Criterion 1

Conservation of Biological Diversity

Criterion 1. Conservation of Biological Diversity

Biological diversity or **biodiversity** is the variety of life forms and processes that support them (The Keystone Center 1991). Conservation of biological diversity involves preserving the variety of species, the genetic variation within them, and the spectrum of communities and environments in which they occur (figure 2).

Genetic Diversity
The variation in genetic composition of individuals within and among species (e.g., variation with a population of rabbits).

Species Diversity
The variety of different species found in an area (e.g., the variety of species found in a prairie.

Ecosystem and Community Diversity
The variety of physical environments and biotic communities over a landscape (e.g., the variety of forests, grasslands, wetlands, and aquatic systems over a region).

Figure 2. **Types of biological diversity.** There are three widely recognized types of biological diversity: genetic diversity, species diversity, and ecosystem diversity, which includes community diversity (Source: reproduced from Temple 1991 with author's permission).

Provinces of the Northern United States

Ecosystem diversity is evaluated in the assessment on a regional basis and by using maps of provinces coupled with inventories of forest cover and plant associations. Provinces are geographic units that span multiple States. Each province contains a unique mosaic of physical features, vegetation, and community structure that affect ecosystem processes influenced by both nature and people (figure 3).

- Comparisons with historical conditions can provide a baseline for measuring changes with the potential to affect ecosystem functions. Roughly 41 percent (169 million acres) of the 413 million acres of land in the Northern United States is forested (Hansen and others 1992). In 1630, shortly after European settlement began, forests covered roughly 73 percent of the area (Smith and others 2001), whereas at the beginning of the 20th century, forest cover had dropped to as little as 34 percent.
- Forest acreage is not distributed evenly across the Northern United States. Differences in natural potential can be tracked by province (figure 4) and related to the region's history.
- The mountainous Adirondack-New England Mixed Forest-Coniferous Forest-Alpine Meadow Province M212, the Laurentian Mixed Forest Province 212 that bounds Canada, and the mountainous Central Appalachian Broadleaf-Coniferous Forest-Meadow Province M221 had over 90 percent forest cover prior to European settlement. They have the highest percentages of forest cover across the Northern United States today—90, 71, and 70 percent, respectively (Irland 1998, McNab and Avers 1994, Minnesota 1992, Smith and others 2001, Wisconsin 1976).

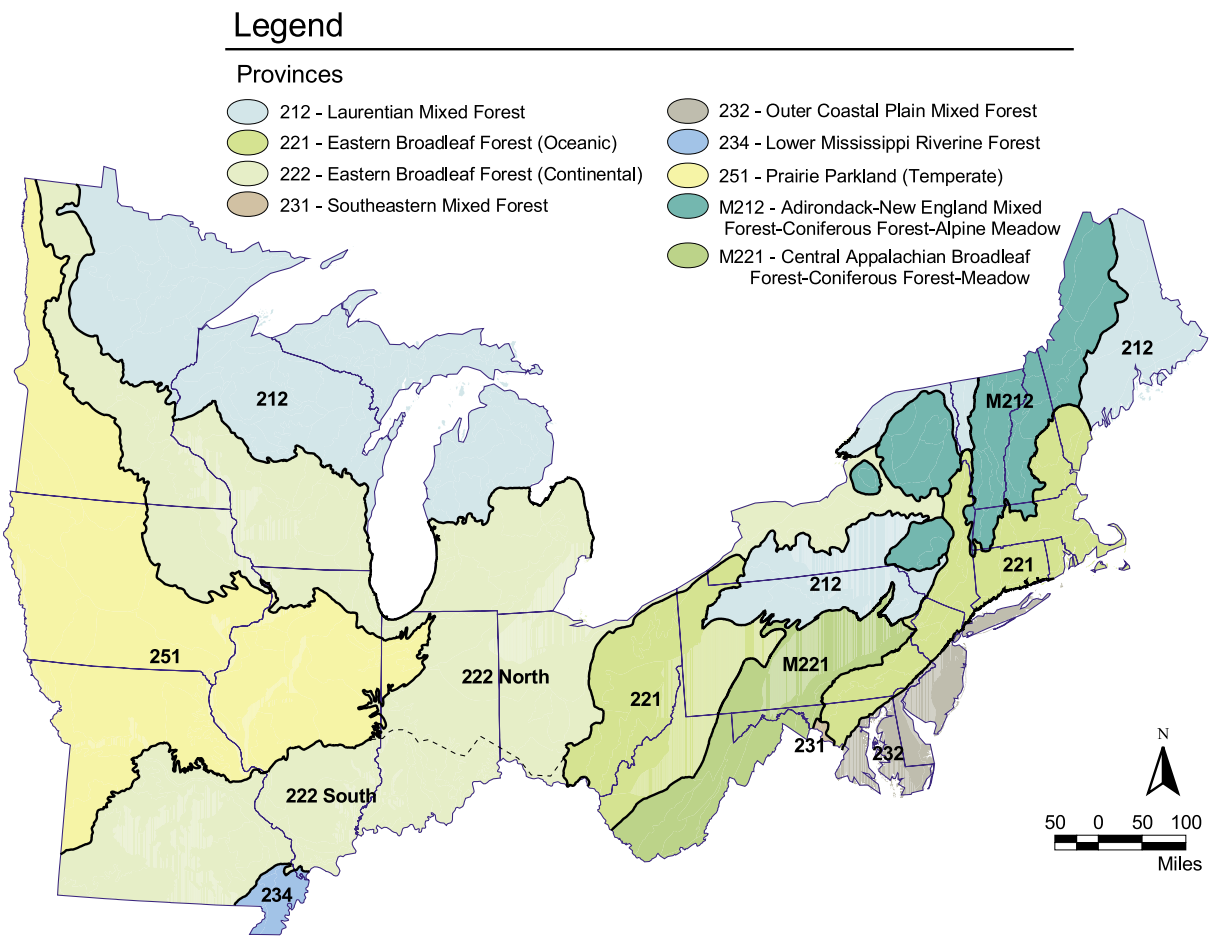


Figure 3. **Ecological units of the Northern United States.** Provinces on this map were developed by the USDA Forest Service using the National Hierarchical Framework of Ecological Units. Ecological units reflect the inherent biological capability of an ecosystem; therefore, they can be used to establish reference environmental conditions against which the predicted effects of management activities can be compared (Source: adapted from Keys and others 1995).

