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# 7 Criterion

## Legal, Institutional, and Economic Framework for Forest Conservation and Sustainable Management

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

### Societal Trends Affecting Forest Conservation and Sustainable Management

Forest conservation and sustainable management are affected by dynamic environmental, social, and economic conditions and changing values.

- The rapid pace of social, demographic, and technological change combined with government budget cutting, restructuring, and personnel reductions, however, stresses existing public institutions in the Northern United States and across the country. Some key external considerations are population increases; increasing cultural diversity; rapid changes in communication technology; an environment in which capital, products, and information flow more quickly and freely across State, regional, national, and international borders; and evolving public attitudes toward management and investment in forest resources. These changes have made monitoring human-natural resource interactions more complex. There is still work to be done, especially in the arena of social and economic indicators.

### Landownership in the Northern United States

- The majority of forest land in the Northern United States, approximately 130 million acres (78 percent), was privately owned according to a 1994 estimate, reflecting an increase of 16 million acres since 1978 (figure 35, Birch 1996).

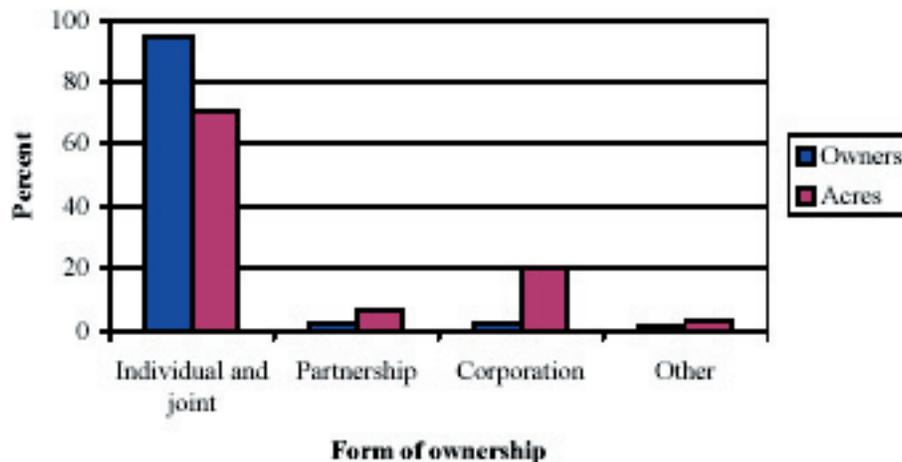


Figure 35. **Distribution of private ownerships in the Northern United States, 1994.** Individuals own the bulk of private forest land in the Northern United States (Birch 1996).

- Privately owned forest land contributes to the economy while providing recreation, forest products, biological diversity, wildlife habitat, and clean water. It is in the public's best interest for private property owners to have a sound stewardship ethic and practice long-term forest management.
- There were approximately 75 million acres of publicly owned land in the Northern United States in 1999 (Carpenter 1999), about half of which is forested (Birch 1996). Public lands



land. Recreation and aesthetic enjoyment is the primary reason for 29 percent of owners. Only 1 percent say their land is owned or managed primarily for timber production, but these owners control 19 percent of the private forest land (Birch 1996). Nationwide, nonindustrial private forest lands are producing half of the country’s domestic timber supply (Sampson and DeCoster 1997).

- Private landownership patterns are shifting. The number of private landowners, including the number of retired owners, is increasing, and average land tenure and the number of owners tied to the land for income are decreasing (Birch 1996).
- A trend that may have implications for forest sustainability is an increase in forest land ownership by institutional investors such as pension funds, insurance companies, banks, endowments, and foundations (Binkley and others 1996). These organizations often have the capital to invest in and manage forest land, and the ability to retain capital over the decades it takes to realize profit from forestry investments if they chose to do so.

### Laws, Regulations, and Guidelines

The legal framework is set through actions of the legislative, executive, and judicial branches of government.

- An extensive legal framework supports the goals of sustainability in the United States and the Northern United States. The processes and procedures developed to implement the numerous laws and regulations, however, are sometimes unduly complex and counterproductive.
- Federal authority—Many Federal laws affect forestry. Applicable national laws and regulations may be associated with the protection of public benefits from forests and the prevention of damage to natural and cultural resources such as wetlands, water and air quality, wildlife, and threatened and endangered species, and historic sites. Tax, business, health, and safety laws and regulations also affect private forestry, forest-based industries, and community sustainability.
- State authority—Laws and regulations developed at the State level are more common today than in the past. Advocates for State regulation see it as more pragmatic than Federal or local regulation.

