Description of the Basin

The Northeast Lake Ontario-St. Lawrence River (NELO-SLR) Basin is the second largest in New York State (NYS) in terms of land area, covering all or part of 9 counties and about 4.9 million acres (7,600 square miles), including all of St. Lawrence County, most of Franklin County, large portions of northern Jefferson, Lewis, Herkimer and Hamilton counties, and small parts of Essex and Clinton counties. The NELO-SLR Basin is bordered to the west by a north-south line in Lake Ontario, passing through Kingston, Ontario and along the shore as far south as Stony Point, and to the north by the St. Lawrence River. The basin covers three major watersheds (St. Lawrence River, Black River, and the northeastern portion of Lake Ontario and its tributaries) and seven sub-watersheds (St. Lawrence mainstem, Black Lake/Indian River, Grasse River, Oswegatchie River, Saint Regis River, Raquette River, and English-Chateaugay-Salmon Rivers). There are more than 14,000 miles of mapped rivers and streams in the Basin (USGS Watershed Index) and more than 1,000 lakes (DEC Division of Water, 2002). Some of the major lake systems in the Basin include the Stillwater Reservoir, the Fulton chain of lakes (Herkimer County), Raquette Lake, Blue Mountain Lake, Little Tupper Lake, Long Lake, and Round Lake (Hamilton County) in the southern part of the Basin, Perch Lake (Jefferson County), Cranberry Lake, Carry Falls Reservoir (St. Lawrence County), and Tupper Lake (Franklin County) in the central part of the Basin, and Black Lake (St. Lawrence County) and Upper Chateaugay Lake (Clinton County) in the northern part of the Basin.

The St. Lawrence River is one of the most significant waterways in North America. Extending 760 miles from Lake Ontario to the Gulf of St. Lawrence, the St. Lawrence River is the gateway between the North Atlantic and the Great Lakes. At its most downstream point in the United States (near Cornwall, Ontario), the St. Lawrence drains an area of nearly 300,000 square miles (DEC, Division of Water, 2002). The upper St. Lawrence River can be divided into three sections: the Thousand Islands section, the middle corridor section, and Lake St. Lawrence. The Thousand Islands section (northwestern Jefferson County and southwestern St. Lawrence County) includes a complex of islands, numerous shoals, and channels. The middle corridor (St. Lawrence County) is relatively narrow with few islands and is more riverine in nature. Lake St. Lawrence (northeastern St. Lawrence County) is a 30-mile long impounded section created by the Moses-Saunders Power Dam. The river section downstream of Moses-Saunders Dam extends 7 mi. to the Quebec border and has unique habitats of backwaters, tributary mouths, and a powerful tailwater turbulent zone. The most downstream segment and adjoining lands are governed by the St. Regis Mohawk Tribe of American Indians. Because of the benefits provided by the St. Lawrence River in the form of transportation, fishing, hunting, and fertile soils, the river has been used by humans for at least 10,000 years. Despite the heavy use that has occurred since, (Thompson, et al., 2002), including international commercial transport, hydroelectric power generation, and industrial and residential development, the river continues to support a diverse array of fish and wildlife.

Lake Ontario has a total surface area of more than 7,500 square miles and a maximum depth of more than 800 feet. The eastern basin portion of the Lake in the NELO-SLR watershed is about 800 square miles and is relatively shallow, with a maximum depth of less than 200 feet. This eastern part of Lake Ontario