- The Eastern Broadleaf Forest (Oceanic) Province 221 and the Outer Coastal Plain Mixed Forest Province 232 were colonized early in American history and continue to contain the most populated areas of the country. These provinces were predominantly forested when the settlers arrived and today have 54 and 41 percent forest cover, respectively. All but the most unproductive and inaccessible forest land was converted to farm use while the forest resources were heavily exploited for fuelwood, charcoal, local construction, industry, and export. The extent of forest recovery is less in these two provinces than in provinces to the north because the climate and soils are more favorable for agriculture and suitable for development (Foster 1992, McNab and Avers 1994, Shands and Healy 1977, Smith and others 2001).

- Forest was the most common land cover in the Eastern Broadleaf Forest (Continental) Province 222 before European settlement. Today the rugged southern half of the province (222S) is roughly 40 percent forested, while the glaciated northern portion (222N) is only 19 percent forested. Colonization into this province followed major river corridors and lagged over a century behind the East. Much of the land cleared for farming remains in

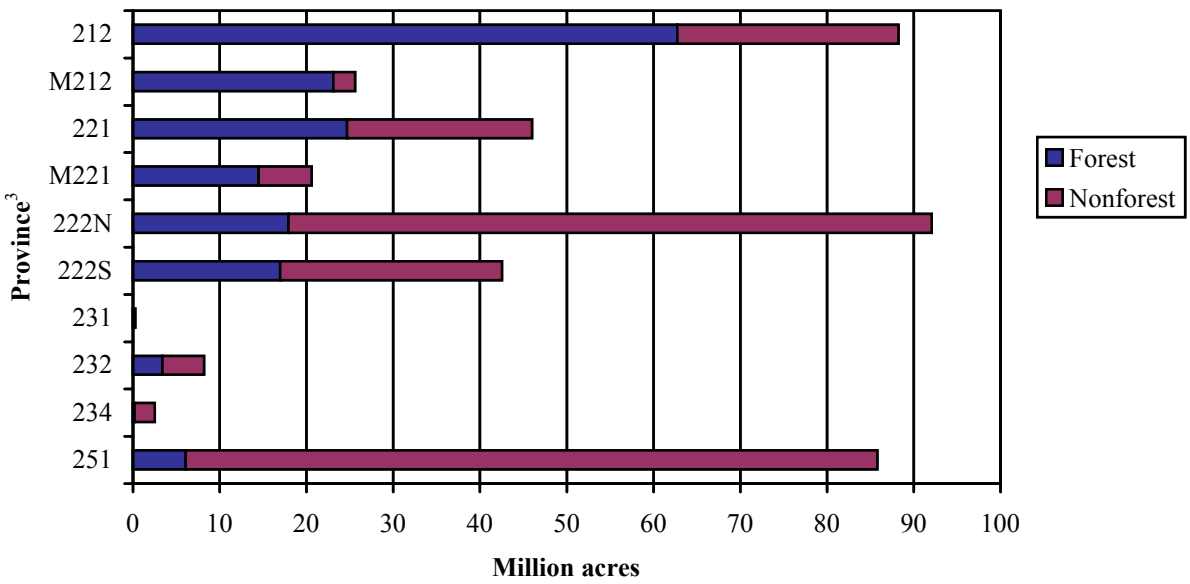


Figure 4. **Amount of forested and nonforested land in each province of the Northern United States**[1] (USDA Forest Service 1999a[2]).

[1]Does not include 2,594,600 acres of Adirondack and Catskill Preserves (NY).

[2]Inventory follows methods in Hansen and others 1992.

[3]Amounts of forest land in provinces 231 and 234 and nonforested land in province 231 are too small to appear on graph but do not equal 0.

agricultural use today, although some marginal, often heavily eroded cropland has reverted to forest cover or was reclaimed by aggressive conservation programs (McNab and Avers 1994, Shands and Healy 1977, Smith and others 2001).

- Prairie dominated the presettlement landscape in the Prairie Parkland (Temperate) Province 251. Then, as today, forests were often found in drainage ways and bottomlands, though upland forests and savannahs also existed. Most of the prairie and adjacent forest land has been converted to and retained as cropland or pastureland (Kuchler 1964, McNab and Avers 1994, Shands and Healy 1977, Smith and others 2001).
- The Lower Mississippi Riverine Forest Province 234 lost much of its bottomland forest to agriculture. The land that is forested today is highly valued for its contribution to plant and animal diversity (McNab and Avers 1994, Smith and others 2001).

Forest Cover Types

Forest cover types are groupings of trees named after the predominate tree species. Sixty-four forest cover types have been identified in the Northern United States (box 1). These forest cover types are divided into nine major forest cover type groups: white-red-jack pine, spruce-fir, loblolly-shortleaf pine, oak-pine, oak-hickory, oak-gum-cypress, elm-ash-red maple, maple-beech-birch, and aspen-birch (figure 5).

- The most extensive forest cover type groups in nearly every province are oak-hickory and maple-beech-birch. They each occupy over 50 million acres of forest land; together they account for more than 60 percent of the total forested land area in the Northern United States (table 1).

Box 1. **Forest cover type groups in the Northern United States**. Nine major forest cover type groups include the 64 forest cover types identified in the Northern United States (USDA Forest Service 2001).

Aspen-Birch Group
- Aspen
- Paper birch
- Gray birch
- Balsam poplar

Elm-Ash-Red Maple Group
- Black ash/American elm/red maple
- River birch/sycamore
- Cottonwood
- Willow
- Sycamore/pecan/American elm
- Sugarberry/hackberry/American elm/green ash
- Silver maple/American elm
- Red maple/lowlands
- Cottonwood/willow

Loblolly-Shortleaf Pine Group
- Loblolly pine
- Shortleaf pine
- Virginia pine
- Table-mountain pine
- Pond pine
- Pitch pine

Maple-Beech-Birch Group
- Sugar maple/beech/yellow birch
- Black cherry
- Cherry/ash/yellow-poplar
- Hard maple/basswood
- Elm/ash/locust
- Red maple/uplands

Oak-Gum-Cypress Group
- Swamp chestnut oak/cherrybark oak
- Sweetgum/Nuttall oak/willow oak
- Overcup oak/water hickory
- Atlantic white cedar
- Baldcypress/water tupelo
- Sweetbay/swamp tupelo/red maple

Oak-Hickory Group
- Post/blackjack oak
- Chestnut oak
- White oak/red oak/hickory
- White oak
- Northern red oak
- Yellow-poplar/white oak/northern red oak
- Sassafras/persimmon
- Sweetgum/yellow-poplar
- Scarlet oak
- Yellow-poplar
- Black walnut
- Black locust
- Chestnut oak/black oak/scarlet oak
- Red maple/oak
- Mixed upland hardwoods

Oak-Pine Group
- White pine/northern red oak/white ash
- Eastern redcedar/hardwood
- Shortleaf pine/oak
- Virginia pine/southern red oak
- Loblolly pine/hardwood
- Other oak/pine

Spruce-Fir Group
- Balsam fir
- White spruce
- Red spruce
- Red spruce/balsam fir
- Black spruce
- Tamarack (eastern larch)
- Northern white cedar

White-Red-Jack Pine Group
- Jack pine
- Red pine
- White pine
- White pine/hemlock
- Hemlock

Urban Forest

Urban forests are forested ecosystems characterized by a high concentration of human influences. Metropolitan areas or urban areas are usually used to approximate the extent of urban forest since ecological maps are not available. Metropolitan area and urban area boundaries are defined by the U.S. Bureau of the Census and the Office of Management and Budget (USDC Bureau of the Census 1997, USDC Economic and Statistics Administration 1994).