Table 15. **Counties, cities, and towns in the Northern United States with the authority to regulate land use and activities** (Ellefson and others 1995).

- Local authority—Counties, cities, and towns have authority to regulate land use and activities (table 15). Municipalities cannot usurp regulatory rights reserved by the State but can pass laws more restrictive than State law.

State	Counties	Municipalities	Townships
Delaware	1 of 3	—	—
Illinois	—	1,000 of 1,200	—
Maryland	20 of 23	—	—
Michigan	—	—	10 to 15 of 1,200
Minnesota	1 of 87	—	—
New Jersey	15 of 21	300 of 567	—
New York	—	70 of 900	—
Pennsylvania	—	13 of 420	—
Vermont	—	2 of 251	—
Wisconsin	2 of 72	3 to 4 of 1,500	—

## Criterion 7

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- The USDA Forest Service identified four national trends affecting property rights (USDA Forest Service 1997a):
  1. There is an increase in the regulatory, legislative, and judicial actions that affect property rights, either expanding or diminishing them.
  2. Changes in patterns of ownership and use are significant.
  3. Economic valuations are being extended to new types of natural resources (e.g., landowners lease land for hunting, States subsidize landowners to protect specific resources, collectors pay for permits to collect nontimber forest products).
  4. There is increasing autonomy for Native American tribes.
- Many Federal, State, and local laws are intended to conserve and protect special environmental, cultural, social, and/or scientific values. Federally designated special areas include Research Natural Areas, Wilderness Areas, Wild and Scenic Rivers, and American Heritage Rivers. A number of States have been leaders in the development of State systems of natural areas.
- Private industrial owners also have opportunities to conserve special areas and values. One of the primary principles of the American Forest and Paper Association's Sustainable Forestry Initiative is the management of forests and lands of special significance (e.g., biologically, geologically, or historically significant) in a manner that takes into account their unique qualities (AF&PA 1994).
- A variety of legal instruments exist to preserve specific forest conditions regardless of ownership, including conservation easements, placing lands in private and public land trusts, marketing of rights traditionally associated with property (e.g., development or pollution), debt-for-nature swaps, and other types of land trades (USDA Forest Service 1997a). These transactions are enacted on a willing buyer, willing seller basis.
- The USDA Forest Service's Forest Legacy Program was authorized to protect environmentally important forests from conversion to nonforest uses. From its initiation in 1992 to 2002, 130,000 acres were protected in the Northern United States. Protection is usually accomplished with conservation easements, but tracts can be purchased outright. States and other organizations contribute to a number of conservation easement programs that protect forested and other lands.
- Public laws, regulations, and policies governing the management of land for nonforest uses or other social benefits can have unintended consequences on the forest resource (e.g., land drainage for development and fire suppression for public safety).

### **Institutions That Support the Conservation and Sustainable Management of Forests**

Both government and nongovernment organizations bring institutional capabilities to bear in implementing laws, regulations, and guidelines on public and private lands. A variety of institutions exist to meet this goal, including forestry agencies, programs for private forest landowners, forest certification, associations, land trusts, institutional investors, and the forest industry.

- A variety of Federal programs exist that support State and community efforts to conserve or protect resources critical to public health, safety, or welfare (table 16).

Table 16. **Major Federal forest conservation programs.** Federal programs offer technical assistance at the landowner, community, State, and regional level.

Agency <sup>1</sup>	Program	Description
USFS	Forest Stewardship	Focuses on management of nonindustrial private forest land; encourages preparation of land management plans for multiple uses.
USFS	Forest Land Enhancement	Replaces the Stewardship Incentive and Forestry Incentives Programs in FY 2003. Focuses on management plan development and cost-share activities on nonindustrial private forest land
NRCS	Environmental Quality Incentives	Develops and implements management plans to protect and conserve soil, water, and related resources.
NRCS	Conservation Technical Assistance	Focuses on land management plans primarily for farm-forest owners.
NRCS	Conservation Reserve	Converts unsuitable cropland to permanent vegetative cover.
USFS	Forest Legacy	Protects forest lands threatened with conversion to nonforest uses by purchasing conservation easements or fee titles from willing private landowners.
NRCS	Wildlife Habitat Incentives	Offers financial incentives to develop fish and wildlife habitat on private lands.
USFWS	Partners for Fish and Wildlife	Offers technical assistance to restore and conserve wildlife habitat.
NRCS	Wetlands Reserve	Protects wetlands through easements and total coverage of wetland restoration costs.
NRCS USFS	Public Law–566 Small Watershed Incentives Program	Focuses on protecting water quality. Assists communities in developing watershed management plans on watersheds less than 250,000 acres.
USFS	Cooperative Forest Health Management	Provides technical expertise to detect, evaluate, and monitor forest health and to suppress or eradicate forest insects and disease.
USFS	Fire Management	Develops State programs to protect lives, property, and natural resources from uncontrolled wildfires.
USFS	Economic Action	Strengthens community economic conditions through programs such as Rural Development and Wood in Transportation.
NRCS USFS	Resource Conservation and Development	Promotes the conservation, development, and utilization of natural resources to improve economic conditions and enhance the quality of life in designated multicounty geographical areas.
USFS	Urban and Community Forestry	Offers technical assistance on urban tree health, protection, and maintenance, and promotes management of forest and related resources in populated areas.
USFS	State Forest Resource Planning	Promotes the development of comprehensive State forest resource plans for the long-term benefit of society and the natural resources people depend upon.

