Self Assessment (CRSA) scores for Superior, MT (sampled in 2009–2010).

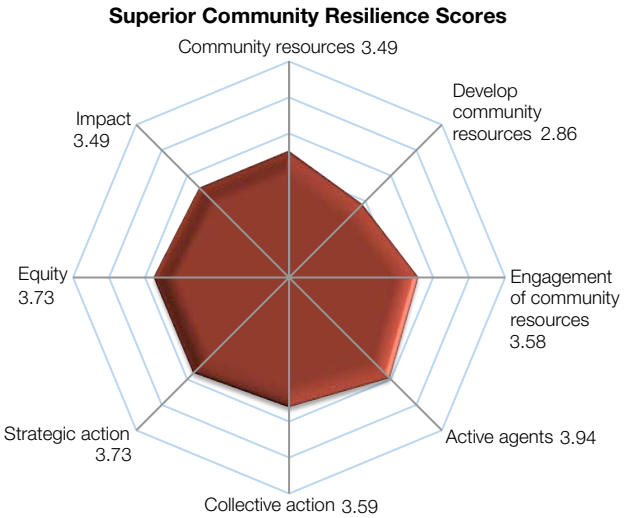
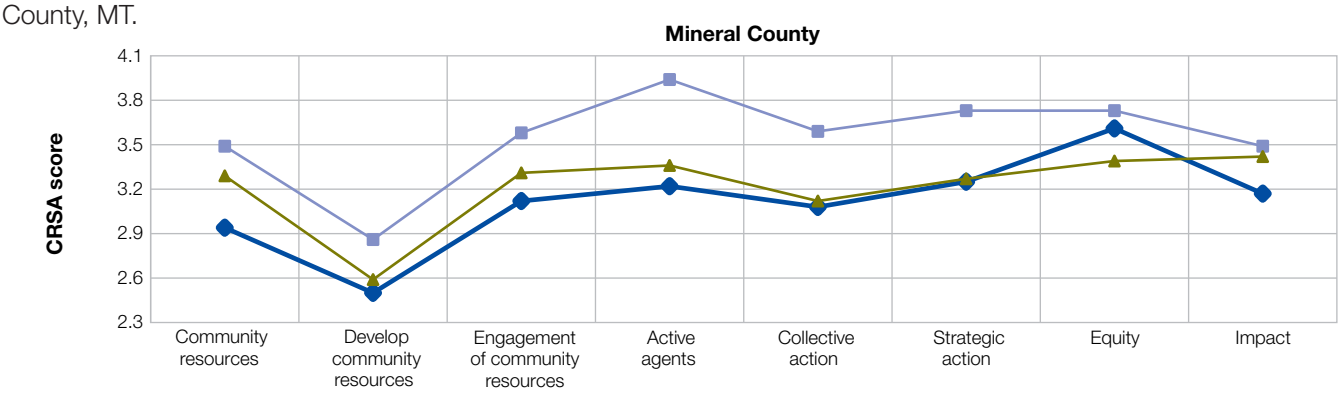


Figure shows CRSA index scores (1 = lowest, 6 = highest)

Figure 38-3. Combined Community Resilience Self Assessment (CRSA) scores for three communities in Mineral County, MT.



Alberton	2.94	2.5	3.12	3.22	3.08	3.25	3.61	3.17
Superior	3.49	2.86	3.58	3.94	3.59	3.73	3.73	3.49
St. Regis	3.29	2.59	3.31	3.36	3.12	3.27	3.39	3.42

Regional differences

As the sample size to date is so small, regional differences cannot yet be discussed. An enhanced sample size will enable this level of analysis, however.

Why can't the entire indicator be reported at this time?

The approach presented here addresses the nature of Indicator 6.38 for the communities that have been sampled. The next phase of this project is to develop a rich-enough sample to reveal the traditions and trends in the Nation's forest-dependent communities and specific relationships between CR and forest sustainability. Hence, the next phase of the development of Indicator 6.38 in the United States is to expand considerably the number of communities utilizing a purposeful framework aimed at developing comparability across space and time.

Indicator 6.39. Area and percent of forests used for subsistence purposes

What is the indicator and why is it important?

In many countries, indigenous groups, rural communities, and others use forests for subsistence purposes, although this use of forests may not be broadly recognized. This indicator measures the extent to which forests are used as a source of basic commodities, such as food, fuel, shelter, and medicinal plants. In addition to the tangible benefits it provides, for many people, subsistence use has a deep cultural, and often, spiritual significance.

What does the indicator show?

Our growing understanding of subsistence use of forests indicates that people from diverse ethnic backgrounds make use of subsistence resources from forests in every region of the United States. These activities have particular cultural importance for indigenous peoples. Three cannons of law provide legal guarantees for subsistence practices of selected populations: (1) treaty law, (2) the Hawaii State Constitution, and (3) the Alaska National Interest Land Conservation Act (ANILCA). Subsistence activities tend to be associated with poverty in the popular imagination. Many residents who hunt, fish, trap, and gather to meet their basic needs, however, regard these practices as a form of wealth, which frequently benefits not only the individual but also the extended family and a larger community. Access to forests for subsistence resources appears to be declining with changes in land use and land ownership that include increases in posting to restrict trespassing and the establishment of exclusive hunting leases.

What has changed since 2003?

We were able to gather more evidence of subsistence activities in the State of Hawaii, particularly on Molokai, where subsistence activities are reported to provide more than 50 percent of food for some residents and an average of 28 percent for all islanders. Additional data on Alaska, where subsistence access is guaranteed on Federal lands (fig. 39-1), was available, thanks to ongoing research by the Subsistence Division of Alaska's Department of Fish and Game. Table 39-1 provides a summary of annual wild food harvests and contributions to food intake in Alaska's 27 census areas. We also had more time to look into the contested nature of subsistence. Although subsistence is guaranteed by ANILCA, the Hawaiian State Constitution, and

Table 39-1. Annual wild food harvests for 27 Alaska census areas

	Lbs./Person	Daily Protein (Percent)	Daily Calories (Percent)
Mean	268	173	24
Median	206	133	19
Minimum	16	10	1
Maximum	698	451	64

Source: Alaska Department of Fish & Game, Subsistence Division (http://www.subsistence.adfg.state.ak.us/)

treaties with Indian tribes, litigation over the exercise of those rights has been, and continues to be, ongoing. In several places around the country, Federal and State agencies have entered into Memoranda of Understanding and Agreement that assure access by members of local tribes to hunting, fishing, and gathering resources for purposes that include subsistence. In 2007, the Inland Consent Decree between the State of Michigan and five tribes affirms treaty-guaranteed access to hunt, fish, and gather on State and some private lands and inland waters in an area that covers 13,827,207 acres (fig. 39-2). Finally, Norris's 2002 history of the National Park Service provides a detailed picture of how NPS policies toward subsistence have evolved during the past 90 years.

Are there important regional differences?

Yes, in Alaska, subsistence is formally recognized by the State and Federal Governments as a vital social, economic, and cultural activity. ANILCA (P.L.96-487, Dec. 2, 1980) provides for the subsistence use of forest resources by all rural Alaskans regardless of race or income. The Hawaiian Constitution protects the customary and traditional rights of Native Hawaiians, including subsistence use of marine and terrestrial resources. Some federally recognized tribes retain treaty rights to hunt, fish, trap, and gather on specified off-reservation lands. Subsistence activities by other groups in other locations do not enjoy formal legal status under U.S. or State laws.

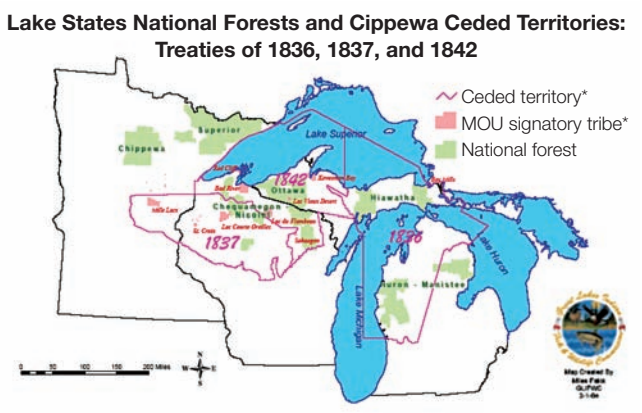
Why can't the entire indicator be reported at this time?

The indicator addresses area and percent of forests used for subsistence, yet relevant data currently are collected by Federal and State agencies only in Alaska. These agencies quantify subsistence by metrics such as numbers of users, weight of subsistence resources harvested, and numbers of persons giving or receiving subsistence goods in barter or gift exchange. Providing a spatial display of forested areas used for subsistence is challenging because subsistence does not occur in discreet areas, but is diffused and, if anecdotal evidence is indicative, widespread. It is not possible to summarize these sorts of data into simple numerical measures.

The fact that Hawaii and Alaska have specific State provisions protecting subsistence use indicates the importance of subsistence in these States. The absence of such provisions (or data for that matter) in other States, however, does not necessarily indicate that subsistence activities are largely absent or unimportant.

Figure 39-1. Federal lands in Alaska, which are generally open to rural Alaskans for subsistence harvest (map courtesy of U.S. Fish and Wildlife Service).

Figure 39-2. The 2007 Inland Consent Decree area (map courtesy of the Great Lakes Indian Fish and Wildlife Commission).



* The ceded territory and tribal reservation boundaries are representation and may not be the legally binding boundaries.

Indicator 6.40. Distribution of revenues derived from forest management

What is the indicator and why is it important?

Revenues derived from forest management activities, including the sale of forest products and environmental services, are one of the principal sources of funds for paying annual operating costs and making capital investments in the forest estate. This indicator tracks who shares in the revenues—workers through wages and income, communities through taxes, and others at different geographic scales. Therefore, information on the collection and distribution of these revenues will be useful in understanding economic support for sustainable forest management.

What does the indicator show?

We first look at who shares in the revenues from the operation of forest products industries. These industries include forestry and logging, wood products, paper products, and wood furniture. Figure 40-1 shows the shares of revenues in these industries that go to workers in the form of wages, to business owners in the form of profits, and governments in the form of taxes. In 2002, of a total $72.5 billion (2005 dollars) in wages, profits and taxes, 80 percent went to wages, 18 percent to profits, and 2 percent to taxes. It is notable that these amounts are only part of the uses of the total revenue from product shipments of about $300 billion (2005 dollars) in 2002. Revenue is also used to pay for other costs of production, including materials, energy, insurance, and interest on debt. The profits received in 2002 by owners ($11 billion (2005 dollars) were about 3.7 percent of the value of shipments.

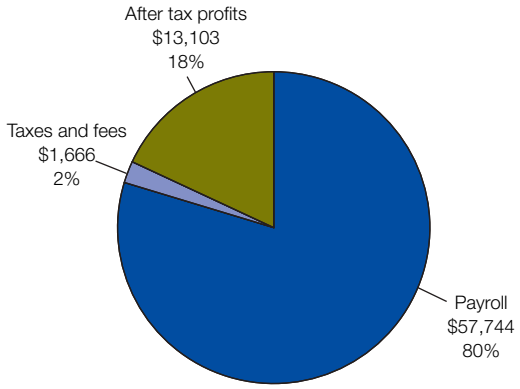
Of the $72.5 billion in wages, profits, and taxes, 43 percent was provided by paper products industries, 35 percent by wood products industries, 17 percent by wood furniture industries, and 5 percent by forestry and logging. The share of revenue going to workers was somewhat higher for the paper and wood furniture industries, 82 and 83 percent, respectively (with correspondingly lower profit shares), than for the wood products and forestry and logging industries, at 76 and 79 percent respectively.

We next look at who shares in the revenues from sale of timber from forest land. We have data for 1997 that indicate how this revenue is shared among various forest land owners, including owners of national forests, other public forest land, industry forest owners, and other private forest owners. Based on rough estimates for the total stumpage sales value in 1997 of $22 billion (2005 dollars), 5 percent went to national forests, 6 percent went to other public lands, 33 percent went to industry land owners, and 56 percent went to other private landowners (fig. 40-2). Since 1997, a significant amount of industry forest land has been sold to Timber Management Organizations and Real Estate Investment trust, so the share of stumpage revenues going to industry land owners has probably declined.

A considerable amount of Native-American land is forested. These forests provide wood and nonwood forest products and other values that are vital to Native-American communities. Therefore it also important to note the share of U.S. timber stumpage revenues that goes to Native Americans.

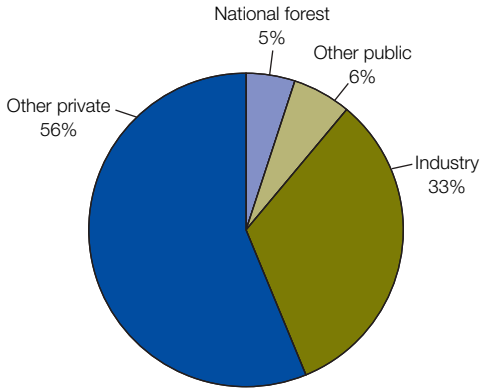
Approximately 18 million acres of forest land exist on Indian reservations in the United States, of which 5.7 million acres are classified as commercial timber land. In 2001 these lands provided $95 million of revenue (2005 dollars) mostly from industrial timber harvest. This 2001 stumpage revenue is 0.4 percent of the estimated total U.S. 1997 stumpage revenue of $22 billion (2005 dollars). The 18 million acres of Native-

Figure 40-1. Payments going to forest products business owners (profits), to forest products firm employees (payroll), and to governments (taxes and fees), 2002 (in millions of 2005 dollars and percent).



Sources: USDA Forest Service analysis, multiple data sources

Figure 40-2. Share of stumpage revenue from U.S. timber harvest by owner, 1997.



Sources: USDA Forest Service analysis, multiple data sources

American *forest land* is about 2 percent of total U.S. forest land (749 million acres). The 5.7 million acres of Native-American *timber land* is about 1 percent of total U.S. timber land (504 million acres).

For Native-American forest land in 2001, the Pacific Northwest Region accounted for more than 70 percent of the harvested timber volume and more than 85 percent of revenue, followed by the Lake States at 13.5 percent of the harvested timber volume and more than 7 percent of revenue.

What has changed since 2003?

Data are not available to determine a time trend in share of revenue received by various groups from forest industry activities or from timber sales.

Are there important regional differences?

The estimated share of timber stumpage revenues going to various landowners varies widely among regions (fig. 40-3). In 1997, the share going to public owners (national forest and other public) was highest in the Rocky Mountain Region (37 percent) followed by the Pacific Coast (23 percent), North (14 percent), and South (1 percent). The share going to other private owners (nonindustry) was highest in the South (75 percent) followed by the North (70 percent), Rocky Mountains (33 percent), and Pacific Coast (24 percent).

Another way to look at the geographical distribution of revenue shares is by looking at where various types of owners receive most of their stumpage revenue.

For national forest or other public land owners in 1997, the largest share of stumpage revenue came from the Pacific Coast (68 percent), followed by the North (18 percent), Rocky Mountains (10 percent), and South (4 percent). For industry owners the largest share of revenue came from the Pacific Coast (54 percent) followed by the South (36 percent), North (7 percent), and the Rocky Mountains (3 percent). For other private landowners, the largest share for revenue came from the South (66 percent), followed by the North (18 percent), Pacific Coast (14 percent), and Rocky Mountains (2 percent) (fig. 40-4).

Why can't the entire indicator be reported at this time?

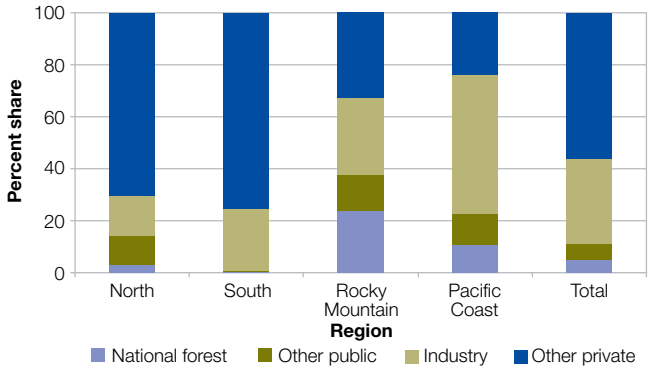
Data are not available to determine a time trend in share of revenues received by various groups.

Information of overall revenues from environmental services is shown under Indicator 27. Data, however, are not available on the shares of such revenues going to workers, businesses, and governments. Nor are data available on the shares of revenues from such services going to various types of forest land owners.

Relation to other indicators

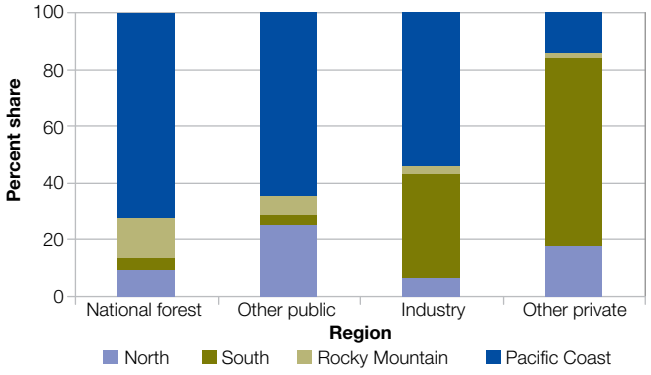
The trends in who obtains benefits from forests would aid our understanding of the importance of forests (Indicator 6.44), and would aid our understanding of the influence of changing benefits on resilience of forest-dependent communities (Indicator 6.38)—to whom and where are benefits flowing. The trends in who obtains benefits from forest would also suggest how the stakeholders in forests are changing. As benefits increase to certain stakeholder groups, their voices may become more influential in determining forest investment (Indicator 6.37), research and education (Indicator 6.35), and institutions (Criterion 7).

Figure 40-3. Share of stumpage revenue from U.S. timber harvest for each type of forest owner by region, 1997.



Sources: USDA Forest Service analysis, multiple data sources

Figure 40-4. Share of stumpage revenue from U.S. timber harvest for each region by type of forest owner, 1997.