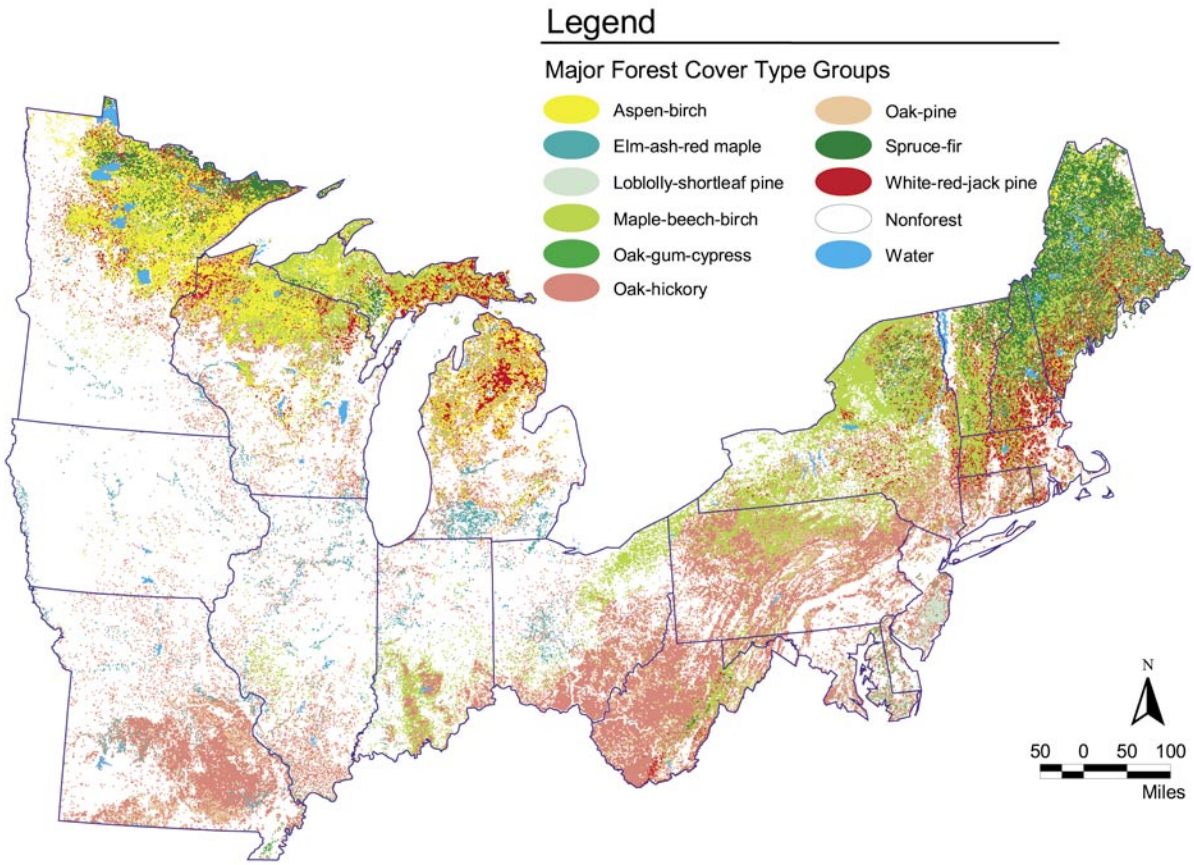


Figure 5. **Forest cover type groups in the Northern United States** (Source: developed by the USDA Forest Service Forest Inventory and Analysis Group using AVHRR [Advanced Very High Resolution Radiometer] data).

Table 1. **Amount of forest land by forest type group and province in the Northern United States**[1,2]. The most extensive cover type groups are oak-hickory, maple-beech-birch, aspen-birch, and spruce-fir (USDA Forest Service 1999a[3]).

Province	Oak-hickory	Maple-beech-birch	Aspen-birch	Spruce-fir	Elm-ash-red maple	White-red-jack pine	Oak-pine	Loblolly-shortleaf pine	Oak-gum-cypress	Non-stocked	Total
	Thousand acres										
212	5,353	20,623	14,226	12,419	3,626	5,622	303	30	28	344	62,575
M212	842	11,878	1,531	3,972	180	1,825	226	5	6	25	20,489
221	12,622	6,682	472	88	1,500	1,921	923	369	38	51	24,666
M221	10,046	2,849	69	83	169	445	525	269	11	21	14,487
222N	6,035	6,093	1,389	192	2,881	975	107	62	118	86	17,938
222S	11,767	1,978	0	0	1,272	58	1,088	597	158	50	16,968
231	66	8	0	0	0	0	0	0	0	0	74
232	1,603	60	6	0	136	6	483	849	235	11	3,388
234	45	18	0	0	52	0	0	0	31	23	169
251	3,223	1,341	28	0	1,258	24	39	33	93	28	6,069
Total	**51,604**	**51,533**	**17,726**	**16,753**	**11,074**	**10,883**	**3,694**	**2,213**	**719**	**639**	**166,838**

[1]Does not include 2,594,600 acres of Adirondack and Catskill Preserves (NY).

[2]Values in the columns may not add up to the totals due to rounding.

[3]Inventory follows methods in Hansen and others 1992.

- Metropolitan areas encompass roughly 34 percent of the land area in the Northern United States. Urban areas, the most densely populated core of metropolitan areas, occupy nearly 6 percent of the Northern United States land base.
- A conservative estimate by Dwyer and others (2000) indicates that nearly 26 percent of the forest land in the Northern United States is located in metropolitan areas (figure 6).

Natural Communities

A **natural community** is comprised of all species, including trees, shrubs, herbs, ferns, mosses, algae, and other plants; animals; and organisms that are not plants or animals such as fungi, protozoa, and bacteria.

