Invasive and Other Problematic Species, Genes and Diseases

The threat category 'invasive and other problematic species, genes and diseases' (IUCN 8) includes both native and non-native plants, animals, pathogens, microbes, and genetic materials that have or are predicted to have harmful effects on biodiversity following their introduction, spread and/or increase in abundance. This definition encompasses a broad array of organisms, and the types of impacts to native species and habitats are equally variable. It includes invasive species that were not present in New Hampshire prior to European settlement, and have been directly or indirectly introduced and spread into the state by human activities.

A variety of wildlife species are vulnerable to increased predation from both native and non-native animals. Many species are also affected by diseases and parasites, including white-nose syndrome in bats, fungal pathogens in reptiles, and ticks and nematodes in moose. Native and non-native insects act as forest pests, damaging or killing native tree species and causing significant changes to wildlife habitats. Native tree species can also be affected by non-native fungal pathogens. Invasive plants can compete with native species for nutrients, water and light, and can change the physical environment by altering soil chemistry.

Risk Assessment Summary

Invasive species affect all 24 habitats and 106 SGCN. This is second only to pollution in the number of species affected. The majority of threat assessment scores were ranked as low (n=116, 51%), followed by moderate (n = 83, 37%) and high (n = 26, 12%). Only the moderate and high-ranking threats are summarized for each category in Table 4-17.

Non-native species and diseases affected the most species and habitats. This includes invasive animals, plants and diseases. Some of these have the potential to have dramatic effects on a species, as White-Nose Syndrome in bats has proven by reducing the populations of three species of bats by 90% and others by 50-90%.

An overpopulation of native species and disease also affects multiple species. In particular the increase of generalist predators such as foxes due to increased food sources in suburban neighborhoods can increase predation on other native species. Disease and parasite outbreaks are also causing mortality in some species, such as moose.

Known Wildlife Exposure Pathways

Avian & Mammalian Predators

Introduced and native predators (cats, raccoons, foxes, gulls, etc.) can have serious impacts on ground-nesting birds, particularly Piping Plover, Common Nighthawk, Common Tern, Least Tern, and Roseate Tern. Island-nesting birds such as Common and Roseate Terns also face competition from gulls for nesting sites. In freshwater habitats, introduced species such as bass can impact populations of native

fish such as redbelly dace and bridle shiner. Changes in fish communities can also adversely impact some freshwater mussel species by reducing the number of available host fish species.

Some species of gulls have increased exponentially along the northeastern coast resulting from a combination of factors including the protection of all seabirds, changes in human land use along coastal islands, a rise in the fishing industry, and the use of open landfills. Herring gulls began nesting on the Isles of Shoals in the 1920s, and the population peaked at 5,000 pairs in the late 1970s. Great black-backed gulls began nesting on the Islands in the 1950s and have steadily been replacing herring gulls (numbers compiled from Drury 1973, Borror and Holmes 1990, United States Fish and Wildlife Service (USFWS) Colonial Waterbird Survey 1994). These larger, more aggressive birds compete with terns for nesting sites and can prey directly on tern eggs and chicks (Goodale 2000, Donehower 2003). Data suggest that lobster bait is the primary food of herring gull chicks in Penobscot Bay. The frequency of lobster bait in the herring gull chick diet on five study islands was 56% in 1999 (n=251) and 41% in 2000 (n=605) (Goodale 2000).

Increased development and human use of coastal areas have allowed for an abundance of potential tern and plover predators (USFWS 1998, Kress and Hall 2004). Mammalian predators such as feral cats, rats, raccoons, mink, skunk, and fox that gain access to breeding habitats can devastate some local bird populations. Additionally, avian predators such as Great Horned Owls and Black-crowned Night-Herons feed on tern chicks and adults. Predation is a proximate mortality factor for New England cottontails, particularly those that occupy small habitat patches (Barbour and Litvaitis 1993, Brown and Litvaitis 1995, Villafuerte et al. 1997).