extends from Stony Point, northward to the outlet of the St. Lawrence River (Tibbetts Point, New York - Wolfe Island, Ontario). The area contains a series of rocky points, islands, and shoals. Several are found here which include Henderson Bay, Black River Bay, Chaumont Bay, and Guffin Bay. Wetlands occupy the more protected areas of the bays. The bays are considered mesotrophic and open lake areas are oligotrophic. As with the St. Lawrence River, Lake Ontario in general, and the bays of northeastern Lake Ontario in particular, have been providing consumptive and non-consumptive benefits to people for thousands of years. The region continues to help support New York State's economy by sustaining a robust recreational fishery, by serving as a commercial transportation link, and by providing high-value residential and commercial development. Chaumont Bay was formerly the center of a robust commercial fishery for brown bullhead, yellow perch, and other pan fish. There are only 4 active license holders in that fishery today. Northeastern Lake Ontario and its tributaries have provided recreational benefits in the form of fishing, hunting, trapping, boating, and wildlife viewing, and provide crucial fish and wildlife habitat, such as nursery and spawning grounds for a diverse array of fish species, islands that support a significant breeding population of colonial waterbirds; a migratory corridor for passerine birds, raptors, and waterfowl, and marshes that support amphibians, invertebrates, and other species of conservation concern.

Several major rivers carry water from the northern slope of the Adirondacks and converge near Massena, where they join the St. Lawrence. The Salmon, St. Regis, Raquette and Grasse rivers each have headwater and midsection areas as trout fisheries. Their lower sections are in the St. Lawrence Plain as sandy-low gradient habitat suited to fishes of the St. Lawrence, like sturgeon, muskellunge and Iowa darters. The Oswegatchie River joins the St. Lawrence farther to the west, at Ogdensburg, and the watershed has west-slope Adirondack areas which are more severely affected by poor neutralizing capacity to the acid rainfall. There are portions of 20 rivers in the basin that have been designated under DEC's Wild, Scenic, and Recreational Rivers Program. Some of these include the Grasse, Salmon, Oswegatchie, Raquette, and St. Regis.

The Black River and smaller tributaries of the Northeast Lake Ontario shoreline drain about 2,500 square miles in north-central NYS. This area includes portions of the western Adirondacks, the Tug Hill Plateau, and lowlands along the Lake Ontario shore. The Black River itself drains 1,900 mi encompassing much of Lewis County, large parts of Jefferson and Herkimer counties, and smaller portions of Hamilton and Oneida counties. The Black River is a large, warm water river, with a bedrock substrate (in free-flowing sections). The river has been dammed at many upstream and downstream locations for generation of hydroelectric power. Similar to the other river systems described above, the Black River watershed is sparsely populated. Human uses of the area are primarily silviculture and recreation/tourism in the heavily forested Adirondacks, agriculture and silviculture (paper manufacturing) in the valley between the Tug Hill Plateau and the Adirondack Mountains, and agriculture and recreation (e.g., hunting, fishing, trapping) in the East Ontario Plain (lowlands along Lake Ontario in west-central Jefferson County). Conservation efforts to mitigate the effects of hydroelectric dams on this waterway have increased the accessibility of the river to Lake Ontario salmonids in the lower 10 miles, and today the fishery at the river mouth attracts visitors from throughout New York State and beyond.

From a terrestrial perspective, the NELO-SLR Basin is comprised of two ecoregions (as defined by The Nature Conservancy). Roughly half of the watershed is classified as northern Appalachian boreal forest. This area is made up primarily of the Adirondack Mountains and the northeastern fringe of the Tug Hill Plateau (southwestern Lewis County), and is heavily forested. This plan will focus on the Adirondacks, as the vast majority of the Tug Hill Plateau falls within the Southeast Lake Ontario Basin. The St. Lawrence/Champlain Valley ecoregion defines the remaining half of the area and extends from northern Clinton County, along the St. Lawrence River, southwest through Jefferson County, terminating at the East Ontario Plain. This expanse is often referred to as the St. Lawrence Valley and was formed 12,000 years ago as the glaciers receded. The land is primarily flat as a result of the underlying bedrock, the weight of ancient glaciers, and the shifting levels of the water that filled the valley at the end of the last glacial period (Thompson, et al., 2002). The St. Lawrence/Champlain Valley ecoregion also includes the Black River Valley in Lewis County, which separates the Tug Hill Plateau from the Adirondacks. Both the St. Lawrence Valley and the Black River Valley are largely outside of the Adirondack Park boundary and are comprised of relatively open habitats.