Figure 6. **Forest cover in metropolitan areas.** Most metropolitan areas in the Northern United States contain areas with over 40 percent forest cover (Dwyer and others 2000).

The State Natural Heritage Programs and The Nature Conservancy cooperatively developed a taxonomy of terrestrial plant communities called the U.S. National Vegetation Classification (US NVC) (Anderson and others 1998, Grossman and others 1998). The **association** is the most detailed level of classification. US NVC associations are categorized into seven broad taxonomic classes: forest, woodland, shrubland, dwarf-shrubland, herbaceous, nonvascular, and sparse vegetation.

- The Northern United States contains 787 associations, 17 percent of the 4,684 associations identified nationally. The distribution of associations among taxonomic classes in the Northern United States is similar to the national average. Over half of the known associations are classified as forest or woodland (table 2).
-

Table 2. **US NVC natural and seminatural[1] associations by class[2]**. Forest and woodland associations comprise over half of those found in the Northern United States.

Class	Associations			
	Northern United States		United States	
	Number	Percent	Number	Percent
Forest	301	38	1,583	33
Woodland	111	14	849	18
Shrubland	69	9	763	16
Dwarf-shrubland	25	3	135	3
Herbaceous	225	29	1,247	27
Nonvascular	5	1	11	< 1
Sparse vegetation	51	6	96	2
Total	**787**	**100**	**4,684**	**100**

[1]Natural and seminatural communities as distinguished from planted/cultivated types.

[2]Source: TNC 1998. Numbers are subject to change as current inventory results are posted to the database.

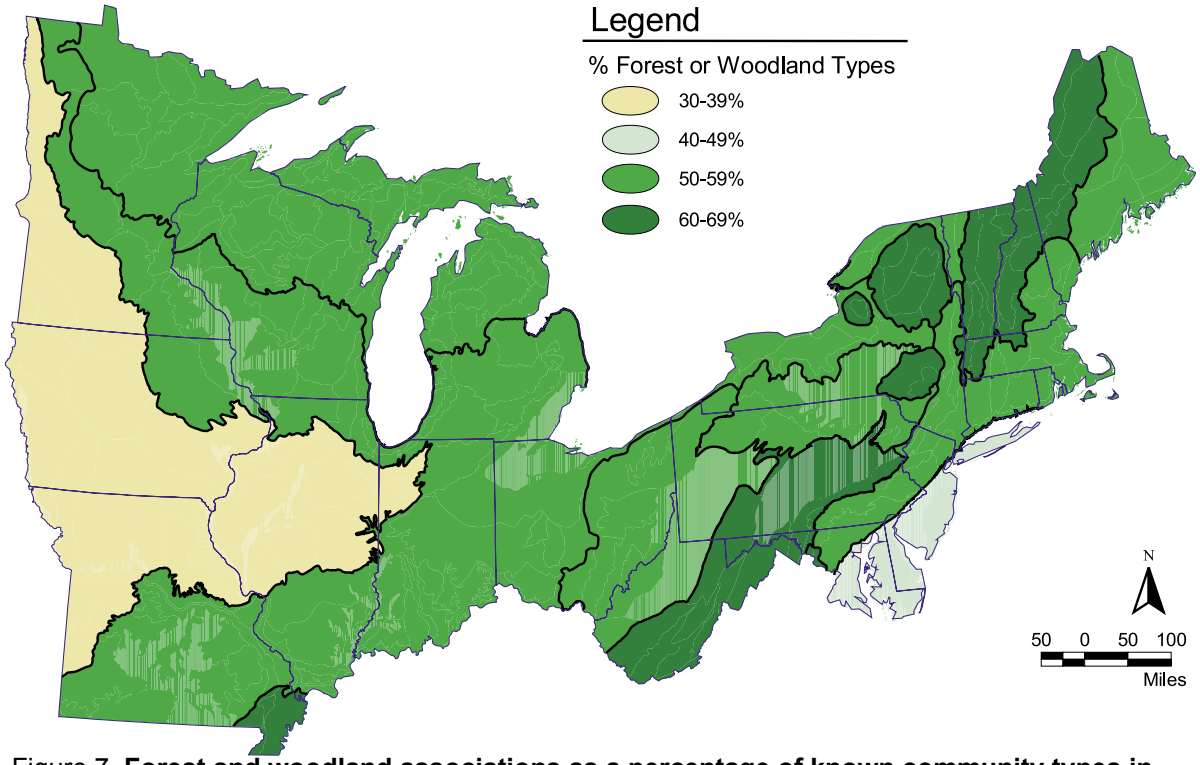


Figure 7. **Forest and woodland associations as a percentage of known community types in each province.** Provinces are displayed in figure 3 (Source: TNC 1998).

Forest and woodland associations add richness to the suite of communities found in each province. Between 34 and 65 percent of known communities in each province are forest or woodland (figure 7). The highest percentages of forest and woodland types occur in the Appalachian Mountains, the lowest in the prairies.

- Of the 787 associations found in the Northern United States, 309 or 39 percent are classified as globally rare. Rare forest and woodland associations represent 17 percent of the total number of associations in the Northern United States and 43 percent of those ranked as rare (table 3).

Table 3. **US NVCS rare associations in the Northern United States by class**. Forest and woodland associations represent 43 percent of associations ranked as rare (TNC 1998).

Class	Rare associations	
	Number	Percent
Forest	74	24
Woodland	59	19
Shrubland	27	9
Dwarf-shrubland	12	4
Herbaceous	121	39
Nonvascular	2	< 1
Sparse vegetation	14	5
Total	**309**	**100**

- No natural communities are known to have been eliminated to date.
- The reasons for rare status vary by natural community and location. Many rare forest and woodland communities in the Northern United States are naturally small and historically of limited extent. Some occur at high elevations, others along the Atlantic coast, and in barrens and bluffs. Other communities that were once common or extensive, however, have been affected by human activities. Many prairies, wetlands, and floodplain forests have been converted to agricultural or urban uses, while fire suppression limits regeneration in communities with fire-dependent trees, such as pitch pine and oak.

Forest Age and Successional Stage

Knowledge of forest type and successional stage is important for biodiversity management because the communities of plants and animals that inhabit any given site vary over time. While there is no direct inventory of the extent of forest cover in the Northern United States by succession stage, the USDA Forest Service has tracked changes in age through its Forest Inventory and Analysis Program.

- An estimated 76 percent of forest stands in the Northern United States are less than 80 years old, and less than 2 percent of stands are more than 120 years old. Mixed age stands comprise 9 percent of those inventoried, although the actual acreage is greater because mixed aged stands were assigned to specific age groups in protocols followed for the North Central States (table 4).