Diseases and Parasites

Diseases have affected a number of wildlife species, most notably white-nose syndrome, which has already decimated bat populations in New Hampshire. Timber rattlesnakes and other snake species are threatened by snake fungal disease. Moose populations are declining apparently as a result of a combination of brain worm and winter tick parasites. Soft-shell clams are being affected by transmissible cancer cells. Some diseases, such as white-nose syndrome, are brought to new places by attaching to the clothing and gear of outdoor recreationists, farm tourists and other travelers. Others come in shipments of goods from other countries, including pets, plants and livestock. Others may be transmitted between species as ranges expand.

White-Nose Syndrome is a disease affecting a variety of native bat species, caused by a non-native fungal pathogen (Lorch et al. 2011). The fungus infects overwintering bats in their hibernacula, damaging tissues and disrupting hibernation, leading to starvation and death. The fungus impacts all bat species in New Hampshire hibernacula, including northern long-eared bat, little brown bat, eastern small-footed bat, and tri-colored bat. In 2010, White-Nose Syndrome was first identified in New Hampshire hibernacula, and since that time, a mortality rate of affected bat species has been documented at almost 99%.

Snake fungal disease (SFD) is an emerging threat that has been documented in a number of native snake species (NEPARC 2013). The fungal pathogen *Ophidiomyces ophiodiicola* has been implicated as the primary cause of the disease, although this has yet to be definitively proven. The disease has been observed across most of the eastern U.S., has been confirmed in eight species of snakes, and is suspected in several others. In New Hampshire, mortality due at least in part to SFD is a particular threat for timber rattlesnakes, which are already highly vulnerable due to the small population size.

Amphibian populations are vulnerable to several established diseases such as *Chytrid* fungus and Ranavirus with concern for additional emerging diseases such as salamander *Chytrid* (*Batrachochytrium salamandrivorans)* currently known in Europe but not the United States.

Fish populations are also vulnerable to disease and parasites, although there is very little baseline data available to evaluate the risk that they pose to native fish populations. Diseases or parasites may impact populations indirectly. The swim bladder nematode *(Anguillicoloides crassus)*, introduced to the American eel from Japanese eel populations, does not kill eels directly, but it may affect the mature eel's ability to migrate to its spawning grounds in the Sargasso Sea (Palstra et al. 2007). Migratory fish populations may be exposed to disease as they encounter fish farming operations in the ocean (Bakke and Harris 1998). Commercially raised live bait used by anglers along with other fish culture operations are another potential source of introduced diseases, such as Viral Hemorrhagic Septicemia (VHS) (AFS 2005).

New Hampshire's moose population is in severe decline, apparently as a result of two different parasites. In northern New Hampshire, moose are preyed upon by winter ticks (*Dermacentor albipictus*). In bad years, these parasites can attack moose in huge numbers, with some individuals carrying 50,000 to 100,000 ticks. Heavily infested animals suffer loss of blood, hair, and overall body mass, often leading to hypothermia and starvation (Musante et al. 2007). In southern New Hampshire, moose are at risk from a nematode known as brain worm (*Parelaphostrongylus tenuis*). This neuroparasite is common in white-tailed deer, which apparently rarely suffer impacts from infection. In moose, however, animals exhibit symptoms such as loss of coordination, general weakness, impaired vision, fearlessness, and walking in circles (Anderson 1964). In moose, infection by brain worms as almost always fatal. In areas where deer populations have increased, infections of brain worm in moose have become more prevalent. In Minnesota, which has seen a similar decline in the moose population, 45% of moose autopsied where found to carry the brain worm parasite (Wunschman et al. 2015).

Along the north Atlantic coast from New York to Prince Edward Island, soft shell clams are experiencing mortality due a leukemia-like cancer. Studies on infected animals have shown that the cancer cells are genetically distinct from the host clams, while being nearly identical to one another (Metzger et al. 2015). It is speculated that these tumor cells developed in a single animal, and then somehow began translocating to other individuals. How these cells have spread over large distances is uncertain.