<sup>1</sup>NRCS = USDA Natural Resources Conservation Service  
 USFS = USDA Forest Service  
 USFWS = U.S. Fish and Wildlife Service

## Criterion 7

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- Federal and State agencies provide infrastructure for forestry technical assistance in the Northern United States. The USDA Forest Service provides service through its State and Private Forestry, Research, and National Forest branches. There are 17 national forests and grasslands in the Northern United States.
- Public institutions are responsible for developing and maintaining infrastructure on public lands. It is recognized that the maintenance of roads, trails, and watershed improvements is backlogged, and much attention needs to be focused in the near future to maintain the integrity of forest resources on public lands.
- In developed areas, community organizations and agencies are compiling inventories of restoration needs, including the restoration of wetlands, shorelines, floodplains, various vegetative communities, terrestrial and aquatic habitats, and reclamation of various brownfields (areas contaminated by toxic materials) and gravel pits.
- Industry infrastructure is a factor affecting the flow of goods and services from forest lands. The challenge in assessing industry infrastructure is determining the proper balance between manufacturing capacity and the ratio of forest growth to removals, and the appropriate balance between industry profitability and community stability. Key considerations in determining the efficiency of industry infrastructure include the degree of efficient use of raw materials, manufacturing by-products, and recycled materials, and the energy costs associated with the transportation of materials and products.
- In a recent review of public programs and options for private forestry, Sampson and DeCoster (1997) point out that Federal programs supporting private forestry are not keeping pace with the country's changing demographics. They recommend expanding service to rapidly developing communities and suggest more sophisticated marketing to target messages to particular audiences. More detailed information on forest landowners and the relationship between communities and the forest resource may be needed to effectively implement such a strategy; however, a fear of marketing by policy leaders was cited as the major impediment to adopting these changes.
- There were approximately 831 local and regional land trusts operating in the Northern United States in 1998, a 50 percent increase from 1988 (Land Trust Alliance 1998). Of existing trusts, roughly 46 percent identified forests as one target of their efforts; 12 percent identified timberland. The Nature Conservancy, the Trust for Public Land, the Conservation Fund, Ducks Unlimited, and the American Land Conservancy are among the well-known national trusts working to protect forest land.

### Forest Certification

Probably the newest emerging institutions are those associated with forest certification, a process to verify that wood products come from sustainably managed forests. Participation in forest certification programs is voluntary. Certification can be applied to land, forest management activities, or resource managers. Forest certification claims are verified on a first-party, second-party, or third-party basis.

- The Northern United States has the most third-party certification activity nationwide. As of February 1, 2000, approximately 5.1 million acres were certified in the Northern United

States, representing 91 percent of the national total. Pennsylvania had the largest certified acreage in the region (2.3 million acres), followed by Maine (1.0 million acres), New York (717,000 acres), Minnesota (585,000 acres), Wisconsin (252,000 acres), and Michigan (155,000 acres) (Hansen and Bratkovich 2000).

- Manufacturers and retailers may be certified based on their ability to track the chain of custody of products from sustainably managed lands to the market. Ninety-three companies and organizations (42 percent of national total) are certified for chain of custody maintenance in the Northern United States. Pennsylvania has the most with 15, followed by Maine (13), Vermont (11), and Wisconsin (10).
- There are five Forest Stewardship Council certified forest managers the Northern United States (Hansen and Bratkovich 2000).