Table 4. **Acreage of forest land by age class and forest type in the Northern United States**[1,2] (USDA Forest Service 1999a[3]).

Age group	Oak-hickory	Maple-beech-birch	Aspen-birch	Spruce-fir	Elm-ash-red maple	White-red-jack pine	Oak-pine	Loblolly-shortleaf pine	Oak-gum-cypress	Non-stocked[4]	Total
	Thousand acres										
0–40	19,212	16,271	8,887	5,468	5,258	4,108	1,371	1,061	265	549	62,450
41–80	21,226	20,267	7,166	5,622	4,180	4,112	1,469	612	274	34	64,961
81–120	7,072	7,337	863	2,842	1,076	1,149	295	52	60	17	20,764
121–160	599	966	66	825	160	91	0	4	3	3	2,716
160+	19	93	9	140	14	9	0	0	0	0	283
Mixed	3,476	6,599	735	1,856	387	1,414	559	485	117	37	15,664
Total	**51,604**	**51,533**	**17,726**	**16,753**	**11,074**	**10,883**	**3,694**	**2,213**	**719**	**639**	**166,838**

[1]Does not include 2,594,600 acres of Adirondack and Catskill Preserves (NY).
[2]Values in the columns may not add up to the totals due to rounding.
[3]Inventory follows methods in Hansen and others 1992.
[4]Timberland less than 10 percent stocked with all live trees.

- Natural disturbance, timber harvesting, and natural aging are factors that move forests to early successional stages. Types of natural disturbance common across the Northern United States include individual tree falls, fires, and ice storms. Larger fires tend to occur in oak-hickory forests and on pinelands with sandy soils throughout the region. Blowdowns and hurricanes are most common along the Atlantic coast and in New England. Tornadoes occur most commonly in the Midwest. Timber harvesting occurs most often on stands between 60 and 120 years of age, although aspen-birch stands are harvested closer to 60 years, while maple-beech-birch stands are harvested closer to 100 or 120 years.

- The majority of trees in urban areas are small in diameter, though there are some differences in age by land use. For example, institutional and residential lands may have more large trees than industrial and agricultural areas since groundskeepers and residents may work to retain large trees and discourage understory development. Vacant urban lots in the region tend to regenerate to trees naturally over time (Dwyer and others 2000).

Old Growth

Definitions of old growth abound, ranging from mature virgin forested areas to stands managed for old growth characteristics regardless of degree of human intervention. Some definitions focus on the age or size of the trees, others on the age and naturalness of the forest community. Nearly all identify important structural characteristics, including both live and dead vegetation and soil characteristics. The biological diversity associated with old growth depends on the ecological potential of the forested sites and the effects of the natural disturbance regime on the age class structure. For example, spruce-fir forests of all successional stages exhibit less species diversity than maple-beech-birch forests.

- There are varying estimates of how much old growth remains; it is generally believed that there is more than has been reported to date. Davis (1996) identified 1,296,000 acres of old growth in the Northern United States—0.77 percent of the total amount of forested land. This figure includes what Davis calls primary or original forest sites undisturbed by humans or with limited logging or grazing. Davis' definition emphasizes old trees as opposed to big trees, which has resulted in increases to 1993 estimates (Davis 1993).
- National forests in the East were established when the Federal government acquired cutover forest land and spent agricultural land (Shands 1991, Shands and Healy 1977). Therefore, only a limited number of acres on these forests are believed to contain old growth in the sense of primary forest unmodified by humans. Out of necessity, the focus of the national forests has been to plan for future old growth. Some 1.4 million acres, roughly 11 percent of national forest lands in the Northern United States, have been allocated to old growth in existing forest plans (Tyrrell 1996). This allocation is in addition to any old growth that exists on land designated as Wilderness or Research Natural Areas.

Conservation of Ecosystem Diversity

The International Union for the Conservation of Nature (IUCN) defines a protected area as "an area of land and/or sea especially dedicated to the protection and maintenance of biological diversity, and of natural and associated cultural resources, and managed through legal or other effective means" (IUCN 1994, p. 6). Protection can range from strict protection to management in conjunction with other uses. IUCN categorizes public lands based on management objectives in the authorizing legislation (table 5).

- The 11.9 million acres of national forest land in the Northern United States are managed for multiple objectives. These objectives cross the full range of IUCN categories.
- Roughly 5 percent (8.2 million acres) of forest land in the Northern United States is reserved from timber utilization by statute or administrative regulation by some level of government. The majority of this reserved forest land is located in Provinces M212 and 212 (figure 8).
- The majority of reserved forest land in the Northern United States is in the oak-hickory and maple-beech-birch cover types (figure 9). Roughly 76 percent of the reserved lands are less than 40 years old. Mixed aged stands account for just over 2 percent of the reserved land and about 0.5 percent of stands are over 120 years old (USDA Forest Service 1999a).

Table 5. **Northern United States land in International Union for the Conservation of Nature protected area categories** (IUCN 1994).

Protected area category	Objective	Examples[1]	Acres[1]
I. Strict nature reserve or wilderness area	Manage outstanding or representative ecosystem for science or wilderness character	Research Natural Areas, National Forest Wilderness Areas (e.g., Boundary Waters Canoe Area Wilderness, MN)	1,411,984
II. National park	Manage for recreation compatible with ecosystem protection	National Parks (e.g., Isle Royale, MI), State Parks (e.g., Baxter, ME)	2,134,563
III. Natural monument	Manage for unique natural/cultural features	National Natural Landmarks (e.g., Canaan Valley, WV)	373,025
IV. Habitat/species management	Manage for specific habitats or species	National Wildlife Refuges (e.g., Crab Orchard, IL)	1,043,259
V. Protected landscape/ seascape	Manage for landscape/seascape conservation and recreation	State Parks (e.g., Adirondack, NY; Holyoke Range, MA), National Reserves (e.g., Pinelands, NJ)	9,955,202
VI. Managed resource protected area	Manage unmodified natural systems for biodiversity and sustainable flow of natural products	National Forests (e.g., Hoosier, IN), State Forests (e.g., Garrett, MD)	11,625,788

[1]Source: UNEP-WCMC 2002

Private landowners and public land managers can contribute to forest ecosystem diversity by managing their lands in ways that maintain their inherent ecological potential and provide habitat for wildlife, and by establishing land use patterns that allow for the movement of wildlife species across the landscape.

- Land trusts play an important role in biological diversity conservation. They operate at local, regional, and national scales. The *1998 National Directory of Conservation Land Trusts* listed a total of 831 local land trusts operating in the Northern United States (Land Trust Alliance 1998). These local land trusts protected 1,705,287 acres through 1998, including 476,122 acres owned by the trusts, 682,900 acres under easement, and 546,265 acres acquired and transferred to a government agency (figure 10). Of these trusts, 250 listed conservation of rare species habitat as one of their conservation objectives.