Forest Insect Pests

Insect pests have the potential to significantly impact wildlife habitats. Hemlock woolly adelgid is widespread in southern and central New Hampshire, and has the potential to cause extensive tree mortality. Native ash species are at risk from emerald ash borer, which has recently arrived in the state. In northern New Hampshire, spruce – fir forests are vulnerable to widespread mortality as a result of non-native balsam woolly adelgid and native spruce budworm.

Based on FIA plot data, hemlock is the second most abundant tree species in New Hampshire (Morin & Pugh 2014), with the greatest concentration in the hemlock - hardwood - pine forest habitat. The hemlock wooly adelgid sucks sap from young hemlock twigs, resulting in needle drop, twig die-back, growth reduction, and tree mortality over the course of several years (Havill et al. 2014). In terms of wildlife habitat, hemlock provides valuable wintering areas for white-tailed deer, and is an important cover species for ruffed grouse, turkey, and snowshoe hare (Jordan & Sharp 1967). Hemlock is also used as a food source or nesting site for a large number of bird species (Lapin 1994). Widespread

mortality of this species could have significant consequences for a wide variety of wildlife in New Hampshire.

Emerald ash borer (EAB) is an insect pest that feeds on and kills native ash (*Fraxinus* spp.) species. This non-native beetle was first identified in North America in Michigan in 2002 (USDA 2008). It has since spread to 24 states and two Canadian provinces, killing tens of millions of ash trees. It was first discovered in New Hampshire in 2013 in Concord, and has since been found in nine other towns. All three of New Hampshire's native ash species are vulnerable to attack by EAB, but white ash (*Fraxinus americana*) is by far the most abundant species, making up a significant component of the northern hardwood – conifer forest. The loss of ash in this habitat could have significant impact on forest structure, creating large openings and potentially altering soil composition. There are also at least 43 species of arthropods known to feed exclusive on ash species, all of which could face a threat of extinction with the loss of these trees (Gandhi & Herms 2010).

In northern New Hampshire, spruce – fir forests are vulnerable to attack from a combination of insect pests. The first, balsam woolly adelgid, is a non-native insect that attacks balsam fir (and other fir species), feeding on twigs and stems. Although cold temperatures appear to be preventing it from surviving at elevations above 2,200', balsam fir at lower elevations may be eliminated from most areas of the state. The other major insect pest in this habitat is spruce budworm. This is a native moth that, despite its name, feeds primarily on balsam fir, although it will also attack spruces, particularly during significant outbreaks. Historically, budworm and spruce bark beetle outbreaks were important disturbance agents that regenerated spruce-fir forests and maintained a diversity of age classes on the landscape. They primarily target mature forests, and result in regeneration of stands with essentially the same species composition. There has not been a significant outbreak of spruce budworm in recent decades, but recent surveys indicate that budworm concentrations are increasing. A major outbreak in conjunction with balsam woolly adelgid damage could devastate balsam fir by causing the outbreak to be more serious than historical outbreaks. Although regeneration of balsam fir forests is important for healthy forests, a serious outbreak could impact wildlife that rely on those habitats, such as Bicknell's thrush, American marten, and lynx, particularly if the regenerating forest differs form the spruce-fir type.

Invasive Plant and Animal Species

Invasive plants can displace native plant species and alter ecosystem processes. Invasive species such as Japanese barberry (*Berberis thunbergii*), burning bush (*Euonymus alatus*), and glossy buckthorn (*Frangula alnus*) can invade forests, particularly in areas that have been fragmented by development.