Despite the NELO-SLR Basin's large size, it is among the least populated in the state with about 350,000 people. In fact, this Basin has the lowest population density in the state with only 45 people per square mile (U.S. Census Bureau, 2002). The human population of the Basin is mostly rural, with small population centers located along the St. Lawrence River and its larger tributaries. They include Massena (population 13,121, St. Lawrence County), Ogdensburg (population 12,364, St. Lawrence County), Potsdam (population 15,957, St. Lawrence County), and Malone (population 14,981, Franklin County; U.S. Census Bureau, 2002). The City of Watertown near the mouth of the Black River is the largest urban population center in the Basin (population 26,705, Jefferson County; U.S. Census Bureau, 2002). Fort Drum, a 107,000-acre (168 sq. mi.) military reservation, lies just outside the city. The majority of the human population in this Basin is condensed within the St. Lawrence Valley and the eastern shore of Lake Ontario, and as a result, many of the threats to wildlife and their habitats also occur there. However, despite these stresses, the NELO-SLR Basin retains a large percentage of natural and semi-natural habitats.

The Basin is comprised of a diverse array of habitats, from the extensive hardwood and boreal forest and wetland systems of the Adirondacks, to the agricultural and grass and marsh habitats of the lowland areas associated with the St. Lawrence and Black River valleys and the East Ontario Plain. The predominant habitat type within the watershed is forest (about 70%), including deciduous, coniferous, and mixed forest habitats (Figure 1, Northeast Lake Ontario-St. Lawrence Table 1). Anthropogenic uses dominate about 18% of the Basin (Figure 1, Northeast Lake Ontario-St. Lawrence Table 1). This includes agriculture (row crops 10%, pasture/hay land 6%); residential and commercial/industrial development (1%); barren areas (quarries, strip mines, gravel pits < 1%), and lawns and golf courses (<1%). More than 11% of the NELO-SLV Basin is classified as aquatic habitat (Figure 1, Northeast Lake Ontario-St. Lawrence Table 1). About 8% of this is classified as wetlands, the majority of which are wooded wetlands. The remaining 3% classified as "water" encompasses thousands of lakes and ponds, miles of rivers and streams, and roughly one-third of the NYS share of the coast of Lake Ontario (Figure 1, Northeast Lake Ontario-St. Lawrence Table 1).

These habitats accommodate 110 Species of Greatest Conservation Need (SGCN; Northeast Lake Ontario-St. Lawrence Table 2). This is about 21% of the 537 species designated as SGCN in New York State (Northeast Lake Ontario-St. Lawrence Table 3) and includes 61 bird species, 15 insect species, 15 amphibian and reptile species, 9 freshwater fish species, 5 mammal species, 4 mollusk species, and 1 species of marine fish. There are 35 species that historically occurred in the Basin, but are now believed to be extirpated (Northeast Lake Ontario-St. Lawrence Table 4).

Critical Habitats of the Basin and the Species That Use Them

SGCN within the NELO-SLR Basin occupy a landscape mosaic of interconnected terrestrial and aquatic habitats shaped by natural and human processes. Overall, the landscape of the Basin ranges from the high-elevation alpine forests and lowland boreal marshes of the Adirondacks, to the wooded and emergent marshes and rich agricultural lands in the St. Lawrence Valley. These habitats are bordered by Lake Ontario and the St. Lawrence River, which is part of the largest aquatic system in the nation. This diversity and interspersion of habitat types allows this region to support both common and rare species of fish and wildlife.

Forested Habitats

Forested habitats dominate the NELO-SLR Basin and range from lowland deciduous, evergreen, and mixed forests to the boreal forests of the higher elevations of the Adirondacks. For the purposes of this document, the forested habitats will be divided into two general regions: the Adirondack Mountains and the St. Lawrence Valley (including the Black River Valley in Lewis County and the East Ontario Plain in Jefferson County).