Sources: USDA Forest Service analysis, multiple data sources

Indicator 6.41. Area and percent of forests available and managed for public recreation and tourism

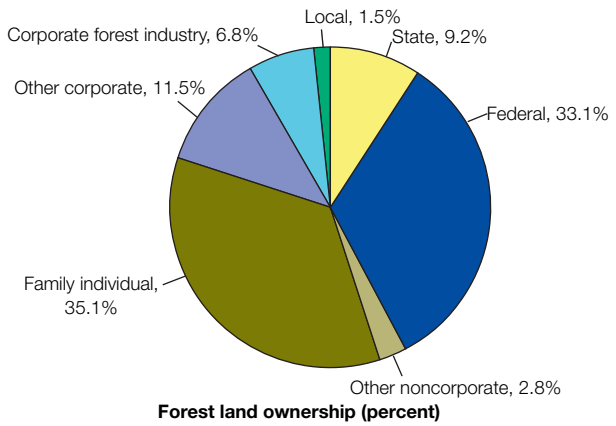
What is the indicator and why is it important?

This indicator is intended to measure the extent to which forests are managed to provide opportunities for recreation and tourism as a specific objective in forest management plans of public agencies and private landowners. When the economic well-being of a country increases, transportation infrastructure is improved, and disposable income grows, public use of forests for recreation grows. These activities are increasingly important as a source of forest-based employment and income. Engaging in outdoor recreation and tourism in forests tends to build support among participants for protecting and managing those forests, indirectly building support for sustainable forests.

What does the indicator show?

Forest area in the United States is estimated at just more than 751 million acres, and has remained relatively constant for the past 100 years. Almost 44 percent of U.S. forest land area is publicly owned (fig. 41-1); one-third is federally owned. More than 18 percent of forest land is owned by private corporations, and almost 38 percent is privately owned by noncorporate entities. Of this noncorporate private forest land, more than 92 percent is family or individually owned. With negligible exceptions, even including Federal experimental forests, government forest lands at all levels are open to someone for some form of outdoor recreation. Given, however, that an inventory of forest tracts by management objectives is not available for the United States, it is not possible, for the most part, to ascertain the degree to which forests under different ownerships are managed specifically for recreation and tourism.

Figure 41-1. Percent of forest land in the United States by ownership category, 2007 (percentages sum to 100) (Almost all forest lands are open for some form of recreation, although who may have access may be restricted).



Source: USDA Forest Service

Government, corporation, and organization-owned forest lands

Open Federal forest lands include forested national forests, national parks, Bureau of Land Management lands, wildlife refuges, and any other federally managed public land. State forest lands include forested State forests, State parks, and other State management areas. Local forests include municipal watersheds, local parks, local forest preserves, greenways, and other local government forests. Private forest lands include those that are owned by forest-industry, by other types of corporations, by individuals and families, and by other noncorporate entities. Like public lands, it is assumed for this indicator report that forest industry, other corporate, and other noncorporate lands are open to someone for some forms of recreational uses, although access to them is most likely restricted. For corporation lands, data are not available for estimating the acreages generally open to anyone versus acreages restricted for use by employees, executives, lessees, or exclusively to others. More than one-half of the forest industry forests are in the South. Large portions of other corporation lands not owned by forest industry are located in the Pacific Coast and South regions. Other noncorporate private forest lands (not including family and individual ownerships) lie mostly in the Northern and Rocky Mountain Regions.

Family and individual forest lands

Almost one-half of the family and individually owned private forest land is in the South Region, nearly 36 percent is in the North Region, and much smaller percentages are in the Rocky Mountain and Pacific Coast Regions. Figure 41-2 shows the percentages of family and individually owned forest land nationally by category of recreational access. More than 42 percent of this forest land is posted to limit access. Posting does not mean not used for recreation, it means access is restricted. The percentage of land posted is highest in the Pacific Coast Region and lowest in the North Region. The National Woodland Ownership Survey estimated that about 54 percent of family forest land was open only to family or friends and no others. Just 14.6 percent of the family forest area was open to the public with permission of the owner. Almost 8 percent of the family forest area was leased in the past 5 years for recreational uses. Percentages open to the public were highest in the North and Rocky Mountain Regions. Leasing was greatest in the Rocky Mountain Region.

Figure 41-3 shows area of family forest land by reasons for owning in 2006. Beauty appreciation is at the top with 65 percent of owners, followed by passing the land to heirs, gaining privacy,

protection of nature, and having it as part of a home or cabin site. Smaller percentages of owners considered owning forest land important because of hunting, fishing, or other recreation opportunities.

What has changed since 2003?

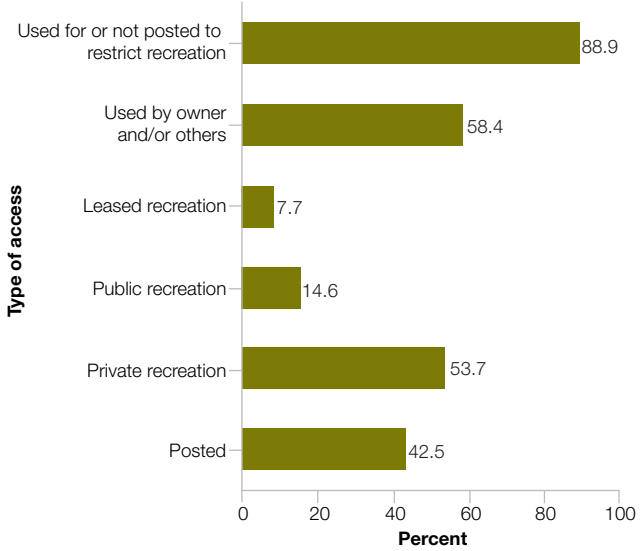
Total area of public forest land at all levels of government has increased slightly. Thus, the trend for public land available for recreation is up slightly. Percentages of nonindustrial land available to the public at large across U.S. regions, however, are modest and have been trending downward during the past several decades. From 1985 to 1986, nearly 25 percent of owners permitted some public access. This percentage dropped by 1995 to nearly 14.5 percent (Cordell 1999). In 2000 to 2001, it was estimated that only 10.9 percent of owners permitted access to the general public. The lowest percentage was in the West, at 8 percent, and highest was in the North, at 13 percent. Based on the National Woodland Ownership Survey, it was estimated that 14.6 percent of family forest owners allow public access. This estimate closely resembles those reported earlier, although the source is different and not directly comparable.

Are there important regional differences?

Almost all of the 751 million acres of forest land in the United States is open to someone for some form(s) of recreation. Almost 29 percent of this forest land is in the South, and just more than 28 percent is in the Pacific Coast Region, which includes Alaska. Almost 23 percent is in the North, followed by the Rocky Mountain Region with 20 percent. Most of the public forest land (especially Federal forests) is in the western two regions. Public lands in the West are essentially open to anyone for recreation, except for certain military or laboratory sites.

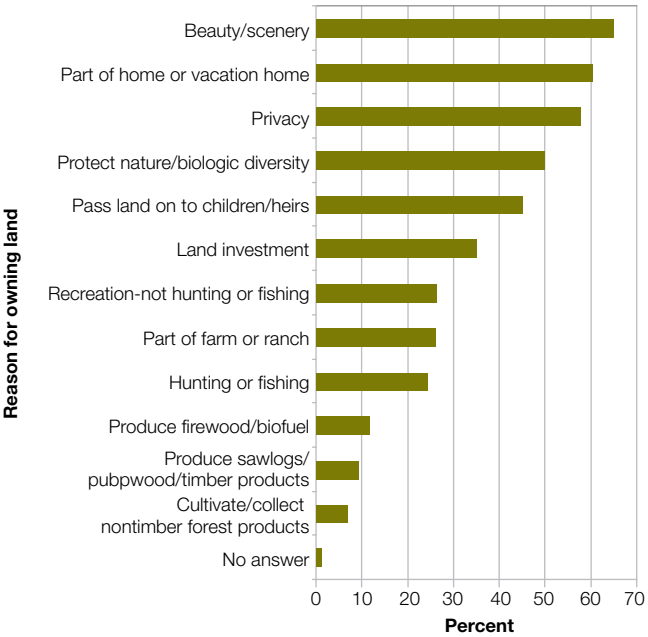
Most of the private land is in the Eastern States (North and South regions). Recreation use is more restricted on private lands than on public lands. The South has by far the greatest area of family or individually owned forest land in the United States, followed in order by the North, the Rocky Mountain and Pacific Coast regions. The North, however, has the greatest area of family forest land open to the general public, 17.2 million acres, 18.3 percent of the region's total. Next is the South with 12.2 million acres, 9.9 percent of the region's total family forest land. The South has the greatest area of family forest leased for recreation, at 12.4 million acres, or 9.7 percent. The next largest area of family forest leased for recreation is the Rocky Mountain Region at 4.1 million acres, 16.9 percent of family forest in that region.

Figure 41-2. Percentage of family or individually owned forest land area by category of recreational access, 2006.



Source: Butler 2008

Figure 41-3. Percent of family forest owners in the United States by reasons for owning, 2006 (excluding interior Alaska, Hawaii, Nevada, western Oklahoma, and western Texas.



Source: Butler 2008, includes owners who rated the objective as very important or important on a seven-point Likert scale, with seven defined as not important

Indicator 6.42. Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available

What is the indicator and why is it important?

Indicator 6.42 provides a measure of recreation and tourism use of forests. These activities are increasingly important as a source of forest-based employment and income. Engaging in outdoor recreation and tourism in forests tends to build support among participants for protecting and managing those forests, indirectly building support for sustainable forests. This indicator focuses on forest recreation visits, facilities, and capacities.

What does the indicator show?

Number of recreation visits to forests for selected recreation activities

The top 10 forest recreation activities, in terms of numbers of visits, are walking for pleasure; viewing and photographing natural scenery; viewing and photographing flowers, trees and other forest vegetation; viewing and photographing birds; viewing and photographing wildlife; day hiking; visiting wild areas; off-highway driving; family gatherings; and visiting nature centers (table 42-1). The numbers of annual forest recreation activity days for these 10 activities (roughly equivalent to visits) range from a high of almost 7.5 billion (walking for pleasure) to just more than 680 million (visit nature centers, and so on). Snowmobiling, mountain climbing, cross country skiing, rock climbing, and snowshoeing account for a much smaller number of recreation activity days, but still they add up to a sizeable number of visits (ranging between about 20 to more than 62 million). Obviously, Americans are strongly interested in viewing and photographing forest natural life.

Over all activities listed in table 42-1, the percentage of forest-based activity days that occurs on *public lands* ranges from under 50 percent (for example, small-game hunting and gathering mushrooms and berries) to more than 75 percent (for example, visiting wilderness, day hiking, visiting nature centers, and backpacking). Over all activities, the percentage of forest-based recreation activity days that occur in *urban forests* ranges between roughly 15 to 45 percent. Activities with the lowest percentages in urban forests are hunting, camping, and backpacking. Activities with the highest percentages in urban forests include walking, picnicking, family gatherings, and visiting nature centers. Public lands and urban forests clearly play significant roles in providing opportunities for outdoor recreation.

Table 42-1. Millions of annual forest recreation activity days by activity and estimated percentages on public forest lands and in urban forests, 2007–2008.

Forest Recreation Activity	Number of Activity Days (millions)	Public Forest (percent)	Urban Forests (percent)
Walking for pleasure	7,493.3	53.8	44.5
Viewing and photographing natural scenery	6,170.6	61.9	31.8
Viewing and photographing wildflowers, trees, and so on	4,858.9	55.4	36.3
Viewing and photographing birds	3,738.3	51.3	37.6
Viewing and photographing other wildlife	3,086.8	57.7	32.2
Day hiking	1,234.8	76.2	34.0
Visiting a wilderness or primitive area	947.6	76.4	24.6
Off-highway driving	837.5	50.4	23.2
Family gathering	805.3	55.9	43.5
Visiting nature centers, and so on	683.8	77.6	45.2
Gather mushrooms, berries, and so on	623.4	47.9	32.3
Mountain biking	463.3	60.2	32.1
Picnicking	455.9	68.4	44.4
Developed camping	356.0	72.8	21.3
Big game hunting	279.8	45.7	16.5
Primitive camping	211.4	75.8	21.4
Backpacking	198.8	78.5	22.1
Visiting historic sites	182.8	60.0	39.1
Horseback riding on trails	177.5	50.8	34.4
Small game hunting	161.5	46.8	17.4
Visiting prehistoric/archeological sites	138.9	70.0	41.6
Snowmobiling	62.1	55.1	27.4
Mountain climbing	57.1	78.6	20.5
Cross country skiing	41.9	60.5	33.7
Rock climbing	34.1	68.8	26.9
Snowshoeing	19.9	60.2	27.6

Source: National Survey on Recreation and the Environment, 2005–2008 (historical data specific to forest-based recreation were not available, thus, the trend in figure 42.3 below is for all outdoor recreation)

Number and capacity of recreation facilities in forests for selected types of recreation activities

Across the United States, more than 6,000 Federal campgrounds exist; most are in the West, especially in the Rocky Mountains/Great Plains and Pacific Coast, where Federal lands are abundant. Private sector businesses in the United States analyzed for this indicator include recreational vehicle parks and campgrounds, snow skiing areas, marinas, historic sites, nature parks and similar sites, and sightseeing and related tourism transportation services.

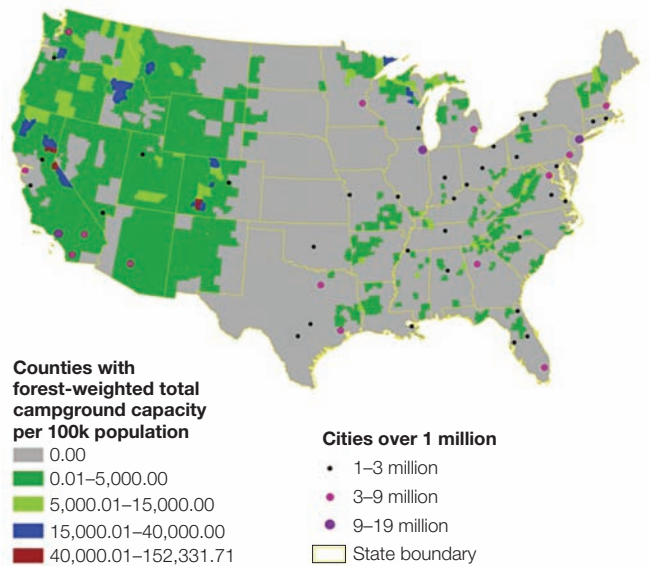
In 2005, an estimated 1,586 privately operated forest-based RV parks and campgrounds existed. More than 180 forest-based, privately run, snow skiing facilities existed in 2005, mainly downhill ski slopes. Most of these skiing facilities were in the North Region. Privately operated historic sites in forested areas were estimated at about 330, almost all of which, 89 percent, are in the East. Estimated number of private, forest-based nature parks and similar sites in the United States was about 200 nationally, of which about 77 percent are in the East, mostly in the Northeast portion of this region. Nearly 160 private forest-based scenic and sightseeing transportation businesses existed, mostly in the East.

Figure 42-1 shows the county-level distribution of Federal forest campground capacity relative to county population and the location of major cities. The greatest amount of Federal forest campground capacity is in the southern Appalachian Mountains, the Ozarks, the Great Lakes area, the southern Rocky Mountains, California, and the Pacific Northwest. Figure 42-2 shows the distribution of private sector capacities summed across a variety of forest-based recreation and tourism businesses. The greatest concentrations of forest-based recreation and tourism businesses are in the New England States, the Great Lakes area, the Pacific Northwest, California, and the southern Rocky Mountain Region. Private facilities, sites, and services are also scattered throughout the Southeast. Many of these businesses are located near Federal and State public lands. Significant amounts of the private forest recreation capacity mapped here lies within a 2-hour drive of U.S. population centers of 1,000,000 or more (shown as red dots and scaled by size).

What has changed since 2003?

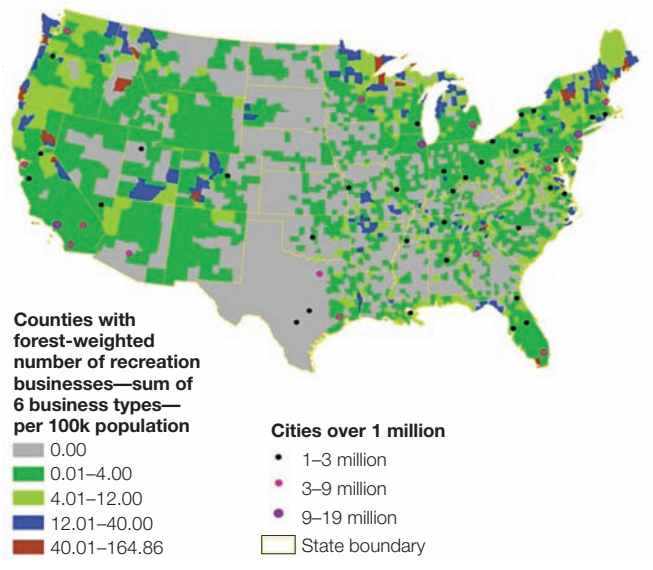
Overall, between 2000 and 2007, the trend has been increased participation in outdoor recreation overall. As reported in *Forest History Today* (Cordell, 2008), the total number of people who participated in one or more outdoor activities grew by 4.4 percent between 2000 and 2007 (fig. 42-3). At the same time, the number of recreation activity days, summed across all activities, increased by approximately 25 percent. (Trend data for forest recreation only were not available.) The number and capacity of public and private forest-based recreation sites have remained about constant or increased slightly.

Figure 42-1. Location of forest-based Federal campground capacity per 100,000 people.



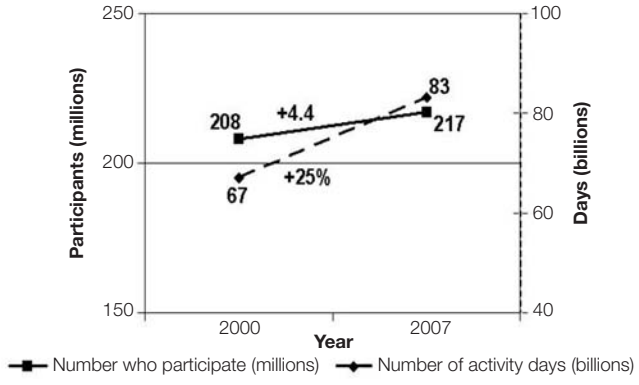
Sources: The primary source is the U.S. Census Bureau, County Business Patterns, 2001 and 2005

Figure 42-2. Location of cities and forest-based recreation businesses (5 types) per 100,000 people.



