Biodiversity

3

Biodiversity

Biodiversity refers to the variety of ecosystems, species, and genes. As part of the North American continent, Canada and the United States contain a large number of different ecosystem types, with biodiversity increasing along a north-south gradient (CEC 1997). The United States has a broader array of ecosystems than any other nation (Stein, Kunter, and Adams 2000).

The World Wildlife Fund (WWF) reports that about half of North America's most diverse ecoregions are now severely degraded (Ricketts, Taylor, and others 1997). Ecosystem degradation and loss leads to the decline in plant and animal diversity. Figure 15 depicts one interpretation of the most ecologically significant and most threatened regions on the North American continent (Hoth 2001). Produced under the auspices of the Commission for Environmental Cooperation of North America, it includes Mexico as part of the NAFTA (North American Free Trade Agreement) region, and shows the obvious transboundary nature of ecosys-

Figure 15
North America's most ecologically important and threatened regions.

Source: CEC 2001a

North America's Most Ecologically Important and Threatened Regions

tems. The prairie is thought to be North America's most endangered ecosystem. For example, some 55-prairie grassland wildlife species are now listed under the US Endangered Species Act (see Box 10, next page) as either threatened or endangered (Bachand 2001).

According to Canada's endangered species list, as of May 2001, a total of 380 species were at risk of imminent or eventual extinction (endangered, threatened, or of special concern) while in the United States, 1,231 species were listed as endangered or threatened under the US Endangered Species Act (ESA) (see Box 10, next page) (COSEWIC 2001; Alonso, Dallmeier, and others 2001). Species that depend on freshwater habitat appear to be most at risk. Almost one-third of the world's freshwater mussel species live in the United States, for example, but 70 percent of these are at risk. Particularly high concentrations of imperiled species are found in Hawaii, California, the southern Appalachians, and Florida (Stein 2001). Some 309 vertebrate species are considered threatened with extinction in North America as a whole (see Figure 16).

Numbers of Threatened Vertebrates, 2001

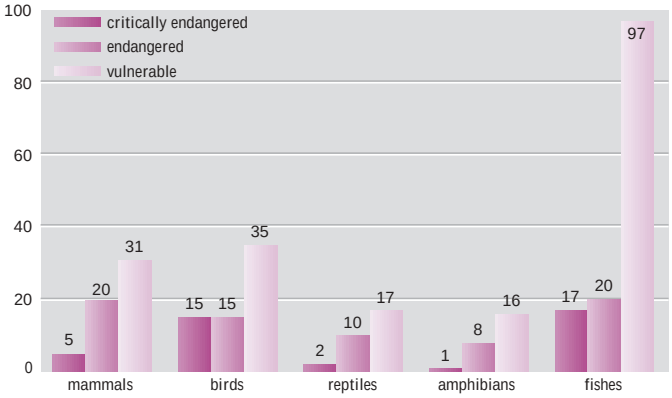


Figure 16
Numbers of threatened vertebrates, 2001.

Source: UNEP-WCMC 2001a

To safeguard biological diversity, North America has increasingly set aside protected areas. According to The World Conservation Union (IUCN) categories, 13.9 per cent of North America's land area was protected in Classes 1-VI in 2001 compared to 4.15 per cent in the same categories in 1972. Table 1 shows protected area data for Classes 1-V in 1999 (UNDP, UNEP, World Bank and WRI 2000). IUCN categories are defined at http://www.unep-wcmc.org/protected_area/categories/index.html

Table 1: Protected Area by IUCN Categories I-V

	Number	Area (000 ha)	Percent of Land Area	No. of Areas at least:		Number of Marine-Protected Areas (IUCN Categories I-VI)***			Biosphere Reserves		World Heritage Sites		Wetlands of International Importance	
				100,000	1m	Total	Littoral	Marine	Number	Area**	Sites	Area**	Number	Area**
Canada	3,083	90,702	9.1	102	20	139	102	76	8	1,512	8*	10,664	36	13,051
United States	3,063	123,120	13.1	153	26	386	255	187	44	20,838	12*	9,741	17	1,178
North America	6,146	213,822	11.1	255	46	525	357	263	52	22,350	18	20,405	53	14,229

Note: *Includes sites shared by two or more neighboring countries, **Area (000 ha) ***An area can be both marine and littoral. The latter has at least some intertidal area.
Source: UNDP, UNEP, World Bank, and WRI 2000