The 6-million acre matrix of public and private lands of the Adirondack Park is comprised of some of the largest, intact stretches of forest (including some first growth) in the state including alpine/boreal forest communities. State-owned lands within the Adirondack Forest Preserve have special regulations covering their use. Logging and prescribed fires are not permitted. Within the Adirondacks, more than 3.2 million acres of Forest Preserve lands will remain forever wild. Predominant vegetation types in this region are beech-maple forest, hemlock-northern hardwood forest, and spruce-fir forests. These habitats support wide-ranging mammals, such as marten and fisher; early successional birds, such as Canada warbler, ruffed grouse, and American woodcock; raptors, such as long-eared owl, and forest interior birds, such as wood warblers and various thrushes. Abandoned mines and natural caves provide bat habitat and support listed species such as the Indiana bat. Alpine tundra ecosystems exist on several of the Basin's highest mountain peaks, such as Seward Mountain (4,300 feet, Franklin County). These areas are characterized by shrubs, herbs, mosses, and lichens. Plant communities of the alpine zone have survived in these isolated and exposed habitats since the end of the last glacial period.

Critical habitat types of the Adirondacks include, mature forests, early successional forests, high elevation regenerating conifer stands, and the lowland boreal system. The lowland boreal system is an area of moderately low diversity in which the plants and animals are adapted to short summers and deep snow and in which songbirds, insects, and evergreens are common (Jenkins, in review). The Adirondacks are technically south of the true Boreal Zone but still have extensive tracts of habitat characteristic of the southern edge of the true boreal, where northern animals and plants are subject to boreal processes (Jenkins, in review). Common forest vegetation types of the lowland boreal include conifer swamps and low bog forests. The largest corridors of boreal habitat are found in the northwest Adirondacks, a large portion of which is within this Basin and contain significant populations of northern plants, such as black spruce, white spruce,

dwarf cranberry, bog aster, and various sedges, and northern animals, such as spruce grouse and bay-breasted warbler (Jenkins, in review).

High elevation forests provide critical habitat for Bicknell's thrush. It is found primarily above 2800 feet in dense fir or spruce thickets, in particular regenerating fir waves. This species has a very limited global population and breeding range, and NYS has a substantial portion of the global population.

Early successional habitats are critical for a host of early successional birds. The vast majority of these species are in widespread and often steep declines. Habitat for these species in the forest preserve is dependent on natural disturbances since the state constitution prohibits management practices that would create and/or maintain them. Therefore, private lands are essential to maintain these habitats and NYS easements on working forests will allow them to remain as working forests and benefit this habitat.

Mature hardwood and mixed forests are also important, as they provide habitat for a wide variety of forest-nesting species, including Neotropical forest birds and amphibians. Most of the bird species that rely on this habitat are doing well, and the large amount of Forest Preserve lands will help to ensure this for the future.

The transitional lowland forests of the St. Lawrence Valley lie between the boreal forests and the broadleaf deciduous zone. Soils in the St. Lawrence Valley are made up primarily of marine clays that resulted from an influx of seawater at the end of the glacial period and have influenced the composition of forested habitats. Forests in this region of the basin are dominated by conifers, such as hemlock and pine, and deciduous species, such as birch, beech, maple, and oak. Due largely to anthropogenic causes, forested habitats are more fragmented in the St. Lawrence Valley than in the Adirondacks. The rich agricultural lowlands in the St. Lawrence Valley comprise the matrix within which these maple-beech-birch northern hardwood forests are embedded. Despite this fragmentation, forest tracts are sizeable enough to support species that require large, intact stretches of forest. Early successional habitats that have taken hold from more recently abandoned agricultural endeavors can be found spread throughout the Valley and support species such as Canada warbler and golden-winged warbler. Examples of this critical habitat type can be observed at Ashland Wildlife Management Area (2,000 acres, Jefferson County).