Sources: USDA Forest Service and U.S. Census Bureau

Figure 42-3. Growth in number of people and number of recreation activity days in 60 outdoor recreation activities in the United States, 2000–2007 (reproduced from Cordell 2008).



Source: Cordell 2008

Indicator 6.43. Area and percent of forests managed primarily to protect the range of cultural, social, and spiritual needs and values

What is the indicator and why is it important?

This indicator measures the area of forest land managed primarily to protect cultural, social, and spiritual values. These values are important dimensions of social well-being for people concerned about forests—whether they live in or near forests or at great distances from them. Where people with unique needs for cultural, social, or spiritual values are only able to meet their needs in unique places; this places a premium on the protection and management of those locations.

What does the indicator show?

Americans favor protecting wild forest areas. Primary reasons for wanting protection are for air quality, water quality, and wildlife habitat, use by future generations, protection of unique plants and animals, and for protection of rare and endangered species. People living in different regions of the country differ very little in what they value about protected wilderness and other public lands (Cordell, 2008—http://warnell.forestry.uga.edu/nrrt/nsre/IRISWild/IrisWild1rpt.pdf).

Protected public forests

Government-owned forest land in the United States by region is listed in table 43-1. This indicator assumes that all government land is protected to some degree. An estimated 328 million acres of Federal, State, or local government forest land exist in the United States, about 44 percent of U.S. total forest area (USDA Forest Service, 2007).

The World Commission on Protected Areas (WCPA) employs a classification system to categorize protected natural areas. Using this system of categories, protected public forests in the United States are described. WCPA Category 1a (science natural areas) is represented by experimental forests across the country. A total of more than 940,000 acres of forest are designated as experimental forests in the United States. More than 58 percent of the total experimental forest area is in the Pacific Coast region; about one-fourth is in the Rocky Mountain Region. Experimental forests represent about 0.1 percent of the United States' total forest area. Table 43-1 also shows acres of public forest land in WPCA Categories Ib through VI. Just more than 20 percent of public forest is protected as wilderness (National Wilderness Preservation System,

Table 43-1. Acres (in 1,000s) and percent of public forest by region and by category using the World Commission on Protected Area (WCPA) classification system. (Percentages sum down to 100, except in the last column, where they represent all 751 million acres of U.S. forest land, both protected and not protected.)

WCPA Category	North		South		Rocky Mountains		Pacific Coast		U.S. Total		All U.S. Forest (percent)
	Acres	(%)	Acres	(%)	Acres	(%)	Acres	(%)	Acres	(%)	
Ia: Strict nature reserves	86.5	0.2	71.2	0.2	233.8	0.2	548.7	0.4	940.2	0.3	0.1
Ib: Wilderness	1,559.1	3.5	2,384.9	8.3	21,338.7	18.9	40,853.1	28.6	66,135.9	20.2	8.8
II: National parks	951.9	2.2	2,941.5	10.3	7,836.1	6.9	10,124.5	7.1	21,854	6.7	2.9
III: Natural monuments	3.7	0	28.7	0.1	865.2	0.8	423.0	0.3	1,320.7	0.4	0.2
IV: Habitat/species management	1,563.8	3.6	3,440.9	12	7,226.7	6.4	31,083.0	21.8	43,314.4	13.2	5.8
V: Protected landscape/seascapes	179.9	0.4	332.9	1.2	0	0	33.8	0	546.6	0.2	0.1
VI: Managed protected areas	39,634	90.1	19,479	67.9	75,255	66.7	59,720	41.8	194,087	59.1	25.8
All public forest	43,979		28,679		112,755		142,786		328,199		43.7

Sources: Include Government agencies, http://wilderness.net, USDA Forest Service, 2009 (appendix table 2)

Category Ib), just under 7 percent, is in national parks (Category II), and 0.4 percent of public forest area is designated as natural monuments. Of government-owned U.S. forest, 13 percent is in WPCA Category IV, mainly wildlife refuges; and 0.2 percent is within the boundaries of protected national lakeshores and seashores. The largest category of government protected forest (Category VI) includes managed lands such as national forests, BLM lands, and other State and local government lands. This category makes up almost 60 percent of total U.S. protected public forest lands. The region with the greatest acreage of government-owned forests is the Pacific Coast Region, which run from California to Alaska, and include Hawaii. The next highest government-owned acreage is in the Rocky Mountain Region.

Protected private forests

Conservation of private land through land trusts has been increasing during the past few years. Figure 43-1 shows the increase in State and local trusts. The National Land Trust Census Report indicated that total acreage conserved through private means in 2005 was 37 million acres, representing a 54-percent increase, since 2000. This acreage includes land protected by local and State land trusts, and land protected by large national land conservation groups. Examples of large national groups include The Nature Conservancy, Ducks Unlimited, The Conservation Fund, and The Trust for Public Land.

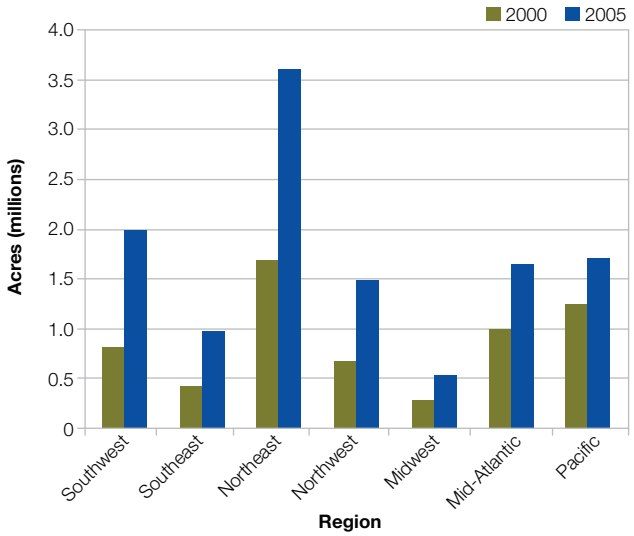
A land trust is a nonprofit organization that actively works to conserve land through conservation easements, direct fee simple acquisitions or by stewardship of easements. The Land Trust Alliance of the United States has been organized to unite organizations in local communities for natural area conservation (http://www.landtrustalliance.org). Internationally, organizations such as the World Commission on Protected Areas works within the framework of the United Nations to track and stimulate countries around the globe to designate forests and other lands as protected areas.

The Forest Legacy Program (FLP) is a Federal program managed by the Forest Service in partnership with States. This partnership is aimed at protection of environmentally sensitive private forest lands. Mostly, FLP easements restrict development and require sustainable forestry practices. FLP can also directly support land acquisition. As of 2008 in the United States, almost 1.6 million acres of privately owned forest land have been protected (table 43-2). About 85 percent of this national total (roughly 1.3 million acres) has been protected through State-level conservation easements (FLP supported specifically). Another 0.2 million acres (about 15 percent) was protected through fee simple acquisition. Much of this protected private forest land is in the North Region, more than 70 percent. By far, the State of Maine was the most successful single State in protecting forest land through the FLP. Maine's program added well more than 600,000 acres through easements and purchases. New Hampshire and Montana were the next largest States for protecting forest land.

What has changed since 2003?

A significant total area of forest land has been added to the U.S. experimental forest system (national increase of 65 percent since 2003). Much of this increase has been in the Pacific Coast Region, mainly by adding a Hawaiian tropical forest (almost 313,000 acres of State land) and more than 7,000 acres of the Tahoe National Forest in California. Slight losses of public land overall in the North and South are primarily reflecting differences in land area estimation methods between the different time periods. For private forest land, a dramatic increase has occurred since 1985 in the total private forest acres protected through trusts and easements.

Figure 43-1. Private land protected by local and State land trusts in the United States, 2000–2005.



Source: National Land Trust Census Report for 2005

Table 43-2. Total private forest acres protected by conservation easements or fee simple purchases through the Forest Legacy Program as of February 2008 by Resource Planning Act (RPA) Region.

RPA Region	Protected Acres	Percent
North	1,116,810	70.9
South	114,099	7.2
Rocky Mountain	281,209	17.8
Pacific Coast	64,176	4.1
U.S. Total	1,576,294	100.0

Source: USDA Forest Service, Forest Legacy Program (http://www.fs.fed.us/spf/coop/programs/loa/flp_projects.shtml)

Indicator 6.44. The importance of forests to people

What is the indicator and why is it important?

Forests are important to people for a wide variety of reasons. Research studies have enumerated the breadth of values that people associate with forests. These values are provided, to greater and lesser degrees, by different types of forests, groves of trees, and even by individual trees. The lists suggest a mix of values that extend from consumptive to nonconsumptive uses and include items that relate to economic, ecological, and social benefits.

This indicator provides information on the range of values communities and individuals hold for forests. These values shape the way people view forests, including their behaviors and attitudes toward all aspects of forest management. This indicator can be used to help understand regional or demographic differences in the importance of trees and forests to people and to monitor changes in perception of the importance of trees and forests over time.

What does the indicator show?

Over the course of 2008, 26 focus groups with 202 individuals were conducted with a diversity of populations across the United States to determine similarities and differences with respect to the importance of forests. Diversity was represented by age, gender, geographic location, race, and ethnicity. The sample consisted of: six college student focus groups, five groups of urban African Americans, two groups each of urban high school students, Native Americans, and rural adults; and one group each of rural high school students, urban Arab Americans, urban senior citizens, Asian Americans, Hispanic Americans, and Caucasians.

Participants offered a very wide range of reasons why forests were important to them personally and to their communities (table 44-1). The depth and breadth of the discussions support and expand on earlier research indicating trees and forests are important to Americans in diverse ways and they are able to clearly articulate this importance.

Focus group participants also discussed ways their interactions with trees and forests have changed over their lifetime, (table 44-2), negative feelings they have about forests (table 44-3) and concerns they have about forests (table 44-4).

The results of the focus groups clearly indicate that forests are important to Americans in many ways and that a broad cross-section of Americans are able to articulate these factors. The results also show that Americans have multiple concerns about the future of forests.

Although many similarities exist across the diverse focus group participants, the data suggest some differences based on race and ethnicity (feelings of exclusion and fear associated with forests among African-Americans), rural versus urban geography (rural respondents were more concerned with forest policy and management issues and forest degradation and urban respondents were more concerned with damage to their home), and age (younger respondents actively interacted with forests and to older respondents aesthetics and the trees they could see out their windows were more important). These differences

Table 44-1. Frequency of mention by categories of importance of trees and forests to individuals and their communities.

Category	Descriptors	Frequency
Environmental/Biological		406
Animals	Wildlife/animals	75
Air	Breathing, cycle	69
Shade	Shade in summer	60
Water	Water, clean, cycle	51
Processes	Succession, C, N, fire	39
Ecological relationships	Links, phenology	30
Shelter		28
Climate change	Global climate change	11
Plants	trees and other plants	9
Cultural Heritage		**320**
Memories	Memories, childhood	78
Community	Unite, pride, patriotism	82
Family relations	Associate with family	62
Traditional knowledge	Rural, TEK, medicine	43
Community service	Service trip, planting	31
Literature and folklore	Fairytales, archetype	20
Products		**287**
Wood products	Fuel, timber, material	176
Nonwood Products	Medicine, food, fish, and so on	87
Recreation		**271**
Nonconsumptive activities	Camping, hiking, play	189
Consumptive activities	Hunting, fishing, etc.	58
Adventure	Exploring, challenge, risk	24
Sense of Place		**200**
Identity	Community, history	74
Attachment	Rootedness, part of life	67
Individual trees	Favorite tree, neighbor	38
Dependence	Nearby nature, daily use	20
Health and Well-being		**199**
Psychological benefits	Quiet, comfort, refuge	112
Well-being activities	Sensory, reading, etc.	64
Aesthetics	Beauty, splendor	**160**
Spiritual	Happiness, growth, intrinsic, stewardship	**114**
Diversity		**80**
Habitat		35
Biodiversity		22
Forest type		18
Economics	Revenue, livelihood	**72**
Education		**67**
Privacy	Separation, borders	**33**

TEK = Traditional Ecological Knowledge.

Note: Frequencies within categories do not sum to the total because some responses were coded to the first-level category only.

reinforce the need to reflect the demographic diversity of the United States when considering the acceptability of forest management activities focused on sustainability.

Why can't the entire indicator be reported at this time?

Although this research has provided a number of categories and descriptions of values related to the environment and forests, no studies were found presenting a statistically robust national sample that would allow for analysis of differences in values based on geographic location across the country, ethnicity, occupation, age, urban or rural residence, gender, or many other socio-demographic or cultural variables. In addition, no known studies have documented the intensity, structure, or correlation of values for forests at this scale. Finally, no known research exists that has monitored how these values change over time. Future research is needed to provide this information and develop a protocol to elicit information that can be replicated over time to monitor trends in these values across population segments.

Table 44-2. Changes in people's interactions with trees and forests over their lifetime.

Changes over lifetime	Frequency
Interactions/perspectives: more/less interaction, care more, understand more	125
Reduced natural resources: fewer fish/wildlife, water trees	42
Policy/Politics: more conservation, less access, more management, loss of rights	23
Competition: competing resources, development	17
Economic changes: increased costs, fewer rural jobs	6
Pollution: trash, traffic, noise	4
Increased natural resources: more fish/wildlife, water, trees	3

Table 44-3. Negative feelings people have about trees and forests.

Changes over lifetime	Frequency
Tree/home interactions: fall on house, disturb plumbing, maintenance costs, leaf litter	59
Safety and fear: being lost, images of lynching	29
Animals: bugs, spiders, disease, negative wildlife interactions	32
Plants: poison ivy, allergies, invasive species, thorns	22
Management: privatization, restricted use, lack of management, deforestation	20
Restricted use/exclusion: feeling "out of place," discriminatory, exclusionary	16

Table 44-4. Concerns people have about trees and forests.

Changes over lifetime	Frequency
Degradation: pollution, GMOs, plantations, fire, clearcutting, fragmentation, land conversion	143
Sustainability: use of resources, environmental effect, human overpopulation	73
Management and policy: mismanagement, loss of grazing rights, activism, local knowledge	58
Forest condition: changes, disturbance regimes, Invasive species, global warming	57
Lost connections: detachment, shallow understanding, less experience with large forests	43
Competition: competing resources, development	24
Economics: jobs, livelihoods, revenue	8
Urban ecosystems: development, lack of trees in urban areas, urbanization	6

GMO = genetically modified organisms.

Criterion 7

Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

What is this criterion and why is it important?

Criterion 7 of the Montréal Process Criteria and Indicators (MP C&I) addresses the social framework within which we manage forests for sustainability. Because of the challenges inherent in addressing this criterion, we have developed a different overall approach than that used for the other indicators. This approach is described in greater detail in the section immediately following the Criterion 7 indicator list presented below.

What has changed since 2003?

Our approach—The approach taken in 2003 treated each indicator separately, providing available data in the context of separate narratives. For the 2010 report we have use a more integrated approach, analyzing each indicator within the context of a common framework. This approach is described in detail in the section immediately following the Criterion 7 indicator table below.

The data—The data for Criterion 7 comes from a variety of sources and are addressed on an indicator-by-indicator basis in the indicator briefs.

The indicators—The 2010 Montréal Process indicators for Criterion 7 are unchanged relative to 2003. Addressing the legal, institutional, and economic dimensions of forest sustainability in general, and these indicators in particular, has proven to be a considerable challenge for all of the countries involved. To address this challenge, the Montréal Process Working Group completely revamped the Criterion 7 indicators for the next round of the reporting process, reducing the total number of indicators to 10 and greatly simplifying the language of each. As a result, this will be the last U.S. report to use the Criterion 7 indicators as they currently stand. The new set of indicators can be found in the latest addition of the MP C&I handbook (Montréal Process Working Group 2009).

Criterion 7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management (1 of 2).

2003 Reference	2003 (and 2010) Indicator	Revision Action	2010 Reference
Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it:			
48	—Clarifies property rights, provides for appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides a means of resolving property disputes by due process	No change	7.45
49	—Provides for periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors	No change	7.46
50	—Provides opportunities for public participation in public policy and decisionmaking related to forests and public access to information	No change	7.47
51	—Encourages best practice codes for forest management	No change	7.48
52	—Provides for the management of forests to conserve special environmental, cultural, social, and scientific values	No change	7.49
Extent to which the institutional framework supports the conservation and sustainable management of forests			
53	—Including the capacity to provide for public involvement activities and public education, awareness, and extension programs, and make available forest-related information	No change	7.50
54	—Including the capacity to undertake and implement periodic forest-related planning, assessment, and policy review, including cross-sectoral planning coordination	No change	7.51
55	—Including the capacity to develop and maintain human resource skills across relevant disciplines	No change	7.52

Criterion 7. Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management (2 of 2).

2003 Reference	2003 (and 2010) Indicator	Revision Action	2010 Reference
56	—Including the capacity to develop and maintain efficient physical infrastructure to facilitate the supply of forest products and services and to support forest management	No change	7.53
57	—Including the capacity to enforce laws, regulations, and guidelines	No change	7.54
Extent to which the economic framework (economic policies and measures) supports the conservation and sustainable management of forests			
58	—Through investment and taxation policies and a regulatory environment that recognizes the long-term nature of investments and permits the flow of capital in and out of the forest sector in response to market signals, nonmarket economic valuations, and public policy decisions to meet long-term demands for forest products and services	No change	7.55
59	—Through investment and taxation policies and a regulatory environment that recognizes the long-term nature of investments and permits nondiscriminatory trade policies for forest products	No change	7.56
Capacity to measure and monitor changes in the conservation and sustainable management of forests			
60	—Including availability and extent of up-to-date data, statistics, and other information important to measuring or describing indicators	No change	7.57
61	—Including scope, frequency, and statistical reliability of forest inventories, assessments, monitoring and other relevant information	No change	7.58
62	—Including compatibility with other countries in measuring, monitoring, and reporting on indicators member countries	No change	7.59
Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services			
63	—Including development of scientific understanding of forest ecosystem characteristics and functions	No change	7.60
64	—And development of methodologies to measure and integrate environmental and social costs and benefits into markets and public policies, and to reflect forest-related resource depletion or replenishment in national accounting systems	No change	7.61
65	—And new technologies and the capacity to assess the socioeconomic consequences associated with the introduction of new technologies	No change	7.62
66	—And enhancement of the ability to predict impacts of human intervention on forests	No change	7.63
67	—And the ability to predict impacts on forests of possible climate change	No change	7.64

An integrated approach to addressing Criterion 7

Overall strategy

Efforts by the United States to address the components of Criterion 7 have been complicated by the lack of information sources to provide quantifiable data to establish baselines. Other Montréal Process Working Group Countries have had similar results with their efforts, resulting in the Working Group's current effort to revise the Criterion 7 indicators. Accordingly, this iteration of the U.S. report is an opportunity to bridge between past, current, and future indicators. To achieve this, we have drawn on the thorough Criterion 7 analysis performed for the *National Report on Sustainable Forests—2003* (Ellefson et al., 2005—see supporting data report for citations referenced in this section), and then developed a new Forest Policy and Governance Matrix as a means to classify the relevant policies and levels of governance addressed in Criterion 7. These two approaches combine the detailed data analyses and summaries from the 2003 report with a theory-based forest policy model to provide better inferences about the indicators.