Lands in the public domain are expected to form the base for nearly all protected areas or reserve systems. It is common, however, for land trusts and large landowners to dedicate some lands to the protection of species and ecosystems. Some private landowners enter into agreements such as conservation easements—legal contracts that provide some compensation to landowners for the dedication of their land or property rights—with public or private organizations. In addition, some contribution to reserves is often a part of forest certification recommendations for large landholders.

Fragmentation

Fragmentation is the breaking up of large and continuous ecosystems, natural communities, and habitats into smaller areas surrounded by altered or disturbed land or aquatic substrate.

- The cause of fragmentation of greatest concern today is the permanent and long-term conversion of forest land to development. According to the USDA Natural Resources Conservation Service (2001), nearly 3.7 million acres of forest land in the Northern United States were converted to developed land between 1982 and 1997, representing 45 percent of the nearly 8 million acres of land developed during that period (figure 11). Pennsylvania (620,500 acres), Michigan (372,900 acres), and Massachusetts (367,800 acres) had the highest losses to development; Iowa (14,800 acres) had the lowest.
- Suburbanization is the primary cause of deforestation on rural landscapes in the Northern United States today, surpassing conversion to agriculture (Zipperer and others 1990). Urban and suburban expansion reduces

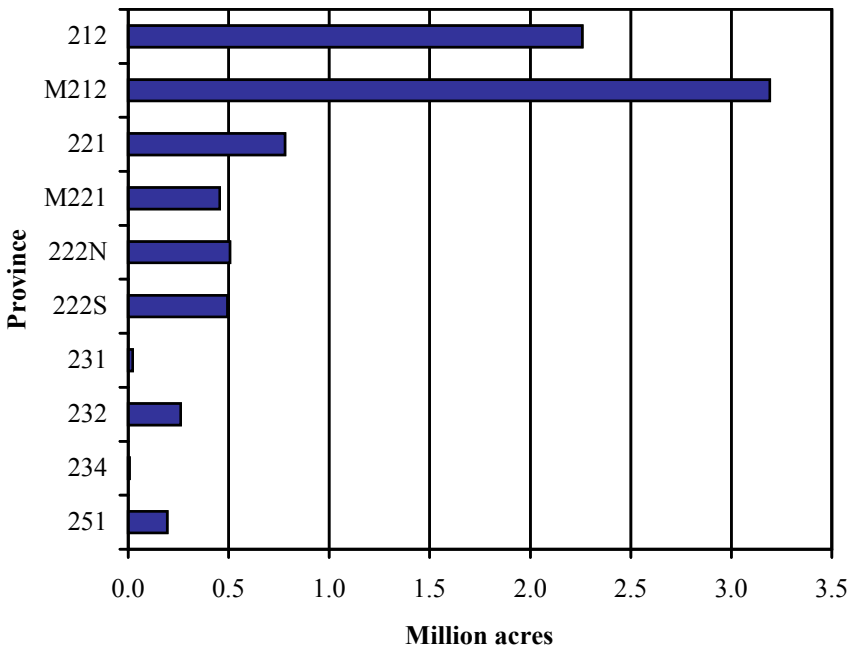


Figure 8. **Reserved forest and by province** (USDA Forest Service 1999a[1]).

[1]Inventory follows methods in Hansen and others 1992.

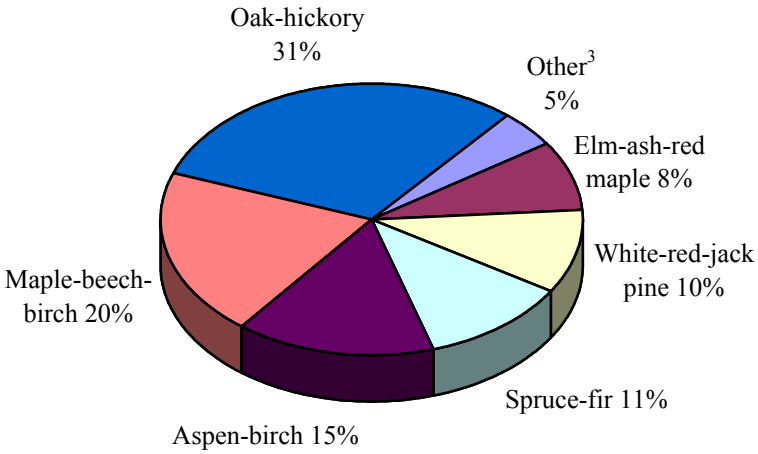


Figure 9. **Reserved forest land by forest cover type in the Northern United States**[1]. The oak-hickory and maple-beech-birch forest cover types comprise over half of the reserved forest land in the Northern United States (USDA Forest Service 1999a[2]).

[1]Does not include 2,456,000 acres of reserved timberland and 138,600 acres of reserved other forest land in the Adirondack and Catskill Preserves (NY).

[2]Inventory follows methods in Hansen and others 1992.

[3]Includes oak-gum-cypress, oak-pine, and loblolly-shortleaf pine.