### **Planning and Public Involvement**

Forest resource management plans identify resource and management needs and opportunities, and priorities for action. New plans are necessary when public expectations change and when new information invalidates previous assumptions. Planning can be strategic, tactical, or operational. Many strategic plans are developed for a particular branch or department of an organization; tactical plans can be developed by department, division, or program area, or for designated management units. Operations are dealt with at landscape and local scales, and on a project-by-project basis.

- Federal law requires national forests and grasslands to prepare and periodically revise their land and resource management plans.
- Each of the 20 Northern States has developed at least one comprehensive State forest resource plan under the Federal Cooperative Forestry Assistance Act of 1978. Many plans, though, need to be updated.
- The institutional framework providing for education and public participation includes Federal and State government agencies and services, environmental groups, nonprofit educational foundations, forest products consortia, professional consultants, tribal governments, and facilitation organizations.
- The present trend for forestry agencies is to invite the public to participate in all steps of the decisionmaking process, whether or not it is legally required. Steps include issue identification, assessment, planning, and developing policy and management alternatives.
- Institutional barriers to successful public involvement in public agency projects include conflicting laws, lack of funds to implement preferred solutions, professional resistance to nontraditional approaches, legal or administrative rules that constrain managers, and at times, a lack of staff experience in facilitating resolutions of conflicting values and objectives among stakeholders.

### **Human Resources**

- The importance of advanced analytical skills is increasing as the public pushes natural resource managers to better integrate environmental, social, and economic information.

## Criterion 7

- The USDA Forest Service employed just over 3,000 permanent workers in the Northern United States at the close of Federal Fiscal Year 2002.
- State forestry agencies in the 20 Northern United States and the District of Columbia employed a total of just over 3,140 permanent employees and 1,900 seasonal or temporary employees in 1998 (NASF 2001). Their staff sizes are proportionate with the amount of forest land in each State and the complexity of issues and programs. Several State forestry agencies face the challenge of retaining experienced field foresters and managers due to State salary structures and caps. Many service foresters are lured to forest industry or private consultation practices, where the salary potential is often much greater.
- There are 984 county conservation districts in the Northern United States. Of the 755 districts responding to a 1998–1999 survey, 88 have a forester on staff and 23 employ forestry technicians (Kershner 2000). However, 207 districts mentioned that other conservation district staff work on forestry issues.

### Professional Credentials

- Standards of professional performance are often set in licensing, registration, and certification programs. Eight States in the Northern United States administer these types of programs, as do some private organizations (table 17).

- Registration** is a procedure requiring a person to meet certain standards before being allowed on a list, usually compiled and administered by a government agency.
- Licensing** is a legal procedure that requires a person to meet certain standards as a prerequisite to granting permission to practice in their profession.
- Certification** is a voluntary procedure in which the certifying organization attests that a person has attained a certain level of competence. The Society of American Foresters and the Association of Consulting Foresters are examples of organizations that offer private forester programs.

Table 17. **Forester registration and licensing programs.** Eight States in the region have forester registration or licensing programs (Society of American Foresters 2001).

States	Program type	
	Voluntary registration	Licensing
Connecticut <sup>1</sup>		X
Maine		X
Maryland		X
Massachusetts		X
Michigan	X	
New Hampshire		X
New Jersey		X
West Virginia	X	

<sup>1</sup>Called mandatory certification in statute.

certification

### Extent to Which Economic Policies and Measures Support the Conservation and Sustainable Management of Forests

The economic framework is an important component in conservation and sustainable forest management efforts. Markets influence the flow of goods and services and the allocation of the various products that are produced from a given forest area. Economic policies influence the velocity of product flow and whether that flow comes from public or private forest lands.

However, traditional economic measures have difficulty capturing the unique diversity of production, its site-specific capacity characteristics, and the value of its nonmarket benefits.

- Calls for acquisition of more public land are sometimes matched by concerns over reduction in the municipal tax base, the loss of working forests, inadequate public funding, and the inability of the public sector to effectively manage more land with less staff and less resources.
- Private management decisions are often constrained by short-run considerations and market signals, while returns from forestry investments tend to be long term.
- Investment, taxation, and forest management policies and programs are established or modified to influence people's decisions and behavior concerning their land. They are intended to encourage or discourage actions and to offer incentives to meet private or public objectives. These mechanisms can alter choices and have economic implications to the individual owner and impacts on the broader public.

Reforestation tax credits can be applied against Federal income tax liability for expenses incurred for reforestation (Public Law 96-451).