The forest policy and governance matrix

To analyze the written or stated forest policy content of laws, regulations, and certification standards, we drew from theory and research on smart regulation (Gunningham, Grabosky, and Sinclair 1998), forest regulatory rigor (Cashore and McDermott 2004), analysis of policy instruments (Sterner 2003, Cubbage, Harou, and Sills 2007), and non-State governance in sustainable forestry (Cashore, Auld, and Newsom 2004). Based on this literature McGinley (2008) developed a model for analyzing the forest policy structure of government regulation and forest certification in Latin America. This structure was modified to analyze Criterion 7 indicators. A component was added to include the role of markets and market-based policy instruments in setting institutional policy, per Sterner (2003) and Cubbage, Harou, and Sills (2007). Scale of policy and program implementation was another consideration. The resulting two-sided classification schema became the matrix used to classify U.S. sustainable forest management institutions under Criterion 7 (table Criterion 7.1).

Using the matrix model

The first column of the model displayed in table Criterion 7-1, mechanism, identifies the means (that is, mandatory, voluntary) through which policies and programs are implemented. The second column denotes scale. The final four columns show the policy structure. Policy structure refers to the approach (prescriptive, process-based, performance-based, or private enterprise) that the policy employs. Each row in the mechanism column contains a code letter to add further detail to the approach columns, with the most prescriptive policies appearing in the upper left of the matrix and the most voluntary appearing in the lower right. To some extent these are continuous scales, not categorical, but we used the categories to facilitate analysis and discussion.

The scale of the institutional responses—national (N), regional (R), State (S), or local (L)—is particularly relevant for Criterion 7 because wide variation exists among the 50 United States, not to mention the numerous local government jurisdictions. Furthermore, many U.S. approaches and institutions are actually determined by private markets, not government policies and programs. Finally, substantial variation exists in the level of compulsion (termed mechanism in the model), and the approach, by State, county or parish, and municipal Governments. The analysis formed by the policy and governance matrix, combined with the prior analyses performed for the 2003 report, provides the basis for the text summarizing each indicator. These will then be updated to analyze revisions in Criterion 7, and for assessing trends in a more systematic manner.

As illustrated in table Criterion 7-1, a *prescriptive policy* mandates a preventive action or prescribes an approved technology be used in a specific situation. It generally allows little interpretation on part of the duty holder, offers administrative simplicity and ease of enforcement, and is most appropriate for problems where effective solutions are known and where alternative courses of action are undesirable.

A *process-based policy* identifies a particular process or series of steps to be followed in pursuit of a management goal. It typically promotes a more proactive, holistic approach than prescriptive-based policies.

Performance-based policy specifies the management outcome or level of performance that must be met, but does not prescribe the measures for attainment. It allows the duty holder to determine the means to comply, permits innovation, and accommodates changes in technology or organization.

Private enterprise relies on voluntary market exchange to allocate many of the forest resources in the world, both in private markets and for allocation of goods and services on public lands. Many new market-based conservation incentives are being developed as well.

Application

The summaries from the 2003 report and the Forest Policy and Governance Matrix are used as a framework to discuss each indicator in Criterion 7 and to make more general observations about the U.S. legal and institutional approach to sustainable forest management. The effectiveness of the MP C&I in achieving sustainable forest management does rely ultimately on normative measures about the effectiveness of policies and institutions. The proper framework can enhance the rigor and clarity of this discussion and analysis, help clarify gaps and weaknesses in our institutions, and identify opportunities for improvement in the pursuit of sustainable forest management. Note that the matrix and associated discussion are intended to summarize the institutional context, not to make policy recommendations. Other parts of this report and related subsequent implementation efforts, such as that by Sample et al. (2006), can provide appropriate means of considering policy responses.

Table Criterion 7-1. U.S. Forest Policy and Governance Matrix by Geographic Scale, Mechanism, and Approach (sample used for explanation).

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]					
Informational/educational[b]					
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]					

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.45. Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it clarifies property rights, provides for appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides a means of resolving property disputes by due process

What is the indicator and why is it important?

Stable property rights and the assurance that those rights will be protected, or disputed through due process, are essential for sustainable forest management. Those who depend on forests for daily subsistence and livelihood, or have a connection to forests over long periods of time, will take responsibility for better long-term care of the land if they are able to own the forest or can be assured legal access to needed forest resources.

What does the indicator show?

Property rights govern the ability of forest owners and other landowners to acquire, manage, use, and dispose of their land and its products and services. These rights are exclusive, but not absolute. Property and tenure rights are determined by the government, and may be changed at the behest of government with due process that includes the interests of the community and the landowners. Landowners' tenure and property rights are generally circumscribed by limits on externalities, such as preventing soil and water pollution, or on usufructuary requirements to leave land in good condition for future generations, such as seed tree or tree planting requirements. Broader landowner and zoning restrictions also have been made to provide for wildlife habitat protection, recreation access, or cumulative landscape effects, although these occur mostly in more urban and developed areas.

Clear property rights are arguably the fundamental requirement for sustainable forest management, and a process to assign those rights, determine who controls and determines those rights, and a means to resolve disputes must be clear and accessible to all owners.

In the United States, property may be owned by any public or private organization, ranging from local private property owners, to corporations, to national public lands to Native-American land reservations. So the scale of ownership for land tenure in the United States varies widely. Approximately 65 percent of all land in the United States is privately owned, and 35 percent is owned by various government sectors, including 28-percent Federal and 7-percent State and local government owners.

Holding clear and absolute title to land is provided by law in the United States, and the administrative services to track ownership are usually provided by various local, county, or parish governments. Land titles may be complete or partial, depending on the bundle of rights that are conveyed with a piece of property. Specific prescriptive laws govern the use and transfer of land; legal processes of contracts and torts govern how land rights are exercised or exchanged; and courts can resolve disputes when they arise.

Tenure rights are set by the government, but are not absolute. The 5th and 14th Amendments of the U.S. Constitution protect the rights of private landowners from the taking of private property without due compensation. These amendments have rarely been involved in direct application to limits of forest regulations of private landowner actions in legal challenges, but do provide significant checks on excessive government regulation.

Table 45-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, I, G	L, R, G	L, R, G	G
Informational/educational[b]					
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]	N, S, L				M, E

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Many different products and services associated with the rights to land exist, and they may be, and often are, owned separately. Rights to manage and protect forests may be separate from rights to exploit minerals or extract oil or water, and often are subservient to more valuable uses, on both public and private lands. Landowners also may sell some or all of their land rights, for fixed periods or perpetuity.

Conservation easements have increased considerably in the United States in the past decade. These easements usually set aside part of the land to protect it from development, and may allow only passive uses such as recreation and hunting, or may permit more active uses such as timber management. Private markets, conservation groups, and government organizations negotiate prices, swaps, and loans for land and its produce, and these agreements are recorded as contracts, conditions on property titles, liens, or other legally binding instruments that reside with the land title.

Federal reservation lands held in trust for or owned by Native Americans may be controlled by separate treaties, tribal laws and regulations for management, sale, and acquisition, but still are subject to Federal environmental restrictions or laws.

All forest landowners, public and private, exercise their tenure rights to achieve their forest land management goals to produce market and nonmarket goods and services. Clear title to the surface land, subsurface rights, water rights, and other assets is required to manage the resource, although complex, clear title is usually sufficient in the United States. In cases where disagreements about land rights occur, courts provide a means to settle these conflicts.

What has changed since 2003?

No notable national laws changed forest property rights and tenure since 2003. Some significant changes, however, in land ownership and conservation uses have continued. At least 10 million acres of land was sold by forest product industries to timber investment organizations since 2005. These sales have been partially attributed to an unfavorable tax treatment of timber income in vertically integrated forest products firms compared to other investor classes.

Also, more conservation easements are being made to protect rural forest and agricultural land from development. These conservation easements and land trusts may conserve entire properties or at least the development rights. Government organizations and nongovernmental organizations have been active in purchasing these forest lands or partial use rights for conservation use. In this case, favorable tax treatment at the State and Federal levels, which allow the deduction of the value of conservation gifts, has been credited with increasing sales or gifts of land.

Indicator 7.46. Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it provides for periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors

What is the indicator and why is it important?

The sustainability of forests depends on society's ability to comprehensively evaluate trends and conditions in diverse sectors and to subsequently take responsive actions that will ensure the sustained use, management, and protection of forest resources and the communities that are dependent on them. These actions are typically predicated on well-focused and technically sound plans, assessments, and policy reviews that are sensitive to a range of forest values and are coordinated with a variety of forest-related sectors.

What does the indicator show?

National, regional, State, and local governments perform periodic forest planning, assessment, and policy reviews. Planning is a prescriptive requirement for all Federal land management agencies for the lands under their jurisdiction, and is similarly required in some fashion for most State and county forest lands. Some regional planning efforts also occur, voluntarily or not. These government planning efforts typically have a required process, usually including some type of public input and appeals. Private landowners do not have required forest planning. Although many large companies and landowners do plan as part of business, specific planning processes are not required for these landowners.

The Federal and State governments also write Federal or State forest plans for private forest lands in the country or State. But these plans do not usually dictate or create mandatory rules, regulations, incentives, or other government interventions in markets. Instead, these plans generally summarize information about forest resource conditions and trends; identify issues and opportunities; and suggest possible policies that could enhance sustainable forest management. Exceptions to this trend do occur, such as the Chesapeake Bay Area Planning, which spawned many environmental regulations in the Maryland and Virginia area to protect the coastal waters, including some regulations that directly affect forest land use.

Educational, research, and analysis policy mechanisms are usually an integral part of forest planning efforts, at all scales

from national to local. These policies provide education to forest managers and policymakers on forest conditions, threats, and management responses. Various incentives have been provided for private or public forest landowners to meet the recommendations contained in forest plans.

The State and the Federal Governments provide data and information about forests, laws, regulations, State forest planning, public forestry programs, forestry and logger training, and public education efforts. The universities coordinate in delivery of forestry programs and cooperate with States in outreach and extension efforts. Federal funding and technical expertise provide assistance to State forestry programs, and community development and public land management of the national forests.

Forest management plans are required in private market certification under all the forest certification systems in the country. Since 1993, when forest certification began, the Forest Stewardship Council (FSC), Sustainable Forestry Initiative (SFI), and American Tree Farm System (ATFS) have certified about 108 million acres in the United States as of 2008. About 60 million acres were certified in the United States in 2003, which did not include the ATFS at that time. FSC requires the release of the complete forest management plan for and audit report of the certified forest; SFI requires the posting of a summary of the audit report for each forest.

All forest certification programs incorporate public consultation in the planning and execution of their programs in some fashion. FSC, with about 24 million acres, requires consultation with external stakeholders on each forest management plan through local meetings and requests for input sent to stakeholders on each forest management plan, and in periodic program revisions. SFI, with about 55 million acres certified in the United States, may consult with external stakeholders in the audit process as deemed appropriate; works through its SFI Implementation Committees (SICs) to promote sustainable forestry at the grassroots level; requires procurement organizations to implement relevant indicators; and has extensive periodic standards reviews and public input processes. ATFS, with about 29 million acres, has periodic program reviews and public input.

What has changed since 2003?

National forest planning has undergone major revisions since the 2003 report. First, the Healthy Forests Restoration Act (HFRA) was passed in 2003. HFRA contains a variety of provisions to speed up hazardous-fuel reduction and forest-restoration planning and projects on specific types of Federal land that are at risk of wildland fire and insect and disease epidemics.

Following HFRA, the Forest Service also developed an extensive new forest planning rule that was released initially in 2005, then revised and released in final form in 2008. That rule was designed to expedite forest planning and reduce appeals and implement an environmental management system (EMS). The rule was released in 2008 at the end of the previous administration, but was under consideration for revocation and return to the previous planning rules.

Various other planning changes have occurred to encourage habitat conservation of threatened and endangered species; to set aside various Federal lands for archaeological, wilderness, scenic rivers, national trails, and wildlife refuges; to protect wetlands; and to govern surface mining and reclamation.

Planning for private forest and farm lands has been authorized in several components of the 2002 and 2008 Farm Bill, and is implemented through cooperation with State and Federal forestry and natural resource conservation agencies.

Table 46-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, R, S, L	L, R, I, G	L, R, I, G		
Informational/educational[b]	R, N, S, L	E, R, A	E, R, A		E, R, A
Discretionary/voluntary[c]					
Fiscal/economic[d]	N, S		I		
Market based[e]	L				M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.47. Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it provides opportunities for public participation in public policy and decision-making related to forests and public access to information

What is the indicator and why is it important?

Forests may be managed more sustainably if citizens have responsibility for their use, management, and protection. If citizens are given an opportunity to identify areas of interest and concern about forests, they are more likely to support the management of forests and the principles of sustainability. Public participation processes can foster practical and political support for sustainable management. Access to timely, complete, and accurate information about forests, forest resources, and socioeconomic trends will enhance those participatory processes and promote better forest management.

What does the indicator show?

Federal agencies all provide some level of opportunity for public participation in policy and decisionmaking, and varying levels of access to information. The Administrative Procedures Act of 1946 provides public oversight of Federal agencies, including public comment on proposed rules; a rigorous process of draft publication, and public review; required agency response to comments; and final publication in the Federal Register. This process leads to final rules with a reviewable record and science basis.

States usually have similar but less rigorous open process and information laws. Local government entities eventually must respond to citizen's interest, but seldom have prescribed measures for public input to forest planning. Nonindustrial private landowners are not required to consult other interests or owners in making decisions or release information publicly, although many businesses do as part of their annual reports and other communications.

Extensive public participation for national forest planning is required as part of the U.S. National Forest Management Act of 1976 (191 million acres), as amended by the Healthy Forest Restoration Act of 2003. The Bureau of Land Management, with 266 million acres, requires planning and local advisory boards for input. Other Federal agencies, including the U.S. Fish and Wildlife Service (84 million acres), National Park Service (84 million acres), and Department of Defense have varying levels of planning and public participation that affects their lands, including forests.

Federal agencies also provide educational, technical assistance, research, and assessment support for sustainable forestry and public participation at the national level, as do many States. This support includes mandates for State forest resource planning and input, and support through the U.S. Department of Agriculture.

The National Environmental Policy Act (NEPA) of 1969 requires an analysis of major Federal actions significantly affecting the environment. An Environmental Impact Statement is required for proposed major Federal actions. A categorical exclusion exists for small projects that do not require individual EIS. An Environmental Assessment (EA) may be performed if the agency does not know if its effects will be significant. The EA may require an EIS if actions are significant, or lead to a finding of no significant impacts (FONSI) if not. NEPA provides for public comment on the EIS and EA processes in the scoping and preparation of the draft EIS, and a formal comment process before the final EIS is issued.

If the general public or individuals are dissatisfied with the lack of openness of Federal public records, they may seek redress through legal actions such as requesting evidentiary documentation and other information under the Freedom of Information Act (FOIA). Similar laws exist in most States. Legal issues that employ these measures are uncommon in natural resources, but not unheard of.

Finally, as noted in 7-46, the forest certification systems have various means to seek consultation with external stakeholders, redress complaints, report progress, and update their standards periodically.

What has changed since 2003?

The Healthy Forest Restoration Act (HFRA) and the 2005 and 2008 National Forest Planning Rules each enacted new rules that affected forest planning and public input. Generally, each of the changes in the regulations was intended to simplify public input procedures so that agency managers could expedite forest management practices. These changes have been contested by environmental interest groups, in general and in the courts. The issue regarding the level of consultation required is complex, but HFRA and the 2005 and 2008 planning rules have allowed somewhat more discretion to the agency, which has been circumscribed, but partially supported, by court decisions.

Concomitantly, increasing public support exists for greater levels of stakeholder involvement in a variety of public decisions. Public policy input and governance processes have become prevalent from the local to the national level, across a range of ownership types and forest resource decisions. These processes have included government decisionmaking, and private market systems such as forest certification.

Table 47-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, G	L, R G	L, R, G	
Informational/educational[b]	N, S, L	E, T, R	A		
Discretionary/voluntary[c]					
Fiscal/economic[d]	N, S		I		
Market based[e]	R, N, L		C		C

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.48. Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it encourages best practice codes for forest management

What is the indicator and why is it important?

Forest management practices that are well designed are fundamental to the sustainability of forest resources. At all levels (stand, landscape, local, regional, national, and global), forests depend on the application of forest practices that are capable of ensuring sustained use, management, and protection of important social, economic, and biological values. Well-founded best practice codes, and the forest management practices that comprise them, can ensure sustained forest productivity for market goods; protection of ecological values; and protection of the various social, cultural, and spiritual values offered by forests. They can be among the most important tools for responding to national trends and conditions involving forests.

What does the indicator show?

National, State, and local government landowners, and all private landowners, have various levels of recommended or required forest best management practices (BMPs). BMPs may be implemented through educational, voluntary guidelines, technical assistance, tax incentives, fiscal incentives, or regulatory approaches.