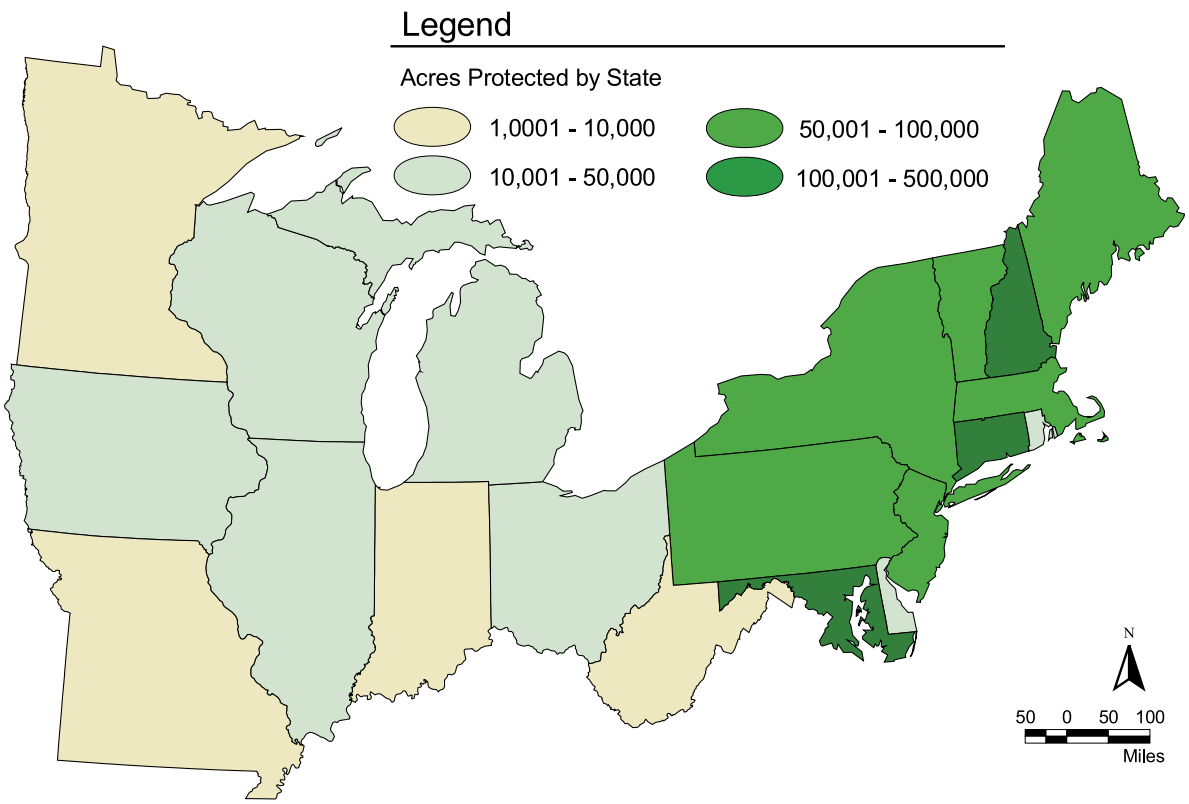


Figure 10. **Acres protected by land trusts through 1998.** Land trusts play an important role in

the amount of land available for the production of forest goods and alters associated environmental services. Habitat deforestation is considered by many to be the most serious threat to biological diversity and a primary cause of species decline (DeGraaf and Healy 1990, Wilcove and others 1986).

Species Diversity

Species richness is a measure of biological diversity based on the total number of species inhabiting a defined area. The number of species is not the only consideration in biodiversity management. For example, a rare species will attract more attention than a common species, and native species are generally preferred over nonnative species.

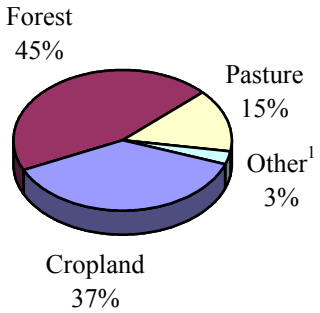
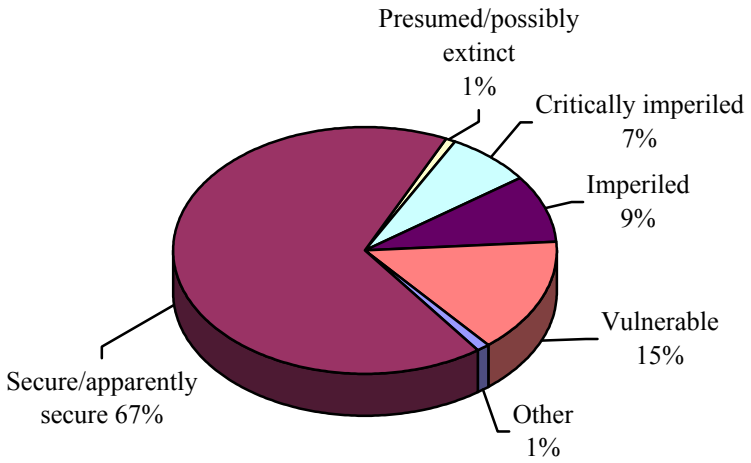


Figure 11. **Land developed, 1982–1997**. About 45 percent of the nearly 8 million acres developed in the Northern United States was forest land (USDA NRCS 2001).

[1]Includes rural land, rangeland, water areas, and Federal land.

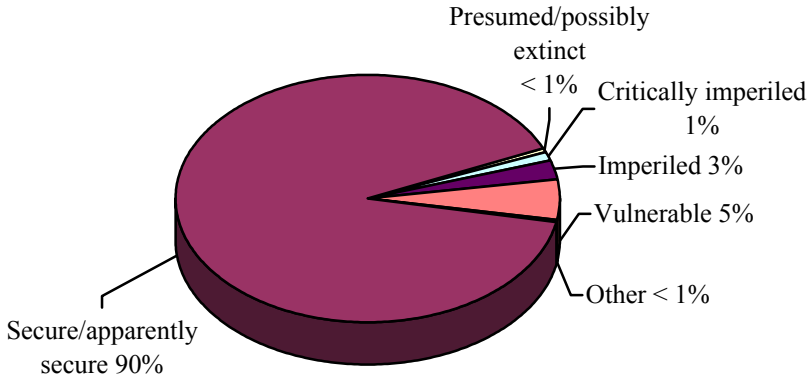
- Roughly one-fifth of the known species, including 13 major groups of plants and animals in the United States, have been studied in sufficient detail to assess their global conservation status (TNC and ABI 2000). The majority of native plants and animals in the Northern United States are secure or apparently secure (figure 12). Twenty-five Northern United States species are presumed to be extinct or possibly extinct: 6 are birds, 7 are fish, 8 are freshwater mussels, and 4 are flowering plants.

United States



Based on 2,536 vertebrates, 1,795 invertebrates, and 16,108 plants (TNC 1997).

Northern United States



Based on 1,169 vertebrates, 725 invertebrates, and 3,975 plants (TNC and ABI 2000).

Presumed extinct	Not located despite intensive searches
Possibly extinct	Of historical occurrence; still some hope of rediscovery
Critically imperiled	Typically 5 or fewer occurrences or 1,000 or fewer individuals
Imperiled	Typically 6–20 occurrences or 1,000–3,000 individuals
Vulnerable	Typically 20–100 occurrences or 3,000–10,000 individuals
Apparently secure	Uncommon but not rare; some cause for long-term concern; usually more than 100 occurrences and 10,000 individuals
Secure	Common; widespread and abundant

Figure 12. **Global conservation status of plants and animals.** The majority of native plants and animals in the United States and in the Northern United States are secure/apparently secure.

- Nonnative (exotic) species are often opportunistic and aggressive, and may prey on native species. Naturalized exotics change community species composition and may decrease the natural diversity of native wildlife (Harty 1993). Examples of nonnative birds that have been introduced into the Northern United States include the house sparrow, the European

starling, and the ring-necked pheasant (Ehrlich and others 1988).