- Federal agencies offer conservation programs to spur investment in the management and retention of forests. Many of these programs are geared to the reforestation, planning, and management of forest lands or to the conversion of marginal agricultural land to forest uses. Programs include the USDA Forest Service's Forest Stewardship and Forest Land Enhancement Programs, and the USDA Natural Resources Conservation Service's Conservation Reserve Program.
- Forestry program expenditures in 1998 in the Northern United States are estimated at \$273 million. An estimated 59 percent of forestry program funding support in the Northern United States is provided by the State, about 31 percent is from revenue, almost 7 percent is from the Federal government, and less than 4 percent is from other government sources (NASF 1998).
- Low-interest loans and grants are another investment mechanism that fosters sustainable forest use. The USDA Forest Service's Rural Development Program offers financial and technical assistance to help communities and small forest-based businesses develop and succeed. These public investments are intended to infuse capital to support start-up business development, encourage rural economic development and diversification, and help retain forest-based industry in rural communities.
- Trends in property, capital gains, and estate tax policies may be more important than income taxes for maintaining a forested land base (Birch 1996, Sampson and DeCoster 1997). When landowners reforest agricultural land it may become subject to higher property tax levels. Capital gains taxes can provide incentives to reforest land, but can hamper long-term management strategies. A landowner who holds forest land for profit is subject to capital gains taxation at harvest. Estate taxes may force heirs to sell land to developers or make unplanned harvests to pay the tax bill.

## Criterion 7

Some States have adopted use-value and other preferential assessments for forest use as well as agriculture. Property taxes are reduced to reflect the lower costs of community services absorbed by the land use and the benefits it returns to the municipality. For example, Pennsylvania's Farmland and Forest Land Assessment Act ("Clean and Green Act") offers lower taxes for land in productive open space.

### International Trade

The United States is the world's single largest international trader and "the U.S. economy is among the most open and transparent in the world" according to members of the World Trade Organization Trade Policy Review Body (World Trade Organization 2001, p. 1; table 18).

Table 18. **Free trade agreements and restrictions.** The United States generally supports free trade policies related to forest products, though there are some restrictions in place.

Free trade legislation	Description
<b>Agreements</b>	
General Agreement on Trade and Tariffs (GATT)	International agreement first negotiated in 1947. Since 1995, the updated GATT serves as the World Trade Organization's principal rule book for trade-in goods including forest products.
North American Free Trade Agreement (NAFTA)	The 1994 agreement to remove most barriers to trade and investment among the United States, Canada, and Mexico. Incorporates most provisions of the 1989 U.S.-Canadian Free Trade Agreement (FTA).
International Tropical Timber Agreement (ITTA)	International agreement among producers and consumers of tropical timber on trade and conservation issues. Has no price regulation or market intervention provisions. Created the International Tropical Timber Organization in 1983.
Free Trade Areas of the Americas (FTAA)	Negotiations began in 1994 to liberalize trade among 34 countries of the Western Hemisphere, including investment regimes and competition policies.
<b>Restrictions</b>	
Final rule of the USDA Animal and Plant Health Inspection Service	Details acceptable treatments and handling procedures for importing logs, lumber, and other manufactured wood articles in order to protect the U.S. domestic timber resource from pests. (Canada and Mexico are exempt.)
Forest Resources Conservation and Shortage Relief Act of 1990 (FRCSRA)	Prohibits export of unprocessed logs from federally owned lands west of the 100 <sup>th</sup> meridian in an effort to support forest-dependent communities (does not affect the Northern United States).
1996 U.S.-Canada Softwood Lumber Agreement	Agreement to cap tax-free Canadian exports to the United States at 14.7 billion board feet annually. Expired March 2001.

- Overall production and consumption of forest products has increased in the United States since 1965, and demand for wood products exceeds domestic production. Forest product imports increased from 1,604 million to 4,029 million cubic feet (roundwood equivalent) from 1965 to 1997 to make up the difference. The United States imports most types of forest products, including structural panels and lumber. Nearly 83 percent of log imports are from Canada (Howard 1999).

- U.S. exports have also increased during the same timeframe, from 544 million to 2,236 million cubic feet (roundwood equivalent). The majority of U.S. lumber exports go to Japan, Canada, and the European Union (Belgium-Luxembourg, Denmark, France, Germany, Greece, Ireland, Italy, the Netherlands, Portugal, Spain, Trieste, and the United Kingdom) (Howard 1999).
- United States exports of pulpwood, paper, paperboard, and converted paper products to the Free Trade Area of the Americas have grown steadily, amounting to \$6.9 billion in 1998 (Canada and Mexico accounted for \$5.3 billion of that total). Tariffs on paper products, however, are high (Smith 1999).
- A 1997 study of wood flows in New York, Vermont, New Hampshire, and Maine found that 22 percent of the roughly 14 million cords of wood harvested in the region crossed a State line or international boundary before it was used (The Irland Group 1999). The majority of products exported from these States were of high value (e.g., softwood logs), while imports were low-value products (e.g., pulpwood and biomass fuel).