Wetland and Other Aquatic Habitats

There are about 400,000 acres of wetlands in the NELO-SLR Basin (MRLC Data, 2005), roughly 250,000 of which are outside the Adirondack Park (DEC, 2003). Wetlands in the Basin can be characterized in three ways:

(1) Wetlands embedded in a forest matrix (primarily the Adirondacks, the fraction of Tug Hill that is in this Basin, and some wooded wetlands of the central St. Lawrence Valley). Wetland types include bogs (characterized by peat and sphagnum mosses), wooded swamp/bottomland forest (mature trees including cedar, red maple, silver maple, and black ash), shrub swamp (woody shrubs such as speckled alder and various species of willow and dogwoods), and vernal pools (seasonal/temporary ponds or wetlands often associated with wooded habitats).

(2) Wetlands embedded in a grassland matrix (primarily the St. Lawrence Valley). Wetland types here are often characterized as "pothole" or "sheetwater" wetlands and include emergent marsh (frequently or continually flooded wetlands with plants such as cattails and rushes) and wet meadows (seasonal wetlands with grasses and sedges).

(3) Coastal marshes and embayments (shores of eastern Lake Ontario and the St. Lawrence River). Wetland types include open embayments, protected embayments, barrier-beaches, and drowned river mouths.

Based on these three broad categories the following descriptions attempt to provide a general feel for the wetlands in the watershed.

The proportion of wooded wetlands in this Basin is among the highest in the state and includes the extensive lowland boreal wetlands of the Adirondacks. New York State's wetlands are found in the Adirondacks, and wetland types include spruce-fir swamp, shallow emergent marsh, sedge meadow, boreal wetlands, and vernal pools dotted across the landscape. These habitats support wetland birds such as American bittern, least bittern, and pied-billed grebe. Marsh and vernal pool habitats also support herpetofauna such as blue-spotted and Jefferson salamanders. As discussed above, wetlands of the lowland boreal system found in the Adirondacks are a significant habitat feature and contain significant populations of wetland-dependent northern plants and animals. Common vegetation types of the lowland boreal include conifer swamps, low-bog forests, open sphagnum bogs, tall-shrub swamps, and shrub-sedge meadows. Some wooded wetland types and plant communities in the Basin are uncommon. Bogs, fens, alpine peatlands, cedar swamps, and black gum swamps are all examples of rare wetland plant communities. An example of a rare wetland ecotype within this Basin is the boreal peatland complex near Lake Clear in Franklin County. Spring Pond Bog Preserve, a 4,200-acre parcel acquired by The Nature Conservancy, contains the second-largest expanse of peatland in New York State.

Wooded wetlands are not restricted to the Adirondacks. Patches of wooded wetlands are spread throughout the St. Lawrence Valley, with concentrations in the central (North-central St. Lawrence County) and eastern (northern Clinton County) parts of the Valley. An excellent example of wooded wetlands can be seen at Upper and Lower Lakes Wildlife Management Area (8,600 acres; St. Lawrence County). Species of interest, found here include black tern, pied-billed grebe, least bittern, osprey, and common loon.

The St. Lawrence Valley contains extensive agricultural grasslands interspersed with abundant freshwater wetlands and tributaries. When compared with other areas in the northeastern United States, the mix of grasslands (400,000 acres) and wetlands (150,000 acres) found in the St. Lawrence Valley provide critical habitat for SGCN (USFWS, 2000). Unlike other agricultural regions, climate and poor drainage conditions favor the establishment of freshwater wetlands and promote late season harvesting of grass, which enhances the value of the region to wildlife (Pashley, et al., 2000). For example, the interspersion of agricultural lands, shrublands and wetlands (forested and marsh) creates habitat conditions that favor, and are of critical importance to several species of migratory birds that are rare and declining elsewhere in the Northeast (USFWS, 2000). These species include the American woodcock and the golden-winged warbler. Furthermore, the

St. Lawrence Valley is one of the most important areas for waterfowl production in NYS. Waterfowl and other water-dependent species rely on the numerous freshwater wetlands scattered throughout the Valley for resting, feeding and staging areas during spring and fall migration. The shallow wetlands characteristic of the Valley provide a greater variety of nutrients for feeding and more abundant cover for nesting and hiding than do many of the deep lakes or fast-moving rivers of the region. Species using these habitats include, waterbirds (e.g., American bitterns, least bitterns, black tern), waterfowl (e.g., blue-winged teal), and herpetofauna (e.g., western chorus frog). An example of wetland habitat embedded in an agricultural landscape can be seen at Perch River Wildlife Management Area (7,800 acres; Jefferson County).