Box 10: The US Endangered Species Act

The Endangered Species Act (ESA) of 1973 provides for the conservation of both vertebrate and invertebrate species listed as either 'endangered' or 'threatened' according to assessments of the risk of their extinction throughout all or a significant portion of their range, as well as the conservation of the ecosystems on which they depend. An individual or organization may petition to have a species considered for listing as endangered or threatened under the Act. Once a species is listed, powerful legal tools are available to protect both it and its habitat (Buck, Corn, and others 2001; NOAA 2001). A recovery plan is prepared, which includes designating critical habitat necessary for the continued survival of the species (NOAA 2001; O'Loughlin 2001).

The ESA is considered by some to be the most comprehensive of US Environmental laws, but it has also been one of the most controversial (O'Loughlin 2001). Since threatened species often flag broader issues of resource scarcity and altered ecosystems, in recent years the ESA has been the subject of debate about allocating scarce or diminishing lands or resources in the face of pressures on species' habitats from growing human populations and economies. Salmon and spotted owls in the Pacific Northwest, both highlighted elsewhere in this report, are examples of resource debates in which ESA-listed species were part of larger economic issues (Buck, Corn, and others 2001). Debate also centers on the listing process and how to determine priorities (Stein 2001).

Eleven species have been removed from the list since 1973, and less than 10 percent of listed species have exhibited improvement in status in that time (O'Loughlin 2001). Litigation and budgetary constraints have made the listing process cumbersome and slow in recent years. During 2000, most of the budget dedicated to listing newly endangered species was used in fighting litigation. But in August 2001, an agreement in principle was announced between the Fish and Wildlife Service and a coalition of ENGOs that begins to address litigation and budget concerns so as to increase protection for dozens of rare species and their habitat (Buck, Corn, and others 2001). The ENGOs agreed to allow more time to designate habitat for eight protected species in compliance with court orders, in return for which the government would accelerate the process for listing 29 of the more than 200 species still under consideration (Schrope 2001).

Canada has signed and ratified the Convention on Biological Diversity (CBD) and continues to work toward introducing a federal Species at Risk Act (SARA), while the United States is not yet party to the CBD, but has a strong Endangered Species Act (ESA). The latter has been used effectively by NGOs to protect substantial areas of habitat for threatened species (see the forestry section in this report and Box 10).

As in other parts of the world, habitat destruction and degradation is the most pervasive threat to biodiversity (Wilcove, Rothstein, and others 2000). For many species, human disturbance of habitat can lead to their demise. But disturbance of some habitat and its conversion to human uses can also favor some species. Canada geese, for example, have adapted to golf courses and urban parks and their numbers have increased significantly over the past

two decades. In such cases, species abundance does not equate with biodiversity, as some adaptable species compete with and often supplant native ones (Martin 2001).

North American wetlands have high biological productivity, providing critical habitats for many species and essential ecological services such as absorbing floodwaters and protecting water quality by filtering pollutants (see Box 11) (Schmid 2000). Wetland protection is therefore a priority issue for biodiversity conservation in North America.

Bioinvasion, now thought to be the second-gravest threat to global biodiversity, is another priority issue for North America. Introduced non-native species can pose threats to domestic species through predation, competition, parasitism, and hybridization. Increased globalization and trade has heightened the risk of invasive species entering and changing the region's ecosystems and the biodiversity they harbor.

Wetlands

Wetlands in North America are generally understood to be marshes, swamps, bogs, and similar transition zones between dry land and deep water (EPA 1997; EC 1999). The different ecological conditions found from the Arctic to the tropics create a great diversity of wetland types (Cox and Cintron 1997). Wetlands provide food and habitat for about one-third of bird species in the United States and although the percentage is unknown for Canada, more than 200 bird species, including 45 species of waterfowl, rely in wetlands in Canada. They are also home to some 5,000 plant species and 190 species of amphibians in the United States and 50 species of mammals and 155 species of birds (CEQ 1997; NRC 2000). Thirty-nine percent of North America's plant species depend on wetlands (Revenga, Brunner, and others 2000). Furthermore, about a third of

Box 11: Wetland Services

Like rain forests and coral reefs, wetlands are among the most biologically productive natural ecosystems in the world, providing habitat and the organisms that form the base of the food web to a wide variety of fish, plants, and wildlife, including many rare and endangered species. Wetlands also provide many other services and benefits: they filter and cleanse the water that passes through them; by absorbing water from snow melt, which recharges the water table for times of drought, wetlands reduce the risks of flooding, shoreline erosion, and sedimentation; and they are important areas for recreation, education, and research (Pembina Institute n.d.; EPA 2001).