### **Capacity to Measure and Monitor Changes in the Conservation and Sustainable Management of Forests**

- Within the United States, a national Roundtable on Sustainable Forests has been formed consisting of Federal, State, and private stakeholders to promote sustainable forest management. The roundtable places strategic focus on implementing the Montreal Process criteria and indicators (C&I) as a means of monitoring changes in the conservation and sustainable management of forests. A technical working group has been formed to develop a national set of protocols to implement C&I, establish a collaborative national arrangement for data collection and reporting of C&I, and help guide development of a national report on sustainable forest management by 2003 (Roundtable on Sustainable Forests 2002).
- The USDA Forest Service's Northeastern Area and the Northeastern Area Association of State Foresters determined that C&I can provide relatively complete, accurate, and unbiased information on forests, and they are committed to supplementing national C&I assessments at the regional level. The *Sustainability Assessment Highlights for the Northern United States* represents results from the Northeastern Area's first effort to use C&I. The assessment builds on information provided by the Forest Service's Forest Inventory and Analysis Program, Forest Health Monitoring Program, and other information readily available to the public. More work is needed to address data gaps and inconsistencies in measures used.
- The Northeastern Area and the Northeastern Area Association of State Foresters are working with the Northeastern Forest Resource Planners Association on measurement guidelines for 18 regional scale indicators that will be used in future sustainability assessment reports (USDA Forest Service 2002b).
- A survey of significant sustainability projects, including national efforts as well as regional, State, county, and municipal efforts within the Northern United States, yielded 54 projects, 9 of which draw directly from the Montreal Process criteria (USDA Forest Service 2002b).

## Criterion 7

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- Remote sensing products are increasingly used to inventory conditions and trends important to forest sustainability such as the extent, type, age, and health of forests. Computer-based geographic information systems allow for the analysis of more complex information with higher reliability, consistency, and accuracy than in the past. Changing technologies and inventory methodologies, however, affect the availability and accuracy of trend analyses.
- Public and private entities throughout the Northern United States conduct forest inventory and monitoring at a variety of scales. Examples at the Federal level include the USDA Forest Service's Forest Inventory and Analysis Program, Forest Health Monitoring Program Detection Surveys, and North American Maple Project.
- Data compatibility is an important issue for management units that share ecosystems, watersheds, or program implementation responsibilities. The USDA Forest Service in the Northern United States and the Northeastern Area Association of State Foresters are cooperating with national efforts to identify common measurement and reporting protocols that relate to sustainability. Many of these will provide for data compatibility at the regional and State level.

### **Capacity to Conduct and Apply Research and Development**

- The institutional infrastructure of Federal, State, and private research and educational facilities is well developed in the Northern United States. A variety of institutions conduct research beneficial for forest sustainability. The capacity of these organizations to conduct and apply research depends on the expertise, equipment, and facilities available. Equally important are the institutional arrangements and incentives that direct individual researchers to respond to society's needs.
- Two of seven USDA Forest Service research stations are located in the Northern United States—the North Central Research Station and the Northeastern Research Station. These stations administer about 40 project work units among 18 field offices as well as 22 experimental forests and watersheds (table 19).
- Historically, forest research includes watershed management, mined-land reclamation, wildlife habitat needs and management, forest genetics, forest silviculture, insect and disease detection and treatment, forest products, harvesting and utilization, economics and marketing, recreation, urban forestry, and forest inventory. More recent issues include acid deposition, global climate change, and international forestry. The majority of forest industry research, however, is directed to the development, processing, marketing, and use of forest products rather than basic scientific or management research (Ellefson and Ek 1996).
- The forest research community is looking for linkages and integrating principles among individual disciplines, such as systems-based approaches. Ecological classification and mapping is used in the Northern United States to frame research into ecological processes and functions.
- Research agencies in Federal and State government and in private industry have been affected by the widespread downsizing and restructuring common across the country in the

Table 19. **Experimental forests and watersheds.** The USDA Forest Service maintains 22 experiment forests and watersheds for long-term research into forest and watershed management throughout the Northern United States. The region is served by the Forest Service’s Northeastern and North Central Research Stations.