Ellefson et al (2005) provide detailed summary of BMPs, albeit for 1992, but it can provide a guide for types of programs now. More than 25 States have regulatory forestry BMPs to protect water quality and to protect landowners from wildfire, insects, and diseases. Almost all States (greater than or equal to 45) have educational and technical assistance programs for BMPs aimed at water quality, timber-harvesting methods, protecting wildlife and endangered species; and more than 40 have such programs to enhance recreation and aesthetic qualities.

Even States that do not have legally required BMPs often have water quality laws intended to control surface erosion into water bodies of the State, and can be used to enforce BMP compliance. Local governments also implement BMPs for private forest lands, along with other land use controls on development, agriculture, or mining.

BMPs may be prescriptive and mandatory, as required in the State forest practice laws of all the States on the West Coast and many in the Northeast; may require that forest managers and loggers follow specific processes, such as in Virginia; or may be performance or outcome based, ensuring that water quality is protected, such as in North Carolina.

BMPs may cover a variety of practices, such as timber harvest, road construction, fire, site preparation and planting, and insect and disease protection. They also may cover diverse natural resources to be protected, such as water quality, air quality, wildlife, endangered species, or visual impacts.

Although BMPs are pervasive, differences of opinion exist about their effectiveness. Almost all forestry compliance surveys have found a high overall rate of compliance for most landowners, but environmental groups contend that many individual practices, such as road-building or wildlife habitat impacts, remain problematical.

The Federal Government and most States provide detailed technical assistance for information and education about BMPs, and research about efficacy, benefits, and costs. The private sector—including forest industry, large timberland investors, nonindustrial private forest owners, and forest consultants—have been actively involved in development and promotion

Table 48-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, G	L, R, G	L, R	
Informational/educational[b]	N, S, L	P, T, R	E, T, R	E, T, R	
Discretionary/voluntary[c]	N, S	B	B	B	B, S
Fiscal/economic[d]					
Market based[e]	N, S, L				C

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

of BMPs. BMP compliance also is required as part of the standards of all three major forest certification standards in the United States: the Sustainable Forestry Initiative (SFI), Forest Stewardship Council (FSC), and American Tree Farm System.

What has changed since 2003?

Voluntary and regulatory State best management practices for forestry have continued to evolve and improve since 2003. They have been evaluated periodically through on-the-ground effectiveness surveys, and periodically revised. Their scope has been extended in some States to cover more than just timber harvesting and roads to include wildlife, landscape level effects, or aesthetics. Enforcement has increased through inspections, even in States with voluntary BMPs. Several States also have issued separate BMPs for biomass fuel harvesting. BMPs are now explicitly required under all forest certification systems in the United States.

Indicator 7.49. Extent to which the legal framework (laws, regulations, guidelines) supports the conservation and sustainable management of forests, including the extent to which it provides for the management of forests to conserve special environmental, cultural, social, and/or scientific values

What is the indicator and why is it important?

Forests often possess unique or otherwise special social, cultural, scientific, and environmental values. Formal legal mechanisms are often needed to protect those values from certain uses and activities. Because the values to be protected are often large in number and wide in scope, the resulting legal framework is frequently complicated and broadly dispersed among Federal, State, and local governments.

What does the indicator show?

National, State, and local laws, along with international agreements, are used to identify sites (forested and otherwise) with special environmental, cultural, social, and scientific values and to provide for their management. For Federal, State, and local government ownerships, these laws are usually mandatory and prescriptive, being the strictest on Federal lands. At a minimum, the government may require that such lands be considered in forest planning and protection through an explicit or implicit process. The government may also require specific regulations to protect sites with special values, or at least require that an acceptable outcome or level of protection be achieved.

International agreements, including the World Heritage agreement and Ramsar (for wetlands), also identify sites of interest and require Federal efforts to protect them on Federal

lands. Special designations by the United Nations Man and the Biosphere Program and various nongovernmental organization (such as the World Wildlife Fund biodiversity hotspots) encourage the protection of sites of particular value.

A variety of Federal, State, and local government informational policies encourage protection of special sites. These include educational and technical assistance programs about the sites for private owners, designation of sites as protected areas, research regarding protection and management, and planning and analysis to provide protection. Private landowners often are not required to protect these sites, but large corporate and timber investors often do—as part of their commitment to corporate social responsibility.

Some Federal, State, and nongovernment organizations also provide incentives such as tax breaks or subsidy payments to protect these special sites on private lands. These incentives include programs such as the Environmental Quality Incentives Program in the Federal farm bill, or conservation easements obtained by NGOs, or wetland banking and payment systems throughout the country. Many other special values are protected through forest laws and policies, including old growth forests, wilderness areas, endangered and threatened species, or archeological sites.

Use of forests for carbon storage, either through reduced emissions from forest degradation and destruction or through direct afforestation and reforestation, has been the most salient new proposed environmental objective for forests. International conferences and accords to control global climate change have focused on forest emissions and carbon storage. The United States has developed a small private market through the Chicago Climate Exchange, and funded some individual forestry tree planting projects to offset carbon emissions in the country.

Forest certification has explicit standards for protecting special sites listed under this indicator. Wetland banks also provide a mechanism to do so, under a de facto cap-and-trade system where no net loss of wetlands is permitted (the cap), and developers must purchase wetland credits to offset any destruction or loss that does occur (the trade).

The standards in forest certification and in creating wetland banks are prescriptive, mandatory rules and are performance based. A variety of market based mechanisms, including free trade, cap-and-trade, forest certification, wetland banks, or conservation easement mechanisms, may protect special sites on private lands.

What has changed since 2003?

Various changes have occurred to encourage habitat conservation of threatened and endangered species; to set aside Federal lands to protect archaeological resources, wilderness areas, scenic rivers, national trails, and wildlife refuges; to protect wetlands; and to govern surface mining and reclamation. These conservation efforts include the explicit designation of individual wilderness, scenic rivers, national trail system, or archeological areas.

Increased Federal conservation support also includes a large amount of Federal funding through agency budgets and grants to private forest landowners, particularly through the 2002 and 2008 Farm Bills. The Farm Bills also have substantially increased incentives for programs that provide environmental services. The IRS Code also allows for tax deductions with qualified conservation easements or with land donations to land trusts.

Table 49-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, I, G	L, R, I, G	L, R, G	R
Informational/educational[b]	N, S, L		E, T, P, R, A		
Discretionary/voluntary[c]	N, S, L				S
Fiscal/economic[d]	N, S, L			I, T, P	I, T, P
Market based[e]	R, N, S, L	C, W		C, W	W, T, M, C, E

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).

[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).

[c] Best Management Practices (B), Self-regulation (S).

[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).

[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.50—Extent to which the institutional framework supports the conservation and sustainable management of forests, including the capacity to provide for public involvement activities and public education, awareness, and extension programs, and make available forest-related information

What is the indicator and why is it important?

Well-informed, knowledgeable citizens and forest owners create a foundation of support for applying principles of sustainable forest management. To accomplish such a purpose requires institutional conditions (agencies and organizations) that are capable of promoting programs considered necessary to inform the public and private forest owners about forest resource sustainability.

What does the indicator show?

Federal, State, and local government programs exist that provide education, awareness, and extension programs. Most conspicuously, the Cooperative Extension Service is a nationwide partnership between the Federal Government, individual States, and local counties. This program has forestry as one of its components, although agriculture and rural development, and consumer and home economics are perhaps more prominent in many parts of the country. The United States also has separate State efforts for environmental and natural resource education, and a plethora of local governments run such programs for the general public and school children.

Many entities provide information and education about forests as part of their ongoing educational, technical assistance, research, forest protection, and planning efforts. These entities include not only government, schools, and universities but also most environmental nongovernmental organization, such as forestry associations, professional societies, forestry interest groups, broad conservation organizations, and environmental activist groups.

Outreach and education also are required as part of forest certification systems. And many companies have some environmental education activities and facilities, although these have dwindled with the decrease in vertically integrated forest products firms that own forest land.

What has changed since 2003?

Various changes have occurred in public education, awareness, and extension programs for forestry since 2003. Continued agency budgets are authorized under the Federal and State budget process, and these have been relatively stable since 2003. In addition, funds continue to be provided under the 2002 and 2008 Farm Bill. These changes have been largely incremental, based on budget authorizations, rather than based on any new legislation. A shift in focus occurred in the last period, with more efforts devoted to conservation programs, ecosystem services, and public involvement, and less to forest productivity.

Table 50-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, G			
Informational/educational[b]	N, S, L		E, T, R, P, A		E, R, A, T
Discretionary/voluntary[c]					
Fiscal/economic[d]	N, S, L				
Market based[e]	N, L				C

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.51. Extent to which the institutional framework supports the conservation and sustainable management of forests, including the capacity to undertake and implement periodic forest-related planning, assessment, and policy review, including cross-sectoral planning coordination

What is the indicator and why is it important?

The sustainability of forests depends on society's institutional ability to comprehensively evaluate trends and conditions in diverse sectors and to subsequently make responses that will ensure the sustained use, management, and protection of forest resources and the communities that depend on them. Such actions are typically predicated on institutional conditions that foster well-focused and technically sound plans, assessments, and policy reviews that are sensitive to a range of forest values and that are coordinated with a variety of forest-related sectors.

What does the indicator show?

Indicator 7.51 is quite similar to Indicator 7.46 in that it is related to forest planning and policy review, although perhaps with a slightly narrower focus. As a result, the following paraphrases the presentation given for Indicator 7.46. These two indicators are apt to be consolidated in future revisions of the MP C&I.

National, regional, State, and local governments perform periodic forest planning, assessment, and policy reviews. Planning is required as a prescriptive for all Federal land agencies for lands under their jurisdiction, and is similarly required in some fashion for most State and county forest lands. Some regional planning efforts also occur, voluntarily or not. These government planning efforts typically have a required process, usually including some type of public input and appeals. Inter-sectoral consultation and planning is frequently required as part of the process. The Federal and State governments also write Federal or State forest plans for private forest lands in the country or State. These plans usually do not dictate or create mandatory rules, regulations, incentives, or other government interventions in markets. Instead, they generally summarize information about forest resource conditions and trends; identify issues and opportunities; and suggest possible policies that could enhance sustainable forest management.

Educational, research, and analysis policy mechanisms are usually an integral part of forest planning efforts, at all scales from national to local. These policies provide education to forest managers and policymakers on forest conditions, threats, and management responses. Various incentives have been provided for private or public forest landowners to meet the recommendations contained in forest plans.

What has changed since 2003?

The changes in this planning indicator are similar to those for Indicator 7.46.

Table 51-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, I, G	L, R, I		
Informational/educational[b]	N, S	E, R, A	E, R, A		E, R, A
Discretionary/voluntary[c]	N				S
Fiscal/economic[d]					
Market based[e]	L				M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.52. Extent to which the institutional framework supports the conservation and sustainable management of forests, including the capacity to develop and maintain human resource skills across relevant disciplines

What is the indicator and why is it important?

The extensive knowledge and skills applied by people who are engaged in the development and implementation of forest resource policies and programs are critical to accomplishing the wide-ranging goals of forest sustainability and conservation. These disciplinary and resource skills are developed via formal educational programs for field workers, technical staff, and natural resource professionals, and via professional work experiences and access to continuing education opportunities.

What does the indicator show?

Various national and State laws and regulations exist that affect worker safety and training in the forestry sector. Most laws and regulations would fall under the auspices of the Occupational Health and Safety Administration (OSHA), and similar State agencies. Related laws cover highway and trucking safety and operator licensing. These laws require the use of safety equipment, training in safe operations, and now, use of Best Management Practices to avoid adverse environmental impacts.

Most of the actual education and training is conducted by States, either through their educational institutions such as Land Grant universities or community colleges, or through their industry trade associations in cooperation with the relevant State agencies. They also offer technical assistance, research on better methods and procedures, and planning to improve performance.

Similarly, education is provided for forest resource professionals, in addition to field forest workers. This professional education effort is led by accredited forestry programs in most States and complemented by research and extension efforts. Bachelor of Science and graduate degree programs associated with this effort are often complemented by State registration and licensing programs or the national Society of American Foresters Certified Forester program.

Professional education is offered for other forest-related disciplines, including wildlife and fisheries, natural resources, soils and hydrology, environmental sciences, ecology, and others. Several of these, but not all, have professional certification or registration procedures. Some private and public institutions offer forestry programs as well, for field operators, technicians, and professionals.

As of 2009, 2,244 certified foresters were recognized by the Society of American Foresters. This number included forestry consultants (25 percent), personnel in private industry (24 percent), State and local government (19 percent), Federal Government (9 percent), and college and university (7 percent), along with retirees (7 percent) and other (9 percent). There also were 15 States with separate forestry registration laws and thousands of registered foresters; most programs required continuing education as part of their requirements. Similarly, The Wildlife Society had 3,658 certified wildlife biologists in 2009.

What has changed since 2003?

Laws and regulations affecting human resources and skills have continued to evolve incrementally over the last decade. State efforts to improve trucking and logger training are pervasive, and rules about trucking safety and regulations are common. Forest certification has affected training for foresters and in particular for persons who perform audits. Some State forestry registration laws have been eliminated or threatened as part of periodic State budget cuts and reviews.

Table 52-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S	L, R	L, R, G		
Informational/educational[b]	N, S		E, T, R, A	E	E, R
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]	N, L		M	M	M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.53. Extent to which the institutional framework supports the conservation and sustainable management of forests, including the capacity to develop and maintain efficient physical infrastructure to facilitate the supply of forest products and services and to support forest management

What is the indicator and why is it important?

Capital resources of physical infrastructure (e.g., roads, utilities, and processing facilities) are essential to the management of forests and ultimately to economic development and quality of life in rural forested areas. Investments in public infrastructure, such as roads, bridges, sewer and sanitation systems, schools, parks, and other physical facilities, are important government initiatives that complement the capital investments of private firms. Together, these investments constitute the capital basis for protecting forests and related resources and for producing the goods and services that sustain economies of forested areas. Some people have suggested that forest ecosystems per se can be considered a form of green infrastructure.

What does the indicator show?

The development and maintenance of adequate physical infrastructure to facilitate the supply of forest products and services to support forest management is the responsibility of governments who own public lands, teach, or perform research, and of private sector firms and forest owners who manage forests or forest products manufacturing facilities. Provisions to meet this responsibility are generally prescriptive for government forest management, education, and research activities, and largely performance or outcome based for private sector forest managers.

Some informational and educational mechanisms are required by law and could include technical assistance and research to provide adequate facilities and forest infrastructure such as roads, firebreaks, fire-fighting gear, and forest harvesting equipment. Often such infrastructure is required in terms of the process for developing adequate capacity for forestry activities.

Private sector firms develop physical infrastructure and provide institutional capacity through private market, free enterprise efforts. They develop internal firm or trade association rules, processes, or outcome guidelines as necessary, with either voluntary compliance or self-regulation, including through forest certification. Their ultimate success in developing efficient infrastructure is measured by market performance and profits, in the long run.

Direct government subsidies have seldom been employed in developing private forestry infrastructure, but many parts of the Federal tax code related to accelerated depreciation, tax deductions, and tax credits promote investments and manufacturing plants and facilities and in-woods equipment.

What has changed since 2003?

Due to more frequent large forest fires, the budget for national forests has been increasingly dedicated to firefighting. This shift in the allocation of resources has enhanced firefighting capacity, but deleteriously affected funding for other maintenance and ongoing operations in the agency. The Federal economic stimulus package in 2009 included substantial funds for forestry infrastructure, with an allocation of $1.1 billion to be spent on national forests, forest health projects, and related State and private projects. There was a modest decline in tree planting in the United States in the mid-2000s, but appears that total tree planting has increased slightly in the past 2 years. Most other changes in forestry infrastructure at the State or private level have not been notable.

Table 53-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, G			
Informational/educational[b]	N, S	T, R	T, R, A		
Discretionary/voluntary[c]	S, L	B	B	B	S
Fiscal/economic[d]					T
Market based[e]	N, L			M	M, C

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.54. Extent to which the institutional framework supports the conservation and sustainable management of forests, including the capacity to enforce laws, regulations, and guidelines

What is the indicator and why is it important?

Market processes allocate many forest resources. Laws, rules, and regulations are needed, however, to provide the framework necessary to maintain competitive markets even for private forests, and more than one-third of U.S. forests are publicly owned. Effective laws, regulations, and guidelines should promote tenure rights, sustainable forest management, environmental protection, and a competitive market environment.

What does the indicator show?

Laws, regulations, and guidelines for sustainable forest management in the United States are enforced adequately. U.S. laws differ widely among regions and landowner types, ranging from detailed laws and regulations for national forests and for all lands governed by the State forest practice acts in the West Coast to voluntary Best Management Practices in the Southern and Midwestern States.

Federal Government forest lands have complex laws and policies governing forest management, biodiversity, public input, and workforce diversity. Private landowners must comply with the relevant mandatory and voluntary standards. State forestry agencies monitor compliance with forest practice acts, BMP use, and water quality laws. These regulations directly affect private and public lands, and may involve up to several thousand inspections of forest operations each year in many States.

Education, technical assistance, and research are used to help in the training of forestry professionals, monitoring of laws and regulations, and continuous improvement of the mandatory and voluntary practices. These policy mechanisms are used both for the public and private forest land managers who implement the laws, and for the professionals who monitor, inspect, and enforce the rules and regulations.

Private sector firms comply with mandatory laws and with voluntary guidelines. Frequent surveys have found that BMP compliance rates are very high in all States, as is compliance with laws and regulations. Similarly, forest certification provides a clear means to demonstrate that private and public forestry organizations conform to the standards and guidelines for sustainable forest management.

What has changed since 2003?

No major Federal or outstanding laws have been enacted that affect forest law enforcement and governance. Continued pressure on Federal budgets, as noted regarding the fire budgets, may have reduced U.S. forest law enforcement capacity, but no empirical studies are available. Compliance with Federal, State, and local laws is a required indicator in all of the U.S. forest certification systems.

Table 54-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, I, G	L, R, I, G		R
Informational/educational[b]	N, S, L		E, R, T		E, R, T
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]	N, S, L				M, C

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.55. Extent to which the economic framework (economic policies and measures) supports the conservation and sustainable management of forests through investment and taxation policies and a regulatory environment that recognizes the long-term nature of investments and permits the flow of capital in and out of the forest sector in response to market signals, nonmarket economic valuations, and public policy decisions in order to meet long-term demands for forest products and services

What is the indicator and why is it important?