The microbes, plants, and wildlife in wetlands also form part of global water, nitrogen, and sulphur cycles. Furthermore, wetlands may moderate global climate conditions by storing carbon within their plant communities and soil instead of releasing it to the atmosphere as carbon dioxide (EPA 2001).

Table 2: Wetlands in North America

	Wetland Area (1000 ha)	Percent of National Land Area	Percent of North American Wetlands
Canada	153,000	16	58
United States	111,104	12	42
North America	264,104	–	–

(Sources: *Dahl 1990; Rubec and Thibault 1998; Rubec 2000*)

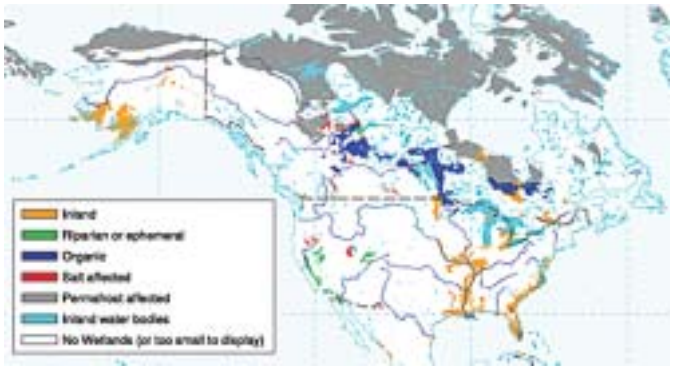
North America's threatened and endangered species depend on wetlands (CEQ 1997; NRC 2000).

North America contains a large percentage of the world's wetlands, with Canada holding about 24 percent, accounting for about 16 percent of its landscape (NRC 2000; Rubec 2000). Wetlands make up more than five percent of the total US area and cover about 111 million ha. Of this amount, almost 69 million ha are found in Alaska, while 42.2 million hectares of wetlands are found in almost a third of the 2,123 watersheds located in the conterminous 48 states (Dahl 1990; USDA 2000a). An estimated 80 percent (33.1 million ha) are located on non-federal rural land (Brady and Flather 1994). Wetlands cover about 264 million ha of North America's land area (see Table 2 and Figure 17).

Figure 17
Map of North America's wetlands.

Source: USDA 1997

Map of North America's Wetlands



Prior to the 1970s, North America's wetlands were perceived as wastelands, nuisance areas, and the breeding grounds of pests. Government programs encouraged wetland drainage and filling to allow conversion to agriculture, settlements, and industrial sites (EPA 1997). As a result, North America, excluding Alaska and Canada's northern regions, lost over half of its original wetland habitat (EC 1999; Bryer, Maybury, and others 2000). Agricultural expansion was responsible for between 85 and 87 percent of the losses (NCSU 1998; NRC 2000).

Since the 1980s, wetland losses in North America have slowed considerably. Recognition of their ecological services (see Box 11), changes in agricultural policies, particularly good hydrological conditions, and cooperative efforts among the North American countries to conserve wetlands for waterfowl were factors in these achievements (NAWMP 1998).

In the mid-1980s, wetlands in the lower 48 states covered an area the size of California, which represents a third of Canada's wetland area (EPA 1997). Between 1974 and 1983, net wetland conversion dropped to about 117,359 ha per year and in the 10 years between 1982 and 1992, it further dropped to 28,328–36,422 ha per year (USDA 2000a). A net of 266,820 ha of wetlands was still lost in the United Sates between 1986 and 1997, although this represents an 80 percent reduction from the previous decade. During this period,

a wide mix of land use change accounted for losses, with urban development responsible for 30 percent, agriculture for 26 percent, silviculture for 23 percent and rural development for 21 percent (American Rivers 2000).