The coastal wetlands along eastern Lake Ontario and the St. Lawrence River can be characterized by four geomorphic types: open embayment, protected embayment, barrier-beach, and drowned river mouth. These critical habitats extend from the lake to the border with Quebec, near St. Regis, New York. There are 28 areas within the Basin designated as Significant Coastal Fish and Wildlife Habitat (SCFWH) by the Department of State in consultation with DEC (Northeast Lake Ontario-St. Lawrence Table 5). These areas encompass more than 37,000 acres and are primarily concerned with marshes and tributaries of Lake Ontario and the St. Lawrence River. Critical coastal wetland habitats designated as SCFWH include Goose Bay and Cranberry Creek (2,035 acres, Jefferson County), Crooked Creek Marsh (1,198 acres, Jefferson County), and Dexter Marsh and the Black River (2,526 acres, Jefferson County). Goose Bay and Cranberry Creek comprise a large, shallow, riverine bay and wetland ecosystem on the St. Lawrence River and is subject to minimal disturbance. It is one of the major concentration areas for migratory birds, including waterfowl, in the St. Lawrence Plains ecological region and has an important reproduction area for northern pike and littoral fishes. SGCN found here include Blanding's turtles, northern harriers, and least bitterns. Crooked Creek Marsh is one of the four largest, undeveloped, coastal streamside wetlands on the St. Lawrence River and has been subject to minimal habitat disturbance. The area supports pugnose shiners, nesting northern harriers and least bitterns, and foraging common terns. Dexter Marsh and Black River comprise an extensive, relatively undisturbed, bay-head complex, unusual in the Great Lakes Plain. Habitats include a 2,000-acre wetland complex located at the confluence of the Black River, Perch River, and Muskalonge Creek. The area supports concentrations of salmonids, lake sturgeon, marsh-nesting birds such as black tern, and migrant waterfowl. Another important coastal marsh is the Eastern Lake Ontario Barrier Beaches/Wetland Complex, designated as an Important Bird Area by Audubon New York. The area covers about 24,000 acres in Oswego and Jefferson counties, extends from the Salmon River north to the Black River, and contains remnants of one of the largest inland dune systems in the eastern Great Lakes, and some of the highest-quality freshwater marshes in NYS. The area supports species such as pied-billed grebes, American bitterns, least bitterns, northern harriers, common terns, black terns, blackchin shiner and Iowa darter. Chaumont Bay, 9,000 acres on the northern edge of this complex, is sufficiently enclosed or protected from waves that it provides vast habitats with submerged aquatic vegetation and open water. Shoreline habitats also support an array of shorebirds during migration, and forest and shrub habitats along and near shorelines of Lake Ontario also provide critical habitats to migrating songbirds and raptors.

Other important aquatic habitats found in the NELO-SLR Basin include the more than 14,000 miles of rivers and streams and more than 1,000 lakes, ponds, and reservoirs. The Adirondack Region alone contains an estimated 2,800 ponds and lakes (both within and outside the Basin), miles of pristine headwater streams, and several large river systems. The ponds and lakes in the Adirondacks provide habitat for rare fish species such as round whitefish, reptiles such as the wood turtle, and foraging sites for raptors such as osprey, and are the stronghold for nesting common loons in the state. Significant lake habitats in the Adirondacks include Stillwater Reservoir, Blue Mountain Lake, and Fulton chain lakes, Raquette Lake, Long Lake, Cranberry Lake, Tupper Lake, North Carry Falls Reservoir, and Upper Chateaugay Lake. Important lake habitats in the northwest part of the basin include Perch Lake, several smaller Indian River lakes and Black Lake. Unique species in Black Lake include mooneye and lake sturgeon.