Opportunities to conserve wildlife species include creating wildlife habitats and enhancing existing habitats through forest and landscape planning and management.

Forest-Dependent Species

Many wildlife species that live in forests can survive in nonforested habitats. **Forest-dependent species** require the use of forested habitat at some point in their life cycle.

- Nationally, the USDA Forest Service reported that at least 90 percent of the bird, amphibian, and fish species in the country and at least 80 percent of mammal and reptile species can be sighted on forested land, though they may or may not be dependent on that habitat for survival (USDA Forest Service 1997a).
- There is no definitive list of forest-dependent species in the Northern United States.
- The ovenbird and the American marten are examples of species that require forested habitat during their entire life cycle (DeGraaf and Rudis 1986).

Endangered Species Act

The intent of the Endangered Species Act of 1973 is to conserve threatened and endangered species and the ecosystems that provide necessary habitat for them. The Act defines **endangered species** as "any species which is in danger of extinction throughout all or a significant portion of its range other than a species of the Class Insecta determined by the Secretary to constitute a pest whose protection under the provisions of this Act would present an overwhelming and overriding risk to man" (16 U.S.C. 1532). A **threatened species** is "any species which is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range" (16 U.S.C. 1532).

- Of the roughly 1,100 species of plants and animals on the Federal list of threatened or endangered species, 105 occur in the Northern United States (appendix B).
- The largest numbers of threatened and endangered species in the Northern United States are found on the Atlantic Coast, Michigan's Upper Peninsula, the Missouri Ozarks, and mountainous West Virginia, followed by the Mississippi River corridor and other river and lake border areas (Flather and others 1999).
- The recovery of Northern United States species such as the bald eagle, peregrine falcon, and small whorled pogonia are due, in large part, to protection afforded under the Endangered Species Act.

Genetic Diversity

Genetic diversity affects the ability of a species to evolve in response to changes in its environment (Soulé 1980). Reduced genetic variation reduces the potential for disease resistance while it increases the likelihood of inbreeding and resulting mutations in individuals (Frankham 1995, O'Brien and Evermann 1988, Ralls and Ballou 1983, Ralls and others 1979, 1988; Wright 1977).

Genes determine the species of an organism; therefore, the diversity of species is a coarse

measure of genetic diversity. Differences in genes among individuals and populations of a species are the next levels of measurement. A **population** is a collection of individuals of a species that potentially interbreed and share a common gene pool. Concern about genetic diversity is most serious for species with populations that are either naturally small or isolated, or populations that have become small because of changes in their environment or impacts from human activity (Nei 1987, Nei and others 1975, Wright 1969).

Managers seek to conserve genetic diversity by managing for viable populations of species across their known range of distribution. It is desirable to preserve genetic diversity through the protection of viable populations in a natural setting, rather than in a laboratory or other site outside a natural habitat. This is especially true of wildlife species, for which the difficulty and costs of conservation can be very high.

- Wildlife species distribution and abundance in Northern U.S. forests have fluctuated since the time of European settlement as result of habitat changes associated first with forest harvest and land clearing practices, and then with reforestation (DeVos 1964, Martin and Klein 1984, Pielou 1991). The distribution and abundance of wildlife species continue to be associated with trends in land cover and use as well as natural successions. Wildlife is also affected by changes in the amount and quality of habitat due to logging, fire, windthrow, insects, and disease (Block and Brennan 1993, Forman 1995, Janetos 1997).
- Examples of wide-ranging forest associated species found across the Northern United States include black bear, white-tailed deer, wild turkey, ruffed grouse, mice and voles, numerous woodpeckers, thrushes, most wood warblers, chickadees, titmice, and raptors.
- Forest carnivores historically and presently found in Northern U.S. forests include large carnivores such as gray and red wolf, coyote, wolverine, lynx, and cougar (Fuller and Kittredge 1996). Other carnivores include red and gray fox, bobcat, and a variety of mustelids (e.g., pine marten, fisher, ermine, long-tailed and least weasels, mink, otter, badger, and striped skunk) (Yamasaki 2003).
- There are at least 150 Neotropical migrant species that breed in forest types common in the Northern United States. Most species breed in more than one forest type. Some Neotropical migratory birds (e.g., wood thrush and cerulean warbler) are declining in some parts of their breeding ranges due to events on their wintering grounds or during migration (DeGraaf and Rappole 1995, Hagan and Johnston 1992, Robbins and others 1992, Terborgh 1989).
- Population trends for waterfowl associated with forested wetlands are complex (Erwin 1996). Wood duck populations have generally increased in the United Sates. The Canada goose, which feeds occasionally in forested wetlands and agricultural fields, has increased in recent years. There have been mid-continental declines in northern pintail, green-winged teal, and Mississippi flyway populations of mallard. The black duck has declined despite stable or increasing forest area in maritime Canada and New England. Blue-winged teal has also declined. Common and hooded mergansers, which feed in wetlands in the northern tier of States, have increased nationally.
- The USDA Forest Service Research Natural Areas Program includes a mandate to

conserve genetic diversity in natural settings. Conservation of genetic diversity is a factor considered by the U.S. Fish and Wildlife Service in the development of conservation and recovery plans for threatened and endangered species.

- Most forestry and wildlife habitat management in the Northern United States depends on wild plants growing in naturally regenerated stands. Silviculturists can prescribe treatments in naturally regenerating stands according to the demands of the locale to favor the most vigorous individuals in order to establish stands with traits that increase their desirability for timber and wildlife.
- Crop and tree breeding programs are forms of genetic resource management that have shown direct benefits by increasing growth and yield. Hybrid species are developed to increase resistance to insects and disease or to increase productivity under specific environmental conditions.
- Seed source testing (provenance testing) often verifies that the seed from local sources grows best over time (Conkle 1973). On the other hand, notable exceptions to this rule suggest more intensive testing might yield nonlocal sources well adapted to variable environmental conditions with other beneficial attributes (Garrett and others 1973, Santamour 1960, Sluder 1963).
- Most land management agencies and private companies have internal policies to maintain genetic variation within commercial forest tree species. These policies guide artificial reforestation, regeneration, and restoration activities.
- In the Northern United States, 15 States have State nursery programs and 21 have State nurseries. There has been general movement away from the production of exotics by public nurseries since the early 1990's (Overton 2001), with the exception of those that grow primarily Christmas tree stock.

Sustainable management attempts to ensure that the trees that remain as breeding stock after a harvest have sufficient genetic variation to maintain the species in the face of environmental change. Continuous **high-grading** (removal of the most vigorous and desirable individuals of a population) is a threat to genetic diversity and may leave breeding stock to produce individuals with undesirable traits.