To make up for wetland losses, both countries endorsed goals of 'no net loss' and instituted mitigation policies that provided incentives to create marshes or to replace those built over. In 1980, the US revised the 1972 Clean Water Act to include a mitigation policy, and in 1997, Canada launched its Wetland Mitigation and Compensation Project (Kaiser 2001; WCC 2001). These efforts have had mixed results, while cooperative efforts to conserve wetland habitat for waterfowl have had notable success (see Box 12. next page).

Since 1985, federal and provincial/state governments adopted wetland conservation and management policies. Over 70 percent of Canada's wetland resources are now covered by federal and provincial wetland policies and about 15 states regulate inland wetlands (NRC 2000; Schmid 2000). US federal subsidies that allowed wetlands to be converted to agriculture ceased in 1985 through the wetland conservation provisions of the Food Security Act, and a new Wetland Plan was issued in 1993 to make wetland regulation more fair, flexible, and effective (EPA 1999; USDA 2000a; Schmid 2000). The Wetlands Reserve Program, set up under the Farm Bill in 1996, is a voluntary program offering landowners the opportunity and government support to protect, restore, and enhance wetlands on their property. By 1999, fully 313,257 ha had been enrolled (TPL 1999, NRCS 2001).

At the global level, the Ramsar Convention on Wetlands of International Importance was signed in 1971, providing a farsighted framework for national and international action to conserve wetlands and use

their resources wisely (The Ramsar Convention 2000; Smart 1997). It is the only international convention addressing wetlands and both countries are Contracting Parties (Cox and Cintron 1997). The Convention establishes a List of Wetlands of International Importance. These sites, of which there are 53 in North America, act like migratory bird sanctuaries (Canada: 36, US: 117) (The Ramsar Convention 2000).

Although past US government authority over wetlands has been fragmented and inconsistent, plans for the restoration of the Florida

Box 12: Bilateral Cooperation, Wetlands and Waterfowl

For at least part of the year, North America's migratory waterfowl use coastal and inland wetlands as feeding, breeding, resting, and nesting grounds, benefiting from the diversity of food organisms (Bacon 1997). Discrete wetlands are used as 'stepping stones' for migratory waterfowl, with the loss of a vital link in the chain threatening the very survival of some species (Davidson 1999). With the extensive wetland loss over the years from the mid-1950s to the mid-1970s, waterfowl species were deprived of crucial habitat, and by the mid-1980s there had been alarming decreases in the populations of some key species compared to1970s levels (EC 1998a).

Waterfowl have always been the most economically important migratory species of bird in North America. Nature tourism and hunter-related activities have brought substantial economic returns: annually, more than US $20 billion in economic activity is generated by the more than 60 million people who watch migratory birds and the 3.2 million who hunt waterfowl (NAWMP 1998). Because of waterfowl's importance to hunters, their declines drew notable attention to the issue of wetland loss. Ducks Unlimited, a private organization originally established to preserve waterfowl for hunters, initiated a cooperative program among their branches in Canada, the United States, and Mexico in the 1990s that helped to restore, protect, or enhance over 3.8 million ha of wetlands (DU 2000).

Diving Duck Population, 1986-1996

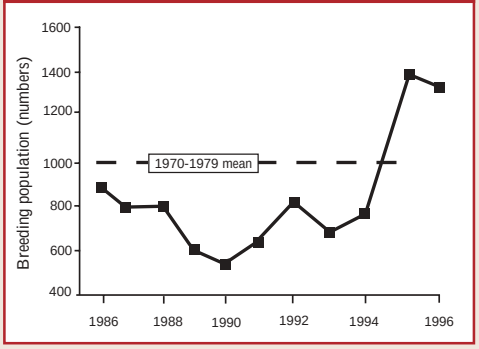


Figure 18 *Source: AAFC 2000*

Canada and the United States signed the North American Waterfowl Management Plan (NAWMP) in 1986, joined by Mexico in 1994. NAWMP is an innovative joint venture partnership among several levels of government, NGOs, the private sector, and landowners. The aim was to restore waterfowl populations to the 1970s benchmark levels (a breeding population of 62 million ducks, and winter populations of 6 million geese and 152,000 swans) through habitat protection, restoration, and enhancement (EC 1998a). During the 1988–1993 period, over 850,000 ha of wetland and associated upland habitat were protected through NAWAMP in Canada alone (NRC 2000). The Plan's vision was expanded in 1998 in a move away from restoring habitat for one particular group of animals to include biologically based planning to support other wetland species and ecological processes; integrated management of conservation, economic, and social programs; and collaborative efforts to find sustainable uses of landscapes (NAWMP 1998). As of April 1995, over a million ha of wetland habitat have been restored or enhanced and nearly 810,000 ha have been protected in the three countries (Cox and Cintron 1997).