Horticulture has been responsible for the introduction and spread of a number of exotic plants. In fact, the majority of woody invasive plants in the U.S. (85%) were introduced for horticultural purposes including landscaping, gardening, mitigation of soil erosion, and improving wildlife habitat (Reichard 1997 as cited in Reichard and White 2001). In accordance with the Invasive Species Act (1258-FN), there are 27 species listed as invasive in New Hampshire, including Japanese knotweed (*Fallopia japonica*), Norway maple (*Acer platanoides*), Japanese barberry, glossy buckthorn, and others. According to the law, "No person shall collect, transport, import, export, move, buy, sell, distribute, propagate or transplant any living and viable portion of any plant species, which includes all of their cultivars and varieties," listed in the Act. These and other invasive exotic plants may decrease plant species diversity, produce allelopathic chemicals that retard other species, modify disturbance regimes, and significantly modify the species' composition and structure of vegetation (Silander and Klepeis 2001). These mechanisms may inhibit forest regeneration and degrade wildlife habitat.

In New Hampshire, there are several exotic plants that are particularly problematic in floodplain habitats, where the combination of rich soils and frequent disturbance are well-suited to non-native invasives. Common invasive plants in floodplains include Asian bittersweet (*Celastrus orbiculatus*), Japanese knotweed, and black swallowwort (*Cynanchum louiseae*) (ISI 2005). Asian bittersweet can completely envelop both hardwoods and conifers, leading to mortality of the trees they use for support. Although research into specific effects of invasive plants on wildlife has been limited, studies have shown that Japanese knotweed (Maerz et al. 2005) and European buckthorn (*Rhamnus cathartica*) can have measurable negative impacts on amphibians. Additionally, climate change may exacerbate the invasive species threat. Increased stress, new deposits of mineral soil, eroded surfaces and edge habitat may lead to increases in invasive species which specialize in disturbed edge habitats. More intense flooding events may also disperse invasive species into new areas.

Invasive aquatic species, including Eurasian milfoil (*Myriophyllum spicatum*)and water chestnut (*Trapa natans*), are gradually increasing their range in New Hampshire (NHDES 2008). These species have the potential to change the composition of native aquatic plant communities, especially in smaller, shallow waterbodies. Invasive plant species are often spread by recreational boaters and their establishment is aided by dredging and other disturbance of native plant communities. Large scale efforts to control invasive aquatic plants using techniques such as herbicide application, mechanical harvesters, or hand pulling, reduce the range of the plant in the short term, but are difficult to sustain over the long term (Roley and Newman 2008). The NH Lake Host Program has been effective at slowing the spread of aquatic invasive species by staffing boat ramps with trained personnel who both educate boaters and inspect boats for invasive species before they are launched.

In aquatic settings, zebra mussels have a high potential to significantly affect the state's freshwater mussels, especially the state endangered dwarf wedgemussel. After their discovery in Lake Saint Clair (in the Great Lakes Region) in 1988, zebra mussels quickly spread throughout many regions of the United States and parts of Canada. Adult zebra mussels are transported to waterbodies while attached to boats, and larvae may be transported in bilge and bait bucket water. Zebra mussels compete with native freshwater mussels for food and may reduce food concentration to levels that cannot support native species (Strayer 1999). The Connecticut River is at high to serious risk of zebra mussel colonization (Michelle Babione, Silvio O. Conte National Wildlife Refuge, personal communication).

The invasive Asian Clam (*Corbicula fluminea*) has been introduced to the Merrimack River watershed and has expanded its range. Like the zebra mussel, the Asian clam has the potential to alter freshwater ecosystems by out competing native fauna and impacting the food web by consuming large quantities of zooplankton (Souza et al. 2008). Introduced fish species can also have major impacts on native aquatic species. Largemouth bass, introduced throughout the northeast due to its popularity with anglers, have contributed to significant declines in native minnow diversity (Whittier et al. 1997). The northern snakehead, a voracious predator native to northeast Asia, was introduced to a pond in Maryland in 2002 and has since expanded its range throughout the Potomac River watershed. Fish introductions, whether by anglers or aquarists, are difficult to prevent without effective public information campaigns and law enforcement.

Research Needs

- Evaluate predator control techniques to protect common, roseate, and arctic terns and piping plovers.