The most significant lake habitat in the basin is Lake Ontario. Nearshore habitats have water depths of less than 50 feet that provide critical habitat for nearly all Lake Ontario fish in the eggs, fry, and juvenile stages. Most fish depend on these habitats during some stage of their life cycle (Stewart, et al., 1999). Offshore habitats have water depths greater than 50 feet and are inhabited by both benthic and pelagic organisms. Species found here include alewives, lake trout, and deepwater sculpin. An important spawning shoal for lake trout is found at Stony Point.

As mentioned above, the St. Lawrence River is often characterized by four distinct segments: the Thousand Islands, the Middle Corridor, Lake St. Lawrence, and Lake St. Francis downstream of Moses-Saunders Dam. The Thousand Islands section includes a complex of 1,768 islands, numerous shoals, channels with moderate water currents, deep channels with strong currents, large shallow bays, and emergent wetlands (LaPan, et al., 2002). The middle corridor (St. Lawrence County) is relatively narrow, with few islands, and is more riverine in nature, with limited shallow water and relatively rapid currents (LaPan, et al., 2002). Lake St. Lawrence (northeastern St. Lawrence County) is a 30-mile-long reservoir created by the Moses-Saunders Power Dam. Unlike the other two sections, this section of the river is subject to significant water level fluctuations. A stabilization of water level by the Moses-Saunders Dam has also caused degradation of wetlands in areas upstream as far as Rochester, and this is currently under study. Average water depth is about 25 feet, with a maximum depth of about 100 feet. Lake St. Lawrence has relatively strong water currents and contains a number of islands and shoals; however, the flooding and dredging associated with power projects along this section of the river have altered its character (LaPan, et al., 2002). The 7-mile river segment downstream of the Moses-Saunders Dam has a tailwater important to lake sturgeon spawning, is part of Lake St. Francis, and has productive shallow areas on the St. Regis Mohawk Reservation. Variation in depth, water current, and the presence/absence of shoals and islands in these different parts of the river support a diverse and productive warm-water fishery, migratory stopover sites for waterfowl and other birds, and breeding and foraging habitat for many species of greatest conservation need. Lake Ontario supplies nearly all of the water to the upper St. Lawrence River. The amount of water available is dependent upon precipitation and evaporation rates in the Great Lakes, in conjunction with the amount of water released from Lake Ontario by control structures on the river.

Some other important aquatic habitats within the Basin, designated as Significant Coastal Fish and Wildlife Habitat by the Department of State (Northeast Lake Ontario-St. Lawrence Table 5), include bays, river systems, and unique island habitats. Examples include Chippewa Bay (2,457 acres, St. Lawrence County), Moses-Saunders Tailwater (467 acres, St. Lawrence County), Grasse River (1,197 acres, St. Lawrence County), and Little Galloo Island (43 acres, Jefferson County). Chippewa Bay is the largest shallow, open-water bay with a substantial littoral zone in St. Lawrence County. This bay is the only habitat type of its kind in the St. Lawrence Plains ecological region and one of the only two examples of this ecosystem type in New York State. This site supports a muskellunge nursery habitat; essential habitat for pugnose shiner; a migratory staging area for waterfowl, shorebirds, and passerines; nesting habitat for common terns and common loons; and is used as a feeding area by bald eagles prior to ice cover. The Moses-Saunders Tailwater is a relatively large, deep, open-water section of the St. Lawrence River extending about 2 miles from the base of Moses-Saunders Power Dam to the St. Lawrence Seaway navigation channel. It encompasses a relatively deep (up to approximately 50 feet), wide, open-water area below the dam and a narrow waterway which connects the two main channels of the river. It is the best known spawning area for lake sturgeon. Additional quality habitat is in the next 5 miles to the border with Quebec. Bald eagle wintering and feeding and lake sturgeon occur here and it is a major concentration area for migrant and wintering gulls and waterfowl in the St. Lawrence Valley. The Grasse River is one of only three major tributaries in the St. Lawrence Plains ecological region and is in relatively undisturbed condition in areas upstream of Massena. The river corridor is largely forested and supports muskellunge and lake sturgeon. Little Galloo Island is an isolated and undeveloped island subject to minimal human disturbance, with an extensive shoal area. The island sustains one of the largest ring-billed gull colonies in North America and one of the few Caspian tern nesting locations in New York State. Shoals around the island support a recreational fishery of state importance for smallmouth bass.