As a result of these and other conservation efforts, there has been a marked rebound in most populations of duck, geese, and swans. Figure 18 shows the rapid recovery of diving duck populations after 1993. The rebuilding of migratory waterfowl populations since the 1980s is considered by some to be one of the most successful aquatic ecosystem conservation efforts in North America and a model of international conservation (Agardy, Hanson, and others 1999; Davidson 1999).

Everglades is testimony to the potential success of combined efforts among many levels of government, business, and ENGOs (see Box 13) (Schmid 2000; UNDP, UNEP, World Bank, and WRI 2000).

As yet, the Canadian government does not track or report on the status of its wetland resources (Rubec 2000). On the other hand, in 1992, Canada was the first nation to adopt a Federal Policy on Wetland Conservation, outlining guiding principles and seven key strategies to implement them. It commits the federal government to

Box 13: Restoration of the Florida Everglades

The Everglades is the central part of a 23,000 km^2 watershed covering the lower third of Florida (see Figure 19). With both fresh and salt water, it harbors a large variety of ecosystems, including rivers and lakes, sawgrass marshes, prairies, tropical hardwood forests, mangrove swamps, pine rocklands, and offshore coral reefs (NRDC 2000). Viewed as 'swampland' and an impediment to urban and agricultural development in the early part of last century, large tracts were drained and water supplies reconfigured. Protected from flooding by levees and canals, the process accelerated over the past 30 years, and South Florida became home to 6 million people along the Miami–Palm Beach corridor and an important sugarcane, fruit- and vegetable-producing region (UNDP, UNEP, World Bank, and WRI 2000).

Map of the Florida Everglades

Figure 19 *Source: USGS 2001a*

Originally stretching over 11,650 km^2, nearly half of the Everglades' wetlands have succumbed to development and to ecosystem destruction from exotic species and polluted runoff from sugarcane fields and other agricultural activity. This has led to less freshwater flowing to the coast, disrupted salinity levels, and altered the ecosystem's natural capacity to store and release water. The health of the Everglades deteriorated most rapidly in the past two decades with seagrass dieoffs, the invasion of non-native species, nutrient contamination, large algal blooms in Florida Bay, and declines in fishing harvests and in some bird populations. The region's wading bird population, for example, has declined by 90 percent over the past two decades (NRDC 2000; UNDP, UNEP, World Bank, and WRI 2000).

Regional efforts to address the problems began in the early 1980s, but it took until 1998 for all parties—the sugar industry, environmentalists, real estate developers, and American Indian tribes—to come together to support a comprehensive plan to restore and preserve south Florida's natural ecosystem while enhancing water supplies and maintaining flood protection. Developed by the Army Corps of Engineers, it is the world's most ambitious and extensive wetlands restoration effort, costing the federal government US $7.8 billion and taking over 20 years to complete (Alvarez 2000; Army Corps of Engineers 2000; UNDP, UNEP, World Bank, and WRI 2000).

'no net loss of wetland functions' on federal lands, a policy that is being complemented by conservation strategies in the provinces. Wetlands ecosystems make up about 17 percent of Canada's national parks and all together, about 10 percent are excluded from development (EC 1998b; Rubec and Thibeault 1998).

North America's abatement in wetland loss is a considerable achievement, but the fact remains that wetlands are still being lost to development. Changing conditions such as population growth, expansion of agricultural production, and economic growth, as well as changes in hydrological conditions linked to climate change may affect wetland habitat and the biodiversity it shelters (NAWMP 1998). Conservation efforts will need to remain flexible and be updated regularly to continue to sustain wetland habitats.

Bioinvasion

Bioinvasion (see Box 14) is now thought to be the second-gravest threat to global biodiversity, next to habitat destruction and degradation (CEC 2000a).