The sustainability of forests and the many benefits they are capable of providing requires high levels of sustained investment in their management and protection. Investments are driven by a number of economy wide factors and government policies, including product or service costs and prices, capital costs, management efficiency, forest land productivity, and tax and incentive policies.

What does the indicator show?

The United States has a wide variety of investment and taxation policies that favor long-term forest resource investments, provide consistent market based incentives and signals, and provide some payments for investments in nonmarket values. These are provided at the national, State, and local level, affecting income taxes, property taxes, and the production of a variety of forest resource goods and services. The regulatory environment is addressed in other indicators, and ranges from strict regulations on public lands and mountainous West Coast States to moderate regulations in the Northeast to voluntary best management practices (BMPs) in States with mostly private forest lands in the South and East. Prescriptive regulations occur at the Federal level for Federal lands, and State level for State and private lands. These include requirements for specific BMPs and for notification, harvesting permits, and timber management plans in a few States.

Federal and State income tax policies for timber production are generally more favorable than for other sources of income, such as wages and salaries. For active investors, timber management expenses may be deducted as a cost of business, similar to agricultural operations. Timber income is currently taxed at a long-term capital gains rate that is less than the marginal tax rates for middle income or higher level individuals. Timber income receives an accelerated tax deduction for reforestation and planting, rather than waiting for the end of a harvest rotation to apply the deduction as a cost of business. This Federal tax treatment is carried over to the State income taxes.

Property tax treatment for forest land owners is also generally favorable for active forest land owners and managers, although this does vary substantially among States and even within States. Property tax rates without special tax treatment can be almost punitive, at up to $30 to $50 per acre per year. But most States offer current use of forest use valuation, which reduces these high rates to less than $10 per acre, at least for landowners who meet program criteria and guarantee to enroll for a fixed program length. Some States also tax timber as real property, but offset the increasing tax values by collecting a yield tax on the timber portion of the asset, and only the land is taxed at actual assessed values.

Many forest incentive programs also promote forest investments in timber, conservation, or other environmental activities. The periodic Federal farm bill has increasingly incorporated provisions for tree planting, crop retirement, and environmental land use programs in each of its authorizations and appropriations since the 1960s. Recent relevant Federal farm bill programs included the Conservation Reserve Program, Wildlife Habitat Incentive Program, Environmental Quality Incentive Program, and the Forest Stewardship Program. Funding for forestry in these programs has been somewhat limited, at least until the 2008 Farm Bill, which authorized more participation for forest and wildlife practices, although actual implementation is pending. Almost 20 States also provide State incentive payments to landowners who plant trees or perform qualifying forest management and planning activities.

Informational and educational programs promote participation in these programs, including program enrollment processes, forest practice requirements, and cost-share payment rates. Research and protection programs help ensure that these incentives and practices remain productive and secure, and extensive Federal and State planning and program development provide the foundations for program delivery.

Private market policy tools also address timber production, ecosystem goods and services production, and environmental protection for sustainable forest management. These specifically include market based programs such as forest certification for sustainable forest management, wetlands banks for wetland functions and values, cap-and-trade for carbon storage or Endangered Species Protection, conservation easements for fixed term or permanent protection from development, and even outright purchase of forest lands by nongovernmental organization or government organizations.

Table 55-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S, L	L, R, I, G	L, R		L, R, G
Informational/educational[b]	N, S		R, P, A		R, P, A
Discretionary/voluntary[c]	N				S
Fiscal/economic[d]	N, S, L	I, S, T		I, S, T, P	I, S, T, P
Market based[e]	N, S, L				C, W, T, E, M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).

[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).

[c] Best Management Practices (B), Self-regulation (S).

[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).

[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

What has changed since 2003?

The American Jobs Creation Act of 2004 changed Federal reforestation tax incentives for private forest landowners somewhat. Landowners were allowed to increase the amount of they could deduct each year, and the excess could be amortized over an 8-year period. Landowners were also allowed to receive capital gains treatment for timber income from lump sum sales and for sales per unit of volume. Federal tax law still taxed vertically integrated forest products firms at rates greater than those for timber investment management organizations and real estate investment trusts, which has been attributed to leading partially to the sale of much land to timber investment management organizations (TIMOs) and real estate investment trusts (REITs).

State forest property taxes continue to fund State and local services, and have increased in many jurisdictions as the demand for services rises rapidly. Debates over tax levels and equity occur, and changes in State laws for timber and current use valuation occur periodically.

Indicator 7.56. Extent to which the economic framework (economic policies and measures) supports the conservation and sustainable management of forests through investment and taxation policies and a regulatory environment that recognizes the long-term nature of investments and permits nondiscriminatory trade policies for forest products

What is the indicator and why is it important?

This indicator provides information about U.S. trade policies and how they may affect markets in ways that can affect sustainable forest management. If trade policies, such as import or export quotas, mask market signals that affect domestic timber harvest, these policies may adversely affect economic, social, or environmental components of sustainable forest management.

What does the indicator show?

Trade policies are obviously the purview of the Federal Government, both as logic dictates and as stated explicitly in the U.S. Constitution. Many national and international laws, rules, regulations, and international agreements address trade in forest products, protection of endangered species and important natural habitats, and potential discrimination. The United States is a net forest products importer, but also exports considerable amount of wood as well. The United States imports mostly sawn wood and panels, and exports pulp, paper, and roundwood, but exports much less than it imports on a volume basis.

Trade from Canada and the United States has been contentious. The United States imported about 39 percent of its sawn wood consumption and 28 percent of its panel consumption in 2004, with almost 90 percent of this coming from Canada. U.S. trade is governed partially by the North American Free Trade Agreement (NAFTA), by some accords under the World Trade Organization (WTO), and by agreements stemming from General Agreement on Trade and Tariffs (GATT). The legal Canadian-U.S. lumber dispute reached a fragile resolution in 2006, and remains in force, but with continuing issues.

The United States also participates in international agreements that have environmental and social objectives. The Convention on International Trade in Endangered Species (CITES) protects endangered fauna and flora; Ramsar protects endangered wetlands; the North American Migratory Bird Treaty acts to protect those bird species whose migration routes include North America; and NAFTA and Central American Free Trade Agreements (CAFTA) include environmental protection and worker protection standards. Private sector forest products firms and forest landowners generally operate completely within these laws, rules, regulations, and international agreements

What has changed since 2003?

The U.S. Lacey Act of 1900 forbade import of foreign animal or interstate commerce in illegally taken wild animals or birds. The Lacey Act was extended in the 2008 Farm Bill to combat imports of illegal flora from other countries. This act was enacted as a means to control illegal logging and is being implemented with detailed regulations, as of 2009.

Concerns with nontrade barriers such as phytosanitary standards and how illegal logging strictures under the 2008 Lacey Act Amendments still require temperate policy responses and monitoring to ensure that fair trade continues. The WTO, for instance promotes free trade, and adjudicates disputes among countries, but recognizes that each case must be considered carefully.

Table 56-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S	L, R, I	L, R, I	L, R, I	
Informational/educational[b]					
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]	N				M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.57. Capacity to measure and monitor changes in the conservation and sustainable management of forests, including availability and extent of up-to-date data, statistics, and other information important to measuring or describing indicators

What is the indicator and why is it important?

This indicator assesses the availability of information needed to measure or describe the indicators associated with Criteria 1 through 7. Successful implementation of the criteria and indicator concept requires the availability of information to report on the indicators.

What does the indicator show?

Compilation and development of up-to-date data, statistics, and other information is mostly a Federal Government responsibility, with some data collected by States as well. Various laws and regulations govern data collection, analysis, and release. For example, the Federal Renewable Resource Planning Act (RPA) mandates data collection and analysis to monitor the trends of the forest conditions in the United States. The Federal Forest Inventory and Analysis (FIA) program measures forest inventories, forest health, and selected forest resource characteristics in the United States. FIA also collects and publishes much of the forest products production data in the United States These data are complemented with trade data from the Foreign Agriculture Service (FAS) and the National Resource Lands Inventory (NRLI), which measures land use and change for all lands in the United States.

As of the *National Report on Sustainable Forests—2003*, 5 of the 67 Montréal Process indicators had data available at the national scale, and 17 had partial data at the national scale. The rest had data available only at the State or local scale, if at all.

Federal, State, and university research and assessments contribute to the availability and extent of the Montréal Process statistics, and help foster continuous improvement of the data generated within the budget constraints. Forestry sector private firms and landowners also contribute to such efforts through voluntary reporting and cooperation with Federal partners.

Private sector organizations also provide various production and trade statistics to forest industry trade associations, which compile and publish the statistics annually or periodically. Certified forest organizations also report some management data, at least, and perhaps most of their management planning information. The full management plans for firms certified by Forest Stewardship Council (FSC) are available from Web sources, and the Sustainable Forestry Initiative (SFI) provides a summary of the certification audits for forest management certificate holders.

What has changed since 2003?

The national Forest Service FIA data system has converted most of its national data collection efforts from a periodic survey of each State to a continuous effort that samples a portion of each sample frame each year. This shift to continuous sampling provides some data each year, and over an extended period should provide continual data with similar accuracy. The Forest Service Forest Health Monitoring data efforts have also been integrated into the FIA data system, and subsample a portion of the same FIA plots, only with more detailed measurements to monitor forest health over time. Various updates in data collection have also been implemented specifically to support the Montréal Process reporting effort. FIA soil sampling to address Criterion 4 is a notable example of this.

Table 57-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, S	L, R, G			
Informational/educational[b]	R, N, S	R, A	R, A		
Discretionary/voluntary[c]	N, R, S, L				S
Fiscal/economic[d]					
Market based[e]	N, S, L				M, C

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.58. Capacity to measure and monitor changes in the conservation and sustainable management of forests, including scope, frequency, and statistical reliability of forest inventories, assessments, monitoring, and other relevant information

What is the indicator and why is it important?

Public discussion and decisions related to natural resource sustainability issues should be based on comprehensive, current, and sound data. Information regarding the frequency, coverage, and reliability of data provides analysts with critical information for evaluating and prioritizing sustainability needs.

What does the indicator show?

Data for the 64 indicators range from full current coverage to one-time studies, to very anecdotal information. By looking at a cross section of the information in three broad categories, a brief overview of the situation for each criterion can be seen.

Although some indicators have a full suite of current data, that are national in scope, and collected frequently, many do not. In some cases, this is the result of a lack of systematic data collection, in others, the indicator in question may not be amenable to a concise, quantified presentation, and systematic data collection activities would likely not be possible even if sufficient resources were available. Often, in these cases, proxy data have been used to provide some information to address the indicator. Certain proxy data series may have excellent characteristics (e.g., high reporting frequency and national consistency), but their applicability in measuring the underlying indicator will vary depending on the indicator in question.

The current status of data for each indicator is summarized in the table below along with its status as recorded in the 2003 report (table 58-1). The rankings are based on the judgment of each indicator's lead investigator and the project analysis team as a whole. They are currently provisional. The rankings may assume different meanings depending on the indicator in question. In particular, the appropriateness of proxy data is not fully reflected in the stoplight categorizations presented in the following table.

Table 58-1. Data adequacy measures for all indicators (1 of 4).

KEY					
Notes on the rating system: This rating provides a general overview of the data supporting the indicators. Green means few gaps, yellow means several gaps, red means no data or numerous gaps, and blue indicates data that has been modelled.		**Data coverage**	**Data currentness**	**Data frequency**	**Reporting scale**
Data generally complete nationally, current, and relaible.		National (90%+)	2000+	Annual to < 5-year periodic	Regional or national
Data may not be consistent nationally, slightly dated, and not measured frequently enough.		Regional or some national	1985-1999	5+ year periodic	
Data are from inconsistent sources or nonexistent, more than 15 years old or partial, and has no consistent plan for remeasurement		Varies or incomplete	Incomplete	One-time or incomplete	
Data are modelled (currency and frequency dots refer to model baseline data)		Modelled			

 =Triangle shows status of variable in 2003 report.

Table 58-1. Data adequacy measures for all indicators (2 of 4).

Criterion	Old	New	Indicators	Data status			Reporting Scale
				Coverage	Current-ness	Frequency	
1. Conservation of biological diversity	1,3	1.01	Area and percent of forest by forest ecosystem type, successional stage, age class, and forest ownership or tenure				Regional
	2,4	1.02	Area and percent of forest in protected areas by forest ecosystem type, and by age class or successional stage				Regional
	5	1.03	Fragmentation of forests				Regional
	6	1.04	Number of native forest-associated species				Regional
	7	1.05	Number and status of native forest-associated species at risk, as determined by legislation or scientific assessment				Regional
		1.06	Status of onsite and offsite efforts focused on conservation of species diversity				Regional
	8	1.07	Number and geographic distribution of forest-associated species at risk of losing genetic variation and locally adapted genotypes				Regional
	9	1.08	Population levels of selected representative forest-associated species to describe genetic diversity				Regional
		1.09	Status of onsite and offsite efforts focused on conservation of genetic diversity				National
2. Maintenance of productive capacity of forest ecosystems	10	2.10	Area and percent of forest land and net area of forest land available for wood production				Regional
	11	2.11	Total growing stock and annual increment of both merchantable and nonmerchantable tree species in forests available for wood production				Regional
	12	2.12	Area, percent, and growing stock of plantations of native and exotic species				Regional
	13	2.13	Annual harvest of wood products by volume and as a percentage of net growth or sustained yield				Regional
	14	2.14	Annual harvest of nonwood forest products				Regional
3. Maintenance of ecosystem health and vitality	15	3.15	Area and percent of forest affected by biotic processes and agents (e.g., insects, disease, invasive alien species) beyond reference conditions				Regional
	16,17	3.16	Area and percent of forest affected by abiotic agents (e.g., fire, storm, land clearance) beyond reference conditions				Regional
4. Conservation and maintenance of soil and water resources	18,19	4.17	Area and percent of forest whose designation or land management focus is the protection of soil or water resources				Regional
	22	4.18	Proportion of forest management activities that meet best management practices or other relevant legislation to protect soil resources				Regional
	21,25	4.19	Area and percent of forest land with significant soil degradation				Regional
	20	4.20	Proportion of forest management activities that meet best management practices, or other relevant legislation, to protect water-related resources				Regional
	23,24	4.21	Area and percent of water bodies, or stream length, in forest areas with significant change in physical, chemical, or biological properties from reference conditions				Regional
5. Maintenance of forest contribution to global carbon cycles	26,27	5.22	Total forest ecosystem carbon pools and fluxes				Regional
	28	5.23	Total forest product carbon pools and fluxes				National
		5.24	Avoided fossil fuel carbon emissions by using forest biomass for energy				National
6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of societies	29	6.25	Value and volume of wood and wood products production, including primary and secondary processing				Regional
	30	6.26	Value of nonwood forest products produced or collected				National
	43	6.27	Revenue from forest-based environmental services				National
	31	6.28	Total and per capita consumption of wood and wood products in roundwood equivalents				National
	34	6.29	Total and per capita consumption of nonwood products				National
	32	6.30	Value and volume in roundwood equivalents of exports and imports of wood products				National
		6.31	Value of exports and imports of nonwood products				National
		6.32	Exports as a share of wood and wood products production and imports as a share of wood and wood products consumption				National
	33	6.33	Recovery or recycling of forest products as a percent of total forest products consumption.				Regional

Table 58-1. Data adequacy measures for all indicators (3 of4).

Criterion	Old	New	Indicators	Data status			Reporting Scale
				Coverage	Current-ness	Frequency	
	38	6.34	Value of capital investment and annual expenditure in forest management, wood and nonwood product industries, forest-based environmental services, recreation, and tourism				Regional
	39-41	6.35	Annual investment and expenditure in forest-related research, extension and development, and education				National
	44	6.36	Employment in the forest products sector				Regional
	45	6.37	Average wage rates, annual average income, and annual injury rates in major forest employment categories				Regional
	46	6.38	The resilience of forest-dependent communities				National
	47	6.39	Area and percent of forests used for subsistence purposes				Regional
		6.40	Distribution of revenues derived from forest management				National
	35-36	6.41	Area and percent of forests available and managed for public recreation and tourism				Regional
	37	6.42	Number, type, and geographic distribution of visits attributed to recreation and tourism and related to facilities available				Regional
	42	6.43	Area and percent of forests managed primarily to protect the range of cultural, social, and spiritual needs and values				Regional
		6.44	The importance of forests to people				National
7. Legal, institutional, and economic framework for forest conservation and sustainable management.	Extent to which the legal framework (laws, regulations, guidelines) support the conservation and sustainable management of forests, including the extent to which it:						
	48	7.45	—Clarifies property rights, provides for appropriate land tenure arrangements, recognizes customary and traditional rights of indigenous people, and provides a means of resolving property disputes by due process				National
	49	7.46	—Provides for periodic forest-related planning, assessment, and policy review that recognizes the range of forest values, including coordination with relevant sectors				National
	50	7.47	—Provides opportunities for public participation in public policy and decisionmaking related to forests and public access to information				National
	51	7.48	—Encourages best practice codes for forest management				National
	52	7.49	—Provides for the management of forests to conserve special environmental, cultural, social, and scientific values				National
	Extent to which the institutional framework supports the conservation and sustainable management of forests, including						
	53	7.50	—The capacity to provide for public involvement activities and public education, awareness, and extension programs, and make available forest-related information				National
	54	7.51	—The capacity to undertake and implement periodic forest-related planning, assessment, and policy review, including cross-sectoral planning coordination				National
	55	7.52	—The capacity to develop and maintain human resource skills across relevant disciplines				National
	56	7.53	—The capacity to develop and maintain efficient physical infrastructure to facilitate the supply of forest products and services and to support forest management				National
	57	7.54	—The capacity to enforce laws, regulations, and guidelines				National
	Extent to which the economic framework (economic policies and measures) supports the conservation and sustainable management of forests through investment and taxation policies and a regulatory environment that recognizes the long-term nature of investments						
	58	7.55	—And permits the flow of capital in and out of the forest sector in response to market signals, nonmarket economic valuations, and public policy decisions to meet long-term demands for forest products and services				National
	59	7.56	—And permits nondiscriminatory trade policies for forest products				National
	Capacity to measure and monitor changes in the conservation and sustainable management of forests, including						
	60	7.57	—Availability and extent of up-to-date data, statistics, and other information important to measuring or describing indicators				National
	61	7.58	—Scope, frequency, and statistical reliability of forest inventories, assessments, monitoring, and other relevant information				National
	62	7.59	—Compatibility with other countries in measuring, monitoring, and reporting on indicators member countries				National

Table 58-1. Data adequacy measures for all indicators (4 of 4).