Location	Research Work Unit (RWU)	Research focus
<b>Northeastern Research Station</b>		
Bartlett, NH	Ecology and Management of Northern Forest Ecosystems	Long-term research and demonstration of sustainable silvicultural and management systems for northern hardwood forests
Fernow, WV	Sustainable Forest Ecosystems in the Central Appalachians	Long-term research and demonstration of sustainable management practices for central Appalachian hardwood forests; impacts of forest management and pollution on watersheds
Hubbard Brook, NH	Ecological Processes: a Basis for Managing Forests and Protecting Water Quality in New England	Part of the U.S. Long Term Ecological Research Network; long-term research on the interactions of forest management, ecosystem processes, and watersheds
Kane, PA	Understanding and Managing Forest Ecosystems of the Allegheny Plateau	Long-term research and demonstration of sustainable management practices for Allegheny and northern hardwood forests; impacts of white-tailed deer herbivory
Massabesic, ME	Ecology and Management of Northern Forest Ecosystems	Demonstration of sustainable forest management practices
Penobscot, ME	Ecology and Management of Northern Forest Ecosystems	Long-term research and demonstration of sustainable silvicultural and management systems for northern conifer forests
Silas Little, NJ	[Managed by Rutgers University]	
Vinton Furnace, OH	Quantitative Methods for Modeling Forest Ecosystems	Long-term research and demonstration of sustainable management practices for oak-hickory forests
<b>North Central Research Station</b>		
Argonne, WI	Ecology and Silviculture of the Northern Lakes States Forests	Management of second-growth northern hardwoods and balsam fir/aspens stands
Big Falls, MN	Ecology and Silviculture of the Northern Lakes States Forests	Management of black spruce swamp stands
Coulee, WI		Hydrology of forested and nonforested lands in the Driftless Area of southwestern Wisconsin
Cutoff Sioux, MN	Ecology and Silviculture of the Northern Lakes States Forests	Management of red pine/jack pine stands
Kaskaskia, IL	Ecology and Management of Central Hardwood Ecosystems	Management of upland oak-hickory forests
Kawishiwi, MN	Ecology and Management of Riparian and Aquatic Ecosystems	Management of upland spruce stands in Laurentian Shield country
Lower Peninsula, MI	Stress Effects on Tree-Insect-Natural Enemy Interactions	Management of white pine and red pine plantations, and oak and aspen stands
Marcell, MN	Ecology and Management of Riparian and Aquatic Ecosystems	Basic and applied research in upland/peatland watersheds
McCormick, MI	Principles of Landscape Ecology for Managing Temperate Ecosystems	Landscape ecology
Paoli, IN	Ecology and Management of Central Hardwood Ecosystems	White and northern red oak planting
Pike Bay, MN	Ecology and Silviculture of the Northern Lakes States Forests	Management of aspen and mixed hardwoods
Sinkin, MO	Ecology and Management of Central Hardwood Ecosystems	Silviculture and ecology of oak-hickory ecosystems, with an emphasis on shortleaf pine and oak reproduction
Udel, MI	Stress Effects on Tree-Insect-Natural Enemy Interactions	Watershed management on deep sands
Upper Peninsula (Dukes), MI	Principles of Landscape Ecology for Managing Temperate Ecosystems	Management of mature northern hardwoods

## Criterion 7

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last decade. For example, between 1985 and 1995, the total number of research scientists employed by the Forest Service declined nationally by 37 percent. The capacity to apply research results in forest management has been affected by similar staffing trends.