Since the 1970s, the largest increases in invasive aliens have been in insect pests and aquatic organisms found in ballast water. Seven and a half million litres of ballast water arrive in the United States every hour. Pacific coastal areas, the eastern part of the Great Lakes, parts of the Northeast, Florida, and Hawaii are entry points for high numbers of species. In San Francisco Bay, for example, a new introduction was established every 15 weeks between 1961 and 1995 (Carlton 2001). Competition or predation by non-native species imperils nearly half of the species listed as threatened or endangered under the US Endangered Species Act (Wilcove,

Box 14: Bioinvasion

Bioinvasion refers to the influx of alien invasive species, or species occurring outside their natural ranges, through direct or indirect assistance by humans. Alien species are considered to be invasive when they become established in natural or semi-natural ecosystems or habitat, are agents of change, and threaten native biological diversity. Alien invasive species include bacteria, viruses, fungi, insects, mollusks, plants, fish, mammals, and birds (IUCN 2001).

Species that become invasive may be introduced either intentionally or unintentionally through pathways (or vectors) that include transportation (by water, land, and air; in the goods themselves; in dunnage, packing materials or containers; and in or on ships, planes, trains, trucks or cars). Agriculture, horticulture and plant nursery stock, the aquaculture industry, the live food fish industry, baitfish, and the aquarium pet trades are major sources (Carlton 2001). Where there are no natural predators, invasive species can come to dominate ecosystems, and can alter the composition and structure of food webs, nutrient cycling, fire cycles, and hydrology and energy budgets, threatening agricultural productivity and other industries dependent on living resources (Westbrooks and Gregg 2000; Alonso, Dallmeier, and others 2001).

Rothstein, and others 1998). In Canada, alien species have been involved in causing risk to about 25 percent of endangered, 31 percent of threatened, and 16 percent of species of special concern (Lee 2001).

There is no scientific consensus on the characteristics that make a species a successful invader, but repeated and widespread introduction is likely to boost the ability of a species to take hold (Enserink 1999). Opportunities for invasives to establish themselves have also been enhanced due to increases in land disturbance from farming; highway and utility rights-of-way; clearing land for settlements and recreation areas such as golf courses; and constructing ponds, reservoirs, and lakes. Human population growth has increased recreational and commercial activity and the demand for food and fiber, which also opens the way to invasive species (Westbrooks 1998). And increased trade has accelerated the rate of exotic introductions.

The zebra mussel (*Dreissena polymorpha*), a mollusk the size of a thumbnail, has been one of North America's most problematic invasives. It probably first arrived in North America in the ballast water of cargo ships from the Black Sea in the late 1980s. In the past decade, it has spread through all major North American river systems and in 2002, it will have cost some US $5 billion in damage to shipping and power plants alone (PCAST 1998; Westbrooks and Gregg 2000). The sea lamprey, another species that invaded the Great Lakes, is responsible for the collapse of lake trout and other native Great Lakes fisheries. North America spends about US $13 million a year trying to control it (Alonso, Dallmeier, and others 2001). Despite requirements that ships exchange ballast water at sea, the influx of new species into the Great Lakes continues (see Figure 20) and is considered to be the most serious threat to the integrity of the Great Lakes ecosystem (GLFC 2000).

A few more examples serve to illustrate the various kinds of bioinvasions and the damage they can cause. The wood-boring Asian longhorned beetle (*Anaplophora giabripennis*), which probably arrived in North America in packing crates from China, was found consuming hardwood trees in New York City in 1996 and in Chicago in 1998. Left alone, the spread of infestation would have costly repercussions (Westbrooks and

Exotic Species Established in the Great Lakes

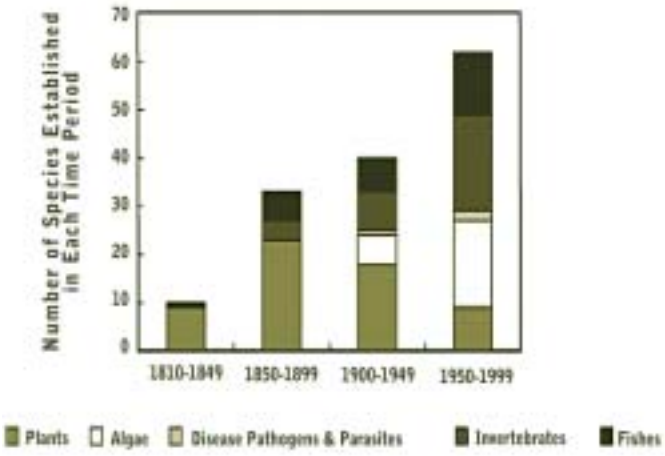


Figure 20
Number of exotic species established in the Great Lakes.