Criterion	Old	New	Indicators	Data status			Reporting Scale
				Coverage	Current-ness	Frequency	
	Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services						
	63	7.60	—Including development of scientific understanding of forest ecosystem characteristics and functions				National
	64	7.61	—And development of methodologies to measure and integrate environmental and social costs and benefits into markets and public policies, and to reflect forest-related resource depletion or replenishment in national accounting systems				National
	65	7.62	—And new technologies and the capacity to assess the socioeconomic consequences associated with the introduction of new technologies				National
	66	7.63	—And enhancement of ability to predict impacts of human intervention on forests				National
	67	7.64	—And the ability to predict impacts on forests of possible climate change				National

Indicator 7.59. Capacity to measure and monitor changes in the conservation and sustainable management of forests, including compatibility with other countries in measuring, monitoring, and reporting on indicators member countries

What is the indicator and why is it important?

Consistent data among countries using the Montréal Process will facilitate comparative monitoring of sustainable forest management and trends over time. The member countries are: Argentina, Australia, Canada, Chile, China, Japan, Republic of Korea, Mexico, New Zealand, the Russian Federation, the United States, and Uruguay.

What does the indicator show?

The United States works with other countries in the Montréal Process through Technical Advisory Committees to help agree on indicator revisions and develop common data formats. Each country may have laws and geophysical situations that are unique, but as much as possible, common data formats for the indicators are adopted. Data compatibility is of course the responsibility of the Federal Government.

The participating countries in the Montréal Process use education, technical assistance, research, and planning to seek common data formats and reporting methods. State forestry agencies, private sector forest products firms, and forest landowners may contribute to these efforts by reporting data in the formats sought for the United States and Montréal Process reports.

What has changed since 2003?

Reporting protocols are harmonized, to the extent possible, by Montréal Process technical advisory committees, but the capacity of each country to collect and report all the data differs. Data compatibility has improved in the 2010 report, but most indicators are still not completely reported by any country, let alone in the exactly same metrics and format.

Table 59-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, R		I		
Informational/educational[b]	N, R, S		E, T, R, A	E, T, R, A	R, A
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]					

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.60. Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services, including development of scientific understanding of forest ecosystem characteristics and functions

What is the indicator and why is it important?

Research and development provide the scientific basis for adaptive management of the Nation's forests. Science improves our understanding of ecological, social, and economic processes in forests, and is fundamental in ensuring that we can meet social goals for those forests. This indicator is a measure of the capacity to understand forest ecosystems processes and components. This understanding is essential to the conservation and sustainable management of forest ecosystems.

What does the indicator show?

Federal, State, and university research and development efforts are authorized by relevant government programs and laws, which prescribe that research programs must provide scientific information for forest resource management and protection. Development of research to improve scientific understanding of forest ecosystem characteristics and functions is a blend of national research and development performed by the Federal Government, universities throughout the country, a few State forestry and natural resource agencies, environmental nongovernmental organizations, and the forest industry and forest landowning firms.

According to the 2003 National Capacity in Forestry Research Report, as of 2002, the Forest Service research program had 723 scientist-years of personnel, with about 500 research scientists, and a budget of $241 million. As of 1993, U.S. universities had 1,459 full time employees, with about one-half of those scientist years of effort being dedicated to research, and the rest to teaching and extension. Forest industry reported $72 million in research funding through its Sustainable Forestry Initiative program efforts in 2001.

Other Federal agencies such as National Aeronautics and Space Administration (NASA), the National Science Foundation, the U.S. Department of Energy, and the U.S. Department of Agriculture probably spent $40 to $50 million on forest related research in 2000. Environmental nongovernmental organizations (NGOs) also spent millions of dollars on forest related research and development. More recent data are lacking, but in total, the direct forestry expenditures and effort exceed 1,000 research scientists and budgets of more than $500 million per year. Observations suggest that these funds and personnel levels have declined in recent years, at least in terms of real funding after inflation, but current data are lacking. Other private sector research and development for forestry equipment for land and harvesting operations also contributes significantly to the total expenditures on forestry research, but this amount is not known.

The scientific understanding is developed and disseminated through educational, technical assistance, research, and planning efforts. The private sector also participates in these efforts. Forest certification standards, particularly in the Sustainable Forestry Initiative, require demonstration of forest research.

The National Research Council National Capacity in Forestry Research report classified forestry research by MP C&I criteria as well for all sectors as of 2001. The report found that Biological Diversity (Criterion 1) and Productive Capacity (Criterion 2) had the largest share of the U.S. research effort, at 19 and 24 percent, respectively. Ecosystem Health (Criterion 3, 16 percent), Socioeconomics (Criterion 6, 15 percent), and Soil and Water (Criterion 4, 14 percent) were next. The Institutional Framework Criterion 7, 5 percent) and Carbon Cycles (Criterion 5, 7 percent) had the smallest shares of the U.S. research. The Forest Service had proportionately more ecological research; academic institutions somewhat more social and institutional research; and industry more productive capacity research.

What has changed since 2003?

Federal Forest Service forest resource funding has been stable or declined somewhat in the past 6 years in real terms. A range of Federal organizations and research disciplines continue to examine forests in some fashion, however.

The U.S. vertically integrated forest products sector has declined in size from about 40 million acres in 1980 to about 10 million acres in 2009, and its capacity in forest land management research decreased as well, because the major firms sold their lands and ceased research operations. Timber investment management organizations (TIMOs) and real estate investment trusts (REITs) have maintained modest research programs and many are members of university cooperative research programs.

At least a few research branches of former forest products firms have been spun off and started their own forestry research and development organizations in areas such as in biotechnology and management information systems. Despite the shifts in land ownership, in 2008, Sustainable Forestry Initiative (SFI) certified companies spent or contributed $89 million to forest

Table 60-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N, R, S	L, R, I, G			
Informational/educational[b]	N, S		E, T, R, A	E, T, R, A	T, R
Discretionary/voluntary[c]					
Fiscal/economic[d]					
Market based[e]	R, N, L		C		M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

research, which was slightly more than the amount reported by large forest products firms as of 2001. Many environmental NGOs also perform research and analysis efforts that contribute scientific knowledge about to ecological, social, and economic components of forest resources.

Indicator 7.61—Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services and development of methodologies to measure and integrate environmental and social costs and benefits into markets and public policies, and to reflect forest-related resource depletion or replenishment in national accounting systems

What is the indicator and why is it important?

This indicator assesses the ability to fully account for the costs and benefits of public and private decisions on forest resources. Although information on traditional economic measures of forest market values is usually available, information on social and environmental values is incomplete. Lack of such information in national accounting frameworks can result in poor understanding of the relative value of all forest goods and services, including nonmarket and market values. Similarly, this lack of information could lead to poor allocation of forest resources. Better national accounting practices can also help identify areas where public intervention may improve market allocations.

What does the indicator show?

No specifically required mechanisms exist to develop and incorporate environmental and social costs and benefits into national accounting systems in the United States and its forest resources at this time. Many means exist, however, by which public policies consider environmental effects related to Federal and State projects, and at times private land actions. These include the process-based National Environmental Policy Act, which requires analysis of the impacts of major Federal actions on the environment.

The Endangered Species Act prescribes specific measures to protect threatened and endangered species and uses rigorous means to list such species. The National Forest Management Act Federal regulations include specific directions to provide for ecosystem diversity through a combination of process requirements and prescriptive guidance.

Research and planning are used as part of informational and educational policy mechanisms to implement these environmental and social components of national forest planning actions. Various incentives, subsidies, and taxes also are provided for planning by States, and the protection of endangered, threatened, or rare species and ecosystems. These include specific Federal or State programs and private market actions in forest certification, wetlands banking, and cap-and-trade systems for endangered species or carbon storage. These and other ecosystem services are becoming a much greater focus of both public and private forest management.

What has changed since 2003?

National efforts toward environmental accounting for a broad range of goods and services, including forests, have been considered but not adopted, to date. Most forest products firms and organizations have also now adopted official sustainability policies and are championing corporate social responsibility (CSR) actions such as forest certification, ISO 14001 certification, or CSR policies and statements to burnish their positive environmental image and gain market recognition.

Table 61-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N	L, R	L, R		
Informational/educational[b]	N, S		R, A		
Discretionary/voluntary[c]					
Fiscal/economic[d]	N, S	I, S, T			
Market based[e]	N, L				C, W, T, M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.62. Capacity to conduct and apply research and development aimed at improving forest management and devlivery of forest goods and services and new technologies and the capacity to assess the socioeconomic consequences associated with the introduction of new technologies

What is the indicator and why is it important?

Indicator 7.62 is a measure of the capacity to assess the effects of new technologies in a broadly defined forest sector on the socioeconomic structure in which the technologies are applied (e.g., employment, industrial output, valued added, or productivity in the forest sector). New technology drives economic efficiency but has potential social and environmental consequences that should also be considered.

What does the indicator show?

Development of new technologies for sustainable forest management is largely a research and planning exercise, but is not mandatory or prescriptive in most cases. Federal research was classed as prescriptive earlier, so it is included here for consistency. But the brunt of technology development and assessment is derived from informational, educational, fiscal, or economic policy mechanisms.

Private enterprise interests drive much of the implementation of new technologies based on the research performed, as described in Indicator 7.60. Implementation occurs through voluntary adoption of promising technologies, supported by a variety of government incentives, subsidies, and taxes. Most of this technology adoption is market driven, based on public research that is disseminated through extension, education, scientific publications, conferences, and technical meetings.

What has changed since 2003?

Little direct evaluation of the socioeconomic consequences of the introduction of new technologies exists, although some socioeconomic studies and rural development analyses include this as a component of their analyses. No notable changes have occurred since 2003.

Table 62-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]	N	L			
Informational/educational[b]	N, S		R, A		R, A
Discretionary/voluntary[c]	N				S
Fiscal/economic[d]	N				I, S, T
Market based[e]	N				M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.63. Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services and enhancement of the ability to predict impacts of human intervention on forests

What is the indicator and why is it important?

This indicator is a measure of the capacity to predict how humans affect forests using a quantifiable, aggregate scale. This understanding will help conservation and sustainable management of forest ecosystems.

What does the indicator show?

The ability of the United States to predict the effects of human intervention on forests could be construed to mean the assessment of the effects of research, development, and forest management on forest extent, composition, functions, and values. This subject is broad.

Analysis of the effects of human intervention on forests, at a stand level or perhaps a landscape level, occurs routinely for forest management actions and for research and demonstration. These assessments are occasionally accumulated into an integrated database for monitoring or analysis of trends and for regional policy deliberations and decisionmaking.

Assessments such as the Pacific Northwest Forest Plan, the Northern Forest Lands Assessment, or the Southern Forest Resource Assessment make integrated analyses that occur periodically. The national Renewable Resources Planning Act assessments also contain estimates of the effects of human intervention on forests in general, although not couched in the context of this indicator specifically.

Most of these analyses of the effects of human intervention on forests, in response to normal forest management activities, occur as informational and educational policy mechanisms, through research, professional education, and planning. The private sector is becoming more involved in these analyses, at least in terms of risk analysis and for long range planning.

What has changed since 2003?

The U.S. forest sector has had periodic, comprehensive forest assessments at the regional and national levels. These assessments are apt to continue, in accordance with national laws and mandates (such as the RPA and MP C&I reporting processes), and in the course of periodic regional initiatives (such as the Southern Futures Study). These ongoing and periodic efforts involve incremental improvements in forest sector modeling techniques and public participation processes. Economic, ecological, and social models have become more powerful and pervasive, and stakeholder consultation has become the norm in large scale forest planning and monitoring work.

Table 63-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]					
Informational/educational[b]	N, S	E, R, A	E, R, A		
Discretionary/voluntary[c]					S
Fiscal/economic[d]					
Market based[e]					M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Indicator 7.64. Capacity to conduct and apply research and development aimed at improving forest management and delivery of forest goods and services and the ability to predict impacts on forests of possible climate change

What is the indicator and why is it important?

Climate change may affect forest distribution, extent, pathogens, and productivity. Capacity is needed to quantify the effects of climate change on forest productivity, plant and animal species range shifts, carbon sequestration, water yield, forest health, and changes in stand structure—as is the ability to integrate effects across atmospheric, ecological, and economic systems. Improved understanding of climate change effects will increase the capability to make better informed and earlier climate change mitigating actions, thus, improving the likelihood that forests will be managed on a sustainable basis.

What does the indicator show?

In addition to the moderate research on assessing the effects of traditional forest management practices on forest health, the United States is now devoting a considerable amount of scientific resources to analyze the effects of global climate change on forests, at an aggregate national and regional scale. The analysis uses likely climate change scenarios to predict the biological effects on forest distribution and growth and on pathogens, economic conditions, and possible policy responses. The analysis also uses several components of the MP C&I.

Most of these analyses of the effects of human intervention on forests in response to climate change or normal forest management activities occur as informational and educational policy mechanisms, through research, professional education, and planning. The analysis explores both the opportunities for forests to mitigate climate change through management actions to increase carbon storage, and management techniques that forests might need to respond to the impacts of climate change.

The private sector is becoming actively involved in these analyses in terms of risk analysis for management impacts, for opportunities to develop income streams through carbon storage, and for long range planning. Insurance firms are becoming involved in quantitatively estimating climate change impacts, as are agricultural and forest production firms, such as equipment manufacturers and herbicide and pesticide manufacturers.

What has changed since 2003?

Research about the ability of forests to adapt to climate change and to contribute to amelioration of climate change has occurred for nearly two decades. An emerging consensus among experts is that climate change is certain, that the loss of forests contributes to the severity of climate change effects, and that sustainable forest management can help reduce these effects by reducing forest loss and fostering resilient forest ecosystems while storing additional carbon. This premise was explicitly recognized in the 2007 Framework Convention on Climate Change, in Bali, Indonesia. The contribution of Reducing Emissions from Deforestation and Forest Degradation (REDD) explicitly identified a role for forestry policy in developing, and developed countries. These international accords will call for the scientific improvements that are needed to achieve the goals of REDD and afforestation, through improved scientific methods, better forest management choices, and more effective extension and implementation of techniques.

Table 64-1. Policy and Governance Classification.

Mechanism	Scale: National (N), Regional (R), State (S), Local (L)	Approach			
		Prescriptive	Process or Systems Based	Performance or Outcome Based	Private Enterprise
Nondiscretionary/mandatory[a]					
Informational/educational[b]	N, R, S		R, E		
Discretionary/voluntary[c]					
Fiscal/economic[d]					S
Market based[e]					M

[a] Laws (L), Regulations or Rules (R), International Agreements (I), Government Ownership or Production (G).
[b] Education (E), Technical Assistance (T), Research (R), Protection (P), Analysis and Planning (A).
[c] Best Management Practices (B), Self-regulation (S).
[d] Incentives (I), Subsidies (S), Taxes (T), Payments for Environmental Service (P).
[e] Free enterprise, private market allocation of forest resources (M), or market based instruments and payments, including forest certification (C) wetland banks (W), cap-and-trade (T), conservation easement or transfer of development rights (E).

Appendixes

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Glossary

Note: Source references, in brackets, are located at the end of the glossary.

abiotic *[12]*
Pertaining to the nonliving parts of an ecosystem, such as soil particles, bedrock, air, and water.

age-class *[11]*
A category into which the average age or age range of trees or other vegetation is divided for classification or use. Age-class is usually used in reference to even-aged stands of trees. It represents the dominant age of the main body of trees in a stand. In some mixed-aged stands, age-class can be used to describe the age of the dominant/codominant cohort of canopy trees.

air pollutants *[16]*
Gases, particles, or aerosols generated from management or combustion activities (industry, transportation, agriculture, management, etc.) that are released into the atmosphere, transported, and deposited in human and natural ecosystems. Air pollutants may be absorbed by forest ecosystems without effects (sink) or exceed the absorption capacity and have a deleterious effect on processes or components.

best management practice(s) (BMP) *[12]*
A practice or usually a combination of practices that are determined by a state or designated planning agency to be the most effective and practicable means (including technological, economic, and institutional considerations) of controlling point and nonpoint source pollution at levels compatible with environmental goals.

biological diversity *[1]*
The variability among living organisms from all sources, including inter alia, terrestrial, marine, and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems.

biomass (woody) *[17]*
The mass of the woody parts (wood, bark, branches, twigs, stumps, and roots) of trees (alive and dead) and shrubs and bushes, measured to a specified minimum diameter at breast height (d.b.h.). Includes above-stump woody biomass, stumps, and roots. Excludes foliage.

biotic *[12]*
Pertaining to living organisms and their ecological and physiological relations.

broadleaf (synonym: hardwood or deciduous species) *[11]*
A dicotyledonous tree, usually broad-leaved and deciduous.

carbon absorption *[6]*
The incorporation of the element carbon from the atmosphere into plant tissue.

carbon budget *[6]*
The inventory of the element carbon in carbon pools and the balance of exchange between the pools in the area of study.

carbon cycle *[15]*
The sequence of transformations whereby carbon dioxide is fixed as carbon or carbon compounds in living organisms by photosynthesis or chemosynthesis, liberated by respiration and/or death and decomposition of the fixing organism, used by heterotrophic species, and ultimately returned to its original state to be used again.

carbon emission *[6]*
The emanation of the element carbon from organic matter into the atmosphere.

carbon flux *[24]*
The transfer (net flow) of carbon from one carbon pool (stock) to another. For example, for the atmosphere, common fluxes include carbon removed by plant growth and dissolved into the ocean and carbon added by mineralization, plant respiration, fossil-fuel burning, and volcanic activity.

carbon pool (or stock) *[7]*
The absolute quantity of carbon held within a pool at a specific time. Examples of carbon pools are aboveground forest biomass, soil, wood products, and the atmosphere.

climate change *[3]*
The actual or theoretical changes in global climate systems occurring in response to physical or chemical feedback, resulting from human or naturally induced changes in planetary terrestrial, atmospheric, and aquatic ecosystems.