- Progress in forest ecology, landscape ecology, conservation biology, and genetics that is essential to understanding forest ecosystems is often dependent on long-term research.
- The National Science Foundation was instrumental in establishing a program on long-term ecological research in 1980. Seven out of 21 Long Term Ecological Research Program sites established across the country are located in the Northern United States, and 5 of these deal intensively with forested ecosystems (table 20). The Long Term Ecological Research Program research studies are carried out by a broad range of agencies, companies, and nonprofit organizations, and cover urban to rural and marine, aquatic, and terrestrial ecosystems.
- Research is needed to understand the tradeoffs inherent in environmental, social, and economic policies and the equitable distribution of costs for public benefits. An example application would be to evaluate public tax and zoning laws to identify what incentives and disincentives are in place to influence private forest landowner's decisions to develop or retain their land. Public benefits include water quality, air quality, biodiversity, and an aesthetic living environment.
- Several Forest Service research work units are examining methods to anticipate supply and demand for forest resources and to integrate environmental and social costs and benefits into public policies and landowner decisionmaking.
- Among all State and Federal agencies, the USDA Forest Service has the largest continuous research program aimed at recycling forest products. The Forest Service program is centered at the Forest Products Laboratory in Madison, Wisconsin. One of the greatest technical challenges to using recycled fiber in higher quality printing and writing papers is dealing with adhesive and plastic contaminants.
- There is national and international interest, yet uneven progress, in including environmental and social costs in national income accounts. Conventional economic accounting systems do not recognize the biophysical limits of what the environment can produce or what it can absorb in terms of disturbance or pollution. Likewise, conventional accounting systems tend to ignore or discount the value of future social benefits and costs.
- Technology has increased our ability to measure and model environmental changes. Advancements in remote sensing and geospatial modeling techniques have increased our predictive capabilities, although having the resources to conduct ground-truth investigations at an appropriate scale is often a critical limiting factor. Predictive modeling is also dependent on an increased understanding of the feedback mechanisms among ecological conditions, economic systems, and human behavior.
- Global change, including climate change, is a key national science initiative. The Executive Office of the President, through the National Science and Technology Council Committee on Environment and Natural Resources, developed the United States Global Change Research Program (USGCRP) in 1989 and formalized it in the Global Change

Table 20. **U.S. Long Term Ecological Research Sites.** Five of the seven U.S. Long Term Ecological Research Sites located within the Northern United States deal intensively with forested ecosystems. The sites represent terrestrial and aquatic ecosystems and urban to rural land use conditions (Source: U.S. Long Term Ecological Research Network).

<b>LTER and Location</b>	<b>Principal biome or main communities</b>	<b>Research topics</b>
Baltimore Ecosystem Study Baltimore, MD <sup>1</sup>	Eastern deciduous forest, suburban/agriculture fringe, urban parks, residential, and commercial patches, riparian and stream habitats	Patch dynamics of built, social, biological, and hydrological components of the Baltimore metropolitan area; feedbacks between social, economic, and ecological components of an urban ecosystem; effects on fluxes of nutrients, energy, and water in upland, stream, and coastal regions
Harvard Forest Petersham, MA <sup>2</sup>	<i>Eastern deciduous forest.</i> Hardwood-white pine-hemlock forest; spruce swamp forest; conifer plantations	Long-term climate change, disturbance history, and vegetation dynamics; community, population, and plant responses to human and natural disturbance; forest-atmosphere trace gas fluxes; organic matter and element cycling, fine root dynamics, and forest microbiology
Hubbard Brook West Thornton, NH <sup>3</sup>	<i>Eastern deciduous forest.</i> Northern hardwood forests, spruce-fir forests; streams and lakes	Vegetation structure and production; dynamics of detritus in terrestrial and aquatic systems; atmosphere-terrestrial-aquatic ecosystem linkages; heterotroph population dynamics; effects of human activities on ecosystems
Cedar Creek Minneapolis, MN <sup>4</sup>	<i>Eastern deciduous forest and tallgrass prairie.</i> Old fields; oak savanna and forest, conifer bogs; lakes; pine forest; wetlands	Successional dynamics; primary productivity and disturbance patterns; nutrient budgets and cycles; climatic variation and the wetland/upland boundary; plant-herbivore dynamics
North Temperate Lakes Boulder Lake and Madison, WI <sup>5</sup>	<i>Northern temperate lakes in urban, agricultural, and forested watersheds.</i> Lakes; ponds; streams; sphagnum-leatherleaf bogs; conifer swamps; mixed deciduous and coniferous forests	Physical, chemical, and biological limnology; hydrology and geochemistry; climate forcing; producer and consumer ecology; ecology of invasions; ecosystem variability; lakescape and landscape ecology

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Research Act of 1990. USGCRP research is organized to study global change; assess the consequences of such changes and the vulnerability of human and ecological systems to their potentially adverse impacts; develop the tools and capabilities to conduct integrated assessments; and synthesize and communicate this body of knowledge.

## Criterion 7

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- The USGCRP draws together the results of the regional and sectoral analyses on the potential consequences of climate variability and change for the United States. Sectoral analyses are national in scope and consider the potential consequences on health, water, forests, agriculture, and coastal areas. In addition, regional analyses are conducted in 20 geographic regions throughout the country, six of which are in the Northern United States: Appalachian, Eastern Midwest, Great Lakes, Metro East, Mid-Atlantic, and New England.
- The Northern Global Change Research program operated by the USDA Forest Service looks at the effects of climate change on forests. The program is investigating processes in forest ecosystems that are sensitive to physical and chemical changes in the atmosphere and the implications for forest management.