Source: H. John Heinz III Center, 2001.

Box 15: Introduced Aquatic Weeds

Purple loosestrife, (*Lythrum salicaria)*, which was introduced from Europe in the mid-1800s as a garden ornamental, has been spreading in North America at a rate of 115,000 ha a year, invading wetland habitats where it takes over from native plants and deprives waterfowl and other species of food sources. It is now migrating onto agricultural lands. After unsuccessful attempts to eradicate it by burning, mowing, and flooding, biological control programs, which use natural enemies to control pests, have been introduced. Since 1992, a coordinated program brought in four species of European insects that should significantly reduce its abundance in wetland habitat (Haber 1996; DU Canada 1998; Pimentel, Bach, and others 1999). When non-indigenous aquatic weeds such as purple loosestrife, Eurasian water milfoil, and hydrilla replace native species, they establish dense colonies that can impair navigation, water-based recreation, and flood control; degrade water quality and wildlife habitat; hasten the filling of lakes and reservoirs; and depress property values (Haber 1996; ANS Task Force 2000).

Gregg 2000). A wide variety of exotic tree pests arrive on untreated wooden pallets, crating, bracing, and other solid wood packing materials. Quarantines are established to avoid transporting infested trees and branches and to prevent the further spread of insect pests. Nearly all of the quarantine-significant tree pests found by US port inspectors are associated with such packing materials. Early detection of infestations and rapid treatment are crucial to their successful eradication (USDA 1999; USDA 2000b).

The booming exotic reptile trade is another vehicle for exotic introductions. African ticks have been known to arrive this way and are carriers of heartwater, a disease highly lethal to cattle, deer, sheep, and goats (Simberloff and Schmitz 1999). The US Department of Agriculture warns that with increased trade and movement of animals in a globalized market, heartwater may present a significant threat to the US livestock industry (APHIS 1997).

Invasive aquatic species are particularly threatening to wetland and freshwater ecosystems (see Box 15). Some can also pose serious health risks, as in the case of human cholera bacteria found in ballast tanks and in oyster and finfish samples in Mobile, Alabama in 1991 (ANS Task Force 2000). Others undermine important wetland habitats, as did the Nutria, a beaver-like animal introduced from South America (see Box 16). Alien aquatic species are expected to contribute to the extinction of native freshwater species in North America at a rate of 4 percent over the next century (Ricciardi and Rasmussen 1999).

The high economic costs of damage caused by bioinvasions in North America—to agriculture and other industries, human health and the costs of control—is causing increasing concern. It has been estimated that by 1998, about a quarter of the annual US agricultural GNP was lost to damage from, and control of, invasive species (PCAST 1998).

Responses to the challenge of invasive species include legislation, policies, plans, and programs that focus on preventing the invasion of

new species and the eradication or control of established invasives. Biological control, which involves importing a predator organism to feed on the invasive species, is increasingly being used to control invasives. It is usually more specific to the target than pesticides or herbicides. Because of its potential risk to native species and ecosystem functions, new rules were introduced under Canada's 2000 Plant Protection Act calling for environmental assessments before the release of predatory insects (Knight 2001).

Prevention is the best and cheapest approach to the problem of bioinvasions. Current policies ban the import of organisms that are known to be harmful. Some ecologists would prefer that all plants and animals be denied entry until proven harmless, a policy that was proposed by the US Fish and Wildlife Service in 1970 but opposed by many pet stores and nurseries (Kaiser 1999). Today, concerns are that such a policy could alienate trading partners (Licking 1999).

Over the years, isolated alarms led to a patchwork of federal and state laws and agencies to regulate introductions (Simberloff 1996). The 1990 US National Invasive Species Act was reauthorized and expanded in 1996 to initiate a voluntary open-ocean exchange program for ballast water with mandatory reporting requirements, but its effectiveness is unproven to date (Carlson 2001). With the recognition that threats posed by bioinvasions are broad and pervasive, an executive order in February 1999 created a high-level

Box 16: The Nutria

The nutria (*Myocastor coypus)* is a large semi-aquatic rodent native to South America. It was introduced into many areas of the world, including North America, primarily to be farmed for its fur. It was first brought to the state of Louisiana between the late 1800s and early 1900s, and released when the price of pelts fell and farms failed. Intentionally introduced into other southeastern states to control undesirable vegetation, or released accidentally, it has established widespread and localized populations in many states (Le Blanc n.d.; Westbrooks and Gregg 2000). Prolific breeders, Maryland's nutria population increased from 150 in 1968 to about 50,000 today (MPT 2001).