- Determine ecology of gull populations at Isle of Shoals, including sources and importance of human-subsidized food.
- Evaluate modifications to fishing and aquaculture practices to minimize subsidization of gulls and other predators.
- Evaluate effect of landfills on predator abundance, impacts to at-risk species, and modifications to reduce impacts.
- Evaluate locations and extent of human food supplements for predators in rare species habitats.
- Assess the impacts of predation by introduced fish species on native fish species and other fauna (e.g. freshwater mussels).
- Assess threats from diseases to species of concern in New Hampshire.
- Assist health officials with understanding interactions of wildlife diseases and human health.
- Evaluate the long term impacts of invasive plants and animals on aquatic ecosystems along with the impacts and effectiveness of different control practices to help inform management strategies.
- Identify and monitor existing and potential transport mechanisms for invasive species
- Research and evaluate forms of invasive plant and animal control.
- Collect data on invasive species abundance and distribution to identify current threat areas.
- Identify species and sites for invasive species management, which can be combined with existing efforts (e.g., Invasive Plant Atlas of New England and New Hampshire's Estuarine and Freshwater Working Group).
- Research effects of introduced species on at-risk wildlife and associated habitats
- Assess habitat characteristics that facilitate invasions by exotic plants.

Table 4-17. Habitats and species at highest risk from the effects of invasive & other problematic species, genes & diseases (threats ranked as *Low* not included here). Some habitats and species were evaluated for multiple specific threats separately and therefore listed multiple times below. See Appendix E for additional information on specific threats and rankings.

Habitat	IUCN Level 2	Overall Threat Score
Appalachian Oak Pine Forest	Invasive non-native/alien species/diseases	M
Appalachian Oak Pine Forest	Problematic native species/diseases	M
Coastal Islands	Problematic native species/diseases	H
Dunes	Invasive non-native/alien species/diseases	M
Estuarine	Invasive non-native/alien species/diseases	M
Estuarine	Not Specified	H
Floodplain Forests	Invasive non-native/alien species/diseases	M
Grasslands	Invasive non-native/alien species/diseases	M

Hemlock-Hardwood-Pine Forest	Invasive non-native/alien species/diseases	H
High Elevation Spruce-Fir Forest	Invasive non-native/alien species/diseases	H
Large warmwater rivers	Not Specified	M
Lowland Spruce-Fir Forest	Problematic native species/diseases	H
Marine	Invasive non-native/alien species/diseases	M
Northern Hardwood-Conifer Forest	Not Specified	H
Salt Marsh	Invasive non-native/alien species/diseases	M
Shrublands	Invasive non-native/alien species/diseases	M
Shrublands	Problematic native species/diseases	M
Temperate Swamp	Invasive non-native/alien species/diseases	H
Vernal Pools	Invasive non-native/alien species/diseases	M
Warmwater lakes and ponds	Not Specified	M

Common Name	**IUCN Level 2**	**Overall Threat Score**
American Black Duck	Introduced genetic material	M
American Eel	Invasive non-native/alien species/diseases	M
American Kestrel	Problematic native species/diseases	M
American Marten	problematic native species/diseases	H
American Oysters	Invasive non-native/alien species/diseases	M
American Shad	Problematic native species/diseases	M
Atlantic Sea Scallop	Invasive non-native/alien species/diseases	M
Bald Eagle	Problematic native species/diseases	M
Banded Sunfish	Invasive non-native/alien species/diseases	M
Bicknell's Thrush	Not Specified	M
Big Brown Bat	Invasive non-native/alien species/diseases	M