conifer (synonym: softwood, evergreen, or needleleaf species) *[11]*
A coniferous tree, usually evergreen, having needles or scale-like leaves.

criterion *[11]*
A category of conditions or processes by which sustainable forest management may be assessed. A criterion is characterized by a set of related indicators that are monitored periodically to assess change.

cultural value *[22]*
See social or cultural needs and values.

damage to forest *[17]*
Disturbance to the forest that may be caused by biotic or abiotic agents, resulting in death or a significant loss of vitality, productivity, or value of trees and other components of the forest ecosystem.

diminished biological components *[11]*
A reduction in the diversity of biological species. An ecosystem is considered to have both biotic and abiotic elements. Many species of microflora or insects are important to soil building, plant reproduction, or nutrient cycling. The biotic elements are dynamic in occurrence and will change in response to natural vegetation succession or artificially induced changes. The concept of diminished biological components reflects reductions or shifts in biological processes in a given forest relative to what might be expected, based on an undisturbed, similar reference site.

direct employment *[11]*
The number of jobs created by public and private firms in the process of producing a good or service. In the process of producing the good or service, however, the primary firm also generates secondary economic activity in other sectors of the economy. The jobs created by this secondary economic activity are referred to as indirect employment.

ecological processes *[16]*
Natural activities fundamental to the functioning of a healthy and sustainable ecosystem, usually involving the transfer of energy and substances from one medium or trophic level to another.

ecosystem *[11]*
A dynamic complex of living organisms (plant, animal, fungal, and micro-organism communities) and the associated nonliving environment with which they interact.

ecosystem diversity *[11]*
Describes the variety of different ecosystems found in a region. A categorization of the combination of animals, plants, and micro-organisms, and the physical environment with which they are associated is the basis for recognizing ecosystems.

ecosystem services *[25]*
The conditions and processes through which natural ecosystems, and the species, which make them up, sustain and fulfill human life. They maintain biodiversity and the production of ecosystem goods, such as seafood, forage, timber, biomass fuels, natural fiber, and many pharmaceuticals, industrial products, and their precursors. In addition to the production of goods, ecosystem services are the actual life-support functions, such as cleansing, recycling, and renewal, and they confer many intangible aesthetic and cultural benefits as well.

endangered species *[8]*
A noncritically endangered taxon that is facing a high risk of extinction in the wild in the near future, as defined by any of the criteria A to E of IUCN (1998).

erosion (soil) *[11]*
The movement of soil materials from one place to another. The movement of soil due to natural processes should be distinguished from that related to forest harvesting, road construction, or other human alterations.

ex situ *[12]*
Off the site; away from the natural habitat.

exotic species (synonym: nonindigenous species) *[11]*
Any species growing or living outside its natural range of occurrence. Normally this refers to species purposely or accidentally introduced into countries or regions where they do not historically occur.

extinct species *[8]*
A species for which there is no reasonable doubt that the last individual has died or when exhaustive surveys in known or expected habitat throughout its historic range have failed to record an individual.

forest available for timber production *[14]*
Forest land that is producing or is capable of producing industrial wood and is not withdrawn from timber utilization by statute, administrative regulation, or formal conservation reserve purposes. Includes forest with conditions suitable for timber production even if so situated as to not be immediately accessible for logging.

forest ecosystem *[2]*
A dynamic complex of plant, animal, and micro-organism communities, and their abiotic environment interacting as a functional unit, where the presence of trees is essential. Humans, with their cultural, economic, and environmental needs are an integral part of many forest ecosystems.

forest goods
Things from the forest that are useful and beneficial, and that have intrinsic value or economic utility. Includes all flora and fauna, minerals, and water resources occurring or originating in the forest.

forest land *[4]*
Land with at least 10 percent tree crown cover (or equivalent stocking) and more than 0.5 ha (1 ac) in area, including land that formerly had such tree cover and that will be naturally or artificially regenerated. The trees should generally be able to reach a minimum height of 5 m (16.5 ft) at maturity in situ. May consist either of closed forest formations in which trees of various stories and undergrowth cover a high proportion of the ground; or of open forest formations with a continuous vegetation cover in which tree crown cover exceeds the minimum percent. Young natural stands and all plantations established for forestry purposes, which have yet to reach the minimum crown density or tree height, are included under forest, as are areas normally forming part of the forest area that is temporarily unstocked as a result of human intervention or natural causes, but which are expected to revert to forest.

forest management plan (or equivalent) *[11]*
A written scheme of forest management, aiming at defined management goals, which is periodically revised. These include—

forest management plans
Information (in the form of text, maps, tables, and graphs) collected during (periodic) forest inventories at operational forest units level (stands, compartments), and operations planned for individual stands or compartments to reach the management goals.

equivalents
Information collected on forest area, at forest management or aggregated forest management unit level (forest blocks, farms, enterprises, watersheds, municipalities, or wider units), and strategies/management activities planned to reach the management or development goals.

forest soil *[9]*
Soil with characteristics resulting from, or emphasized by, tree cover. (See soil.)

forest type *[11]*
A category of forest defined by its vegetation, particularly composition, and/or locality, as categorized by each country in a system suitable to its situation. The broadest general groups are—

- Broad-leaved (hardwoods).
- Coniferous (softwoods).
- Mixed broad-leaved and coniferous.

forest-associated species (flora and fauna) *[23]*
A species with a measureable dependence on a forest ecosystem(s) for any aspect of its life history, including indirect dependence (e.g., consuming forest-based or derived resources).

fragmentation *[11]*
Describes one aspect of habitat capacity. Refers generally to the reduction in size of forest patches with coincident decreases in forest connectivity and increases in patch isolation and amount of forest edge. The fragmentation of a forest into small pieces may disrupt ecological processes and reduce the availability of habitat.

genetic diversity *[11]*
Describes the variation of genetic characteristics found within a species and among different species.

goods and services *[12]*
The various outputs and benefits, including onsite uses, produced from forest and rangeland resources.

gross domestic product (GDP) *[19]*
A measure of country output composed of the market value of the goods and services produced by labor and property located in the country. Because the labor and property are located in the country, the suppliers (that is workers and, for property, the owners) may be either country residents or residents of the rest of the world. Gross product, or gross product originating (GPO), by industry is the contribution of each private industry and of government to the nation's output, or gross domestic product (GDP). An industry's GPO, often referred to as its "value added," is equal to its gross output (sales or receipts and other operating income, commodity taxes, and inventory change) minus its intermediate inputs (consumption of goods and services purchased from other industries or imported). The industrial origin of value added is determined by the International Standard Industrial Classification (ISIC), rev. 2.

growing stock *[4]*
The living tree component of the standing volume on forest land consisting of the central stem volume of trees of at least 12.5 cm (5 in) d.b.h. measured from 0.3 m (1 ft) above the ground to a top diameter of 10 cm (4 in). Volume is net underbark.

growth, net annual (synonym: net annual increment) *[4]*
Average annual volume over a given reference period of gross increment minus natural losses of all trees of at least 12.5 cm (5 in) d.b.h.

habitat *[3]*
The natural environment of a living organism, primarily determined by vegetation, climate, soils, geology, and topography.

in situ *[12]*
On site; within the natural habitat.

indicator *[11]*
A measure (measurement) of an aspect of a criterion. A quantitative or qualitative variable that can be measured or described and that, when observed periodically, demonstrates trends.

indigenous people *[11]*
People descended from the first inhabitants of a nation or subnational region.

indirect employment *[11]*
The result of two types of economic transactions. First, jobs are created in secondary firms that provide materials, supplies, goods, and services to the primary firm. Second, employees of primary firms spend their wages and salaries in the local economy, which generates activities in the local retail and service sectors.

IUCN classification system *[8]*
The World Conservation Union (formerly the International Union of Conservation Networks) protected area classifications (IUCN categories):

> *Category I:* An area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring or a large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
>
> *Category II:* A natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations; (b) exclude exploitation or occupation inimical to the purposes of designation of the area; and (c) provide a foundation for spiritual, educational, recreational, and visitor opportunities, all of which must be environmentally and culturally comparable.
>
> *Category III:* An area of land and/or sea containing one or more specific natural or natural/cultural features which are of outstanding or unique value because of their inherent rarity, representative or esthetic qualities, or cultural significance.
>
> *Category IV:* An area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
>
> *Category V:* An area of land with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant esthetic, ecological, and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance, and evolution of such an area.
>
> *Category VI:* An area of land and/or sea containing predominantly unmodified natural systems, managed to ensure long-term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

land area *[20]*
An area of dry land and land temporarily or partly covered by water, such as marshes, swamps, and river food plains; streams, sloughs, estuaries, and canals less than 60 m (200 ft) wide; and lakes, reservoirs, and ponds less than 1.8 ha (4.5 ac) in area.

long term *[21]*
Occurring over or involving a relatively long period of time. In natural resources, generally periods of 50 years or more.

merchantable *[11]*
Trees of a size, quality, and condition suitable for marketing under given economic conditions, even if so situated as to not be immediately accessible for utilization.

monitoring *[11]*
The periodic and systematic measurement and assessment of change of an indicator.

mortality, annual *[14]*
The average annual volume of sound wood in trees that dies from natural causes during a specified year or on average during the period between inventories.

native species (synonyms: indigenous species, autochthonous species) *[3]*
Usually, a species known to have existed on a site before the influence of humans. It depends on the temporal and spatial context of analysis, since long-established exotic species are often considered to be native by default.

net growth *[14]*
The average annual net increase in the volume of trees during the period between inventories. Components include the volume increment of trees at the beginning of the reference period surviving to its end, plus the net volume of trees reaching the minimum size class during the period, minus the volume of trees that died during the period and minus the volume of trees that became cull.

new and improved technologies
Changes to technology that might improve the efficiency and/or effectiveness of management actions. The definition is deliberately broad to allow for changes relating to industrial methods and values as well as to nonwood and nonextractive activities in the tourism, recreation, and indigenous food sectors.

nonconsumptive forest use *[11]*
Forest use that does not lead to the physical extraction of products from the forests. Such use might include recreation, photography, birdwatching, education, and contemplation or meditation.

nonmarket valuation *[13]*
Valuation of goods and services not allocated through traditional markets.

nonmerchantable *[11]*
A species that has no known commercial uses for wood products. Merchantability is usually judged according to the suitability of a species for pulp, paper, lumber, or specialty wood products. Both native and exotic tree species can be considered merchantable tree species.

nonwood forest products (synonym: nonwood products) *[4]*
Products for human consumption: food, beverages, medicinal plants, and extracts (e.g., fruits, berries, nuts, honey, game meats, mushrooms). Fodder and forage (grazing, range). Other nonwood products (e.g., cork, resin, tannins, industrial extracts, wool and skins, hunting trophies, Christmas trees, decorative foliage, mosses and ferns, essential and cosmetic oils).

persistent toxic substance
A relatively nondegrading pollutant that after discharge becomes a long-term component of soils, aquatic systems, and other materials. Upon exposure, ingestion, inhalation, or assimilation into any organism, the substance can cause death or disease, mutations, deformities, or malfunctions in such organisms or their offspring.

plantation *[14]*
Forest stands consisting almost exclusively of planted trees of native or exotic species, and managed to generally maintain this composition at maturity. Management practices may include extensive site preparation before planting and suppression of competing vegetation. Forests that fall outside this classification are not necessarily natural forests.

population *[4]*
1. The number of organisms of the same species inhabiting the same area that potentially interbreed and share a common gene pool.
2. The total number of organisms over a large cluster of areas, such as a physiographic region or a nation.

productive capacity *[16]*
A classification of forest land in terms of potential annual cubic-measured volume growth of trees per unit area at culmination of mean annual increment in fully stocked forest stands.

protected area *[1]*
A geographically defined area that is designated or regulated and managed to achieve specific conservation objectives such as—
1. Strict nature reserves and wilderness areas.
2. National parks.
3. Natural monuments.
4. Habitat and species management areas.
5. Protected landscape and seascape.
6. Managed resource areas.

(See IUCN classification system.)

protective function *[16]*
An attribute of a policy or management decision that serves to preserve the essential components or processes of ecosystems, or specific components of an ecosystem, to maintain a desired quality and quantity of a resource commodity.

rare species *[5]*
A species regarded as having low abundance and/or small range.

recycling *[13]*
Wood fiber or other wood components in any form that are processed after initial use to regain material for human use.

reference condition (synonym: baseline condition) *[26]*
Any datum against which change is measured. It might be a "current baseline," in which case it represents observable, present-day conditions. It might also be a "future baseline," which is a projected future set of conditions excluding the driving factor of interest. Alternative interpretations of the reference conditions can give rise to multiple baselines.

removals, annual *[14]*
The net volume of trees, live or dead, of a specified minimum diameter (generally the same as for growing stock) removed from the forest during a specified year, or average for a reference period, by harvesting or cultural operation such as thinning or stand improvement, or by land clearing. Includes the volume of trees or parts of trees that are part of a harvest operation but are not removed from the forest.

representative species *[11]*
Species with habitat dependencies typical of a group of similar species and which are likely to respond to changes in availability of those habitats or resources. Examples include species dependent on mature forests, air quality sensitive species, wetland dependent species, hollow-tree dependent species, and thermo-regulation dependent species. Selected species are relatively easy to identify and monitor.

resilience *[27]*
The capacity of a system, community, or society potentially exposed to hazards to adapt, by resisting or changing in order to reach and maintain an acceptable level of functioning and structure.

sedimentation *[3]*
The deposition of eroded soil materials suspended in the water of creeks, lakes, or other water bodies. Sedimentation takes place when water velocity falls below a point at which suspended particles can be carried.

social or cultural needs and values *[22]*
A wide range of benefits from forests and other forms of nature perceived as required (needed) by, or of worth (of value) to, a society or a cultural segment of society to sustain lifestyles, tradition, history, health, and community.

soil *[15]*
The unconsolidated mineral and organic material on the immediate surface of the earth that serves as a natural medium for the growth of land plants.

soil chemical properties *[13]*
The elemental and structural composition of the soil, modified by climate, weather, plants, soil insects, and microbes. They directly affect cycling of nutrients and toxic compounds, and are the basis for a healthy and sustainable forest ecosystem.

soil degradation *[28]*
Negative process often accelerated by human activities (improper soil use and cultivation practices, building areas) that leads to deterioration of soil properties and functions or destruction of soil as a whole (e.g., compaction, erosion, salinization, and acidification).

soil erosion *[11]*
The movement of soil materials from one place to another. The movement of soil due to natural processes should be distinguished from that related to forest harvesting, road construction, or other human alterations. Note: Significant erosion needs to be defined by each country and with respect to variation between different landscapes and soils.

soil organic matter (SOM) *[15]*
The organic fraction of the soil that includes plant and animal residues at various stages of decomposition, cells and tissues of soil organisms, and substances synthesized by the soil population; commonly determined as the amount of organic material in a soil sample passed through a 2-mm sieve.

small portion (regarding species range) *[11]*
Dependent on the initial (original or some level agreed as baseline) distribution of the species. Species with very limited natural ranges (which suggests they are a relict population or have very specific habitat requirements) cannot tolerate the percentage reduction in habitat that a widely distributed species can. Small might, therefore, be defined for relict populations as the majority of existing range or, for species with large populations and wide distribution, a lower percentage of the historical population distribution.

species at risk *[18]*
Federally listed endangered, threatened, candidate, and proposed taxon and other taxon for which loss of viability, including reduction in distribution or abundance, where survival is a concern.

species diversity *[11]*
The number and variety of species in a given area.

spiritual needs and values *[22]*
Relationships perceived as required (needed) or of worth for sustaining feelings of respect, reverence, connectivity, and stewardship with forests and other forms of nature.

stream flow *[16]*

The quantity of water in a watershed based on precipitation quantity and the ability of the watershed to store and slowly release water. Typically characterized by seasonal periods of high or low water flow. Changes in high or low flow patterns are indicative of changes in precipitation patterns and changes in the integrity of watersheds that affect its ability to absorb and regulate water flow patterns.

stream timing *[16]*

The seasonal patterns of high and low water flows based on precipitation patterns. Changes in timing of stream flows are indicative of changes in precipitation patterns or watershed integrity.

subsistence *[11]*

The harvesting or growing of products directly for personal or family livelihood. Subsistence needs generally include foodstuffs, fuel wood, clothing, and shelter. Subsistence goods can be considered any goods that are substitutes for a market good.

successional stage *[11]*

A characteristic of many ecosystems that experience a change in structure and/or species on a given site in relation to time since a major disturbance. Where they occur, seral stages include early successional vegetation through to later successional stages. In many cases, the successional stages reflect a shift from the dominance of shade-intolerant species to that of shade-tolerant species.

sustainable forest management

The stewardship and use of forests and forest lands in such a way, and at a rate, that maintains their biodiversity, productivity, regeneration capacity, and vitality, and forest's potential to fulfill, now and in the future, relevant ecological, economic, and social functions at local, national, and global levels, and not cause damage to other ecosystems.

The criteria and indicators are intended to provide a common understanding of what is meant by sustainable forest management. They provide a framework for describing, assessing, and evaluating a country's progress toward sustainability at the national level and include measures of—

1. Conservation of biological diversity.
2. Maintenance of productive capacity.
3. Maintenance of forest ecosystem health.
4. Conservation and maintenance of soil and water resources.
5. Maintenance of forest contribution to global carbon cycles.
6. Maintenance and enhancement of long-term multiple socioeconomic benefits to meet the needs of society.
7. Legal, institutional, and economic frameworks for forest conservation.

tenure *[12]*

The act of owning, using, and controlling land under certain terms and conditions.

threatened species *[3]*

Plant or animal species likely to become endangered throughout all or a significant portion of their range within the foreseeable future.

value added *[19]*

See gross domestic product.

vulnerable species *[8]*

A taxon that because it is very rare and distributed only locally throughout its range, or because it has a restricted range (even if abundant at some locations) is considered to be facing a high risk of extinction in the wild.

wood consumption *[13]*

The amount of roundwood provided from domestic sources and other countries needed to make wood and paper products for domestic consumption.

wood products *[14]*

Logs, bolts, and other round timber generated from harvesting trees for industrial or consumer use. Includes wood chips generated from round timber for industrial use.

wood supply *[13]*

The amount of roundwood provided from domestic sources to meet domestic consumption needs.

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