The nutria feeds only on plants, digging into wetland soils to eat the soft parts, which kills the vegetation, contributes to erosion, and results in loss of coastal land and wetlands (USGS 2001b). These animals have devastated wetland habitat for rare native species such as the bald eagle and eliminated crab and oyster nurseries. Furthermore, their digging has allowed salt water to invade swamps and wetlands, damaging vegetation and aggravating coastal erosion (Westbrooks and Gregg 2000). Although their pelts are economically valuable—the harvest between 1977 and 1984 was worth $7.3 million—their burrowing activity causes economic losses by undermining flood control structures, fish farming levees, buildings, boat docks, and roads. They graze on sugarcane, rice, and other food crops and destroy gardens and golf courses (Le Blanc n.d.). To provide more incentives for trappers to harvest more nutria, Louisiana has attempted to increase the demand for nutria pelts and to allow its meat to be processed for food (USGS 2001b).

Box 17: Bilateral and International Cooperation

The emerging InterAmerican Biodiversity Information Network (IABIN) is prototyping an invasive species information exchange, and under the auspices of the Commission for Environmental Cooperation of North America (CEC), it works with the North American Biodiversity Information Network (NABIN) to establish a framework to share data on invasive species spread, management, taxonomy, and impacts (CEC 2000b).

The CEC has also initiated a project called Closing the Pathways of Aquatic Invasive Species across North America to protect marine and aquatic ecosystems in Canada, Mexico, and the United States from the effects of aquatic invasive species. It is developing a coordinated, multinational prevention and control campaign to help eliminate the pathways through which invasive species are introduced to the region's coastal and fresh waters. The project will also examine pathways between major drainage basins (CEC 2001).

In another cooperative effort to stem bioinvasions, the North American Plant Protection Organization (NAPPO), a regional body of the International Plant Protection Convention, coordinates the efforts among Canada, the United States, and Mexico to protect their plant resources from the entry, establishment, and spread of regulated plant pests, while facilitating intra/interregional trade (NAPPO 2002). Canada and the United States also cooperate in International Joint Commission efforts related to aquatic invasive species in the Great Lakes.

US Council to devise a management plan to combat alien invasives (Kaiser 1999).

Both countries have developed monitoring plans and information systems to help control exotic introductions (Haber 1996; Kaiser 1999). For example, Canada has begun an Invasive Plants of Canada (IPCAN) monitoring project (Haber 1996) and the US Government's Invasive Species Council has developed an online information system (NAL 2000).

In recent years, bioinvasions have increased with the growth in volume of international trade and flow of people (Wilcove, Rothstein, and others 1998). Since January 1999, more than 50 alien pests, which could cause significant damage to forest, agricultural, and horticultural crops, have been intercepted at Canadian ports of entry (CFIA 2000). As the North American countries trade more with each other as well as countries with climates and habitats similar to those on this continent, new invasions are expected. At the same time, the growing commerce within North America strengthens the likelihood that one country's established invaders will spread to the others (Westbrooks and Gregg 2000). Canada and the United States increasingly work together and in international cooperative efforts to help to stem the tide of bioinvasions (see Box 17).

Global climate change is likely to increase the risks associated with invasive species. Warmer conditions may open up ecosystems that were once inhospitable to intruders, longer growing seasons may allow more plants to set seed, and rising CO_2 levels could boost the speed with which some invasive plants grow (Holmes 1998). The ability of exotic annual grasses to invade the deserts of western North America may be

enhanced, for example, which could not only reduce biodiversity and alter ecosystem function, but also accelerate the fire cycle (Smith, Huxman, and others 2000).

The threats posed by the introduction of exotic species in the wake of globalization illustrates that increased cooperation is required to adequately conserve the diversity of shared biological resources. Wider application of lessons learned as well as new strategies and more public understanding of why biodiversity is important are needed, and North American and global cooperation is essential to stem the tide of bioinvasions and the damage they cause.

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