Black-billed Cuckoo	Invasive non-native/alien species/diseases	M
Blueback Herring	Problematic native species/diseases	M
Blue-winged Warbler	Invasive non-native/alien species/diseases	M
Blue-winged Warbler	Problematic native species/diseases	M
Bobolink	Invasive non-native/alien species/diseases	M
Bridle Shiner	Invasive non-native/alien species/diseases	M
Brook Trout	Not Specified	M
Brown Thrasher	Invasive non-native/alien species/diseases	M
Brown Thrasher	Problematic native species/diseases	M
Canada Warbler	Invasive non-native/alien species/diseases	M
Canada Warbler	Not Specified	M
Cerulean Warbler	Invasive non-native/alien species/diseases	M
Cerulean Warbler	Not Specified	M
Common Gallinule	Invasive non-native/alien species/diseases	M
Common Nighthawk	Problematic native species/diseases	H
Common Tern	Problematic native species/diseases	H
Dwarf Wedgemussel	Invasive non-native/alien species/diseases	M
Eastern Meadowlark	Invasive non-native/alien species/diseases	M
Eastern Small-footed Bat	Invasive non-native/alien species/diseases	H
Eastern Towhee	Invasive non-native/alien species/diseases	M
Eastern Towhee	Problematic native species/diseases	M
Eastern Whip-poor Will	Not Specified	M
Field Sparrow	Invasive non-native/alien species/diseases	M
Field Sparrow	Problematic native species/diseases	M
Finescale Dace	Invasive non-native/alien species/diseases	H

Frosted Elfin	Invasive non-native/alien species/diseases	M
Golden-winged Warbler	Invasive non-native/alien species/diseases	M
Golden-winged Warbler	Problematic native species/diseases	M
Hognose Snake	Diseases of unknown cause	M
Horseshoe Crab	Invasive non-native/alien species/diseases	M
Jefferson/Blue-Spotted Salamander Complex	Introduced genetic material	M
Karner Blue Butterfly	Invasive non-native/alien species/diseases	M
Least Bittern	Invasive non-native/alien species/diseases	M
Least Terns	Problematic native species/diseases	H
Little Brown Bat	Invasive non-native/alien species/diseases	H
Lynx	Problematic native species/diseases	H
Marsh Wren	Invasive non-native/alien species/diseases	M
Monarch	Invasive non-native/alien species/diseases	M
Monarch	Problematic native species/diseases	M
Moose	Problematic native species/diseases	H
New England Cottontail	Problematic native species/diseases	M
Northern black racer	Diseases of unknown cause	M
Northern myotis (Northern Long-eared Bat)	Invasive non-native/alien species/diseases	H
Northern Redbelly Dace	Invasive non-native/alien species/diseases	H
Northern Shrimp	Invasive non-native/alien species/diseases	M
Peregrine Falcon	Problematic native species/diseases	M
Pied-billed Grebe	Invasive non-native/alien species/diseases	M
Piping Plover	Problematic native species/diseases	H
Prairie Warbler	Invasive non-native/alien species/diseases	M
Prairie Warbler	Problematic native species/diseases	M

Purple Finch	Invasive non-native/alien species/diseases	M
Purple Martin	Invasive non-native/alien species/diseases	M
Ribbon snake	Diseases of unknown cause	M
Roseate Tern	Problematic native species/diseases	H
Round Whitefish	Invasive non-native/alien species/diseases	M
Scarlet Tanager	Invasive non-native/alien species/diseases	M
Scarlet Tanager	Not Specified	M
Sedge Wren	Invasive non-native/alien species/diseases	M
Softshell Clam	Invasive non-native/alien species/diseases	M
Softshell Clam	Not Specified	H
Sora	Invasive non-native/alien species/diseases	M
Spruce Grouse	Problematic native species/diseases	H
Timber Rattlesnake	Diseases of unknown cause	H
Tri-colored Bat	Invasive non-native/alien species/diseases	H
Upland Sandpiper	Not Specified	M
Veery	Invasive non-native/alien species/diseases	M
Veery	Not Specified	M
Vesper Sparrow	Invasive non-native/alien species/diseases	M
Wood Thrush	Invasive non-native/alien species/diseases	M
Wood Thrush	Not Specified	M
Wood Turtle	Problematic native species/diseases	M

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