Grassland Habitats

Several public and private natural resource conservation organizations have identified the St. Lawrence Valley (central Jefferson County through northern Clinton County) as one of the largest and most important grassland areas in the northeastern United States. This area now represents some of the best farmland in the Northeast. Dairy farming and associated agricultural land uses represent a major economic activity in the St. Lawrence Valley, and many grassland bird species and waterfowl that nest here are dependent upon the pastures, hayfields and agricultural grasslands maintained by landowners. Furthermore, areas with significant amounts of more intensive agricultural operations (e.g., large row crop monocultures) provide habitat for grassland-dependent species, although agricultural practices incompatible with wildlife have reduced the value of these habitats.

The vast "agricultural grassland" of the St. Lawrence Valley supports some of the largest populations of grassland and other early successional bird species in North America (Pashley, et al., 2000). A much higher percentage of bird species that rely on grassland and shrubland/early successional forest are in long-term and widespread decline more so than any other landbird group. Many species that are declining elsewhere are breeding successfully and maintaining stable populations in the St. Lawrence Valley, including the bobolink, eastern meadowlark, short-

eared owl, upland sandpiper, Henslow's sparrow, savannah sparrow, grasshopper sparrow, sedge wren, and the northern harrier (USFWS, 2000). An estimated 17% of the world's bobolink population breeds in the St. Lawrence Valley, and exceptionally high relative abundances of savannah sparrows have been recorded (Rosenberg, 2000).These birds, and many other wildlife species, rely upon the extensive grasslands of the St. Lawrence Valley. An example of a critical grassland habitat in this Basin is the Point Peninsula Wildlife Management Area. The area encompasses about 1,046 acres (967 acres of which is TNC property under a management agreement with DEC) of a 2000-acre mosaic of active farmland, old field, and some woodlots and conifer plantations. The most significant concentration of wintering raptors in New York State has been observed here, including the northern harrier and the short-eared owl.

An example of a unique grassland type in this Basin is alvars. Alvars are grasslands and shrublands that develop on shallow soils with limestone geology and support rare plant communities. They are a habitat type unique not only to this Basin, but on a state and global level as well. Most alvars are concentrated in Jefferson County and are a high priority for conservation. The Nature Conservancy has protected almost 4,000 acres of alvars, including Chaumont Barrens and Three-Mile Creek Barrens. Multiple threats to alvar ecosystems include quarrying of limestone, ATV use, residential development, and invasive plants like swallow-wort, buckthorn, and shrubby honeysuckle.

The extensive mixture of reverting farmlands and shrub and forested wetlands provide critical habitat for shrubland and early successional forest species in lowland areas. This area remains the stronghold for the golden-winged warbler in NYS. Golden-winged warblers favor shrublands with herbaceous ground cover and with trees or near forest edges, in particular in or near wetlands. Also, American woodcock thrive in areas that have a mixture of grasslands, shrub, and forested wetlands. Many other species, such as the Canada warbler and whip-poor-will, rely on these dwindling habitats.

Publicly Held or Designated Lands - Opportunities to Develop Conservation Partnerships

Many of the critical habitats in the Basin have unique ecological (wildlife and plant communities, geological formations) or cultural (recreational, historical value) characteristics, and thus have been designated with some protective status by state agencies such as Office of Parks, Recreation and Historic Preservation (OPRHP) and DEC. These areas include state parks, state forests (also wilderness area, wild forest, primitive area, and unique area), wildlife management areas (WMAs), and bird conservation areas (BCAs), and total about 1,500,000 acres distributed throughout the NELO-SLR Basin. The majority of protected land is in large forest tracts (primarily state forests, wilderness areas, wild forests, and primitive areas) located in the Adirondack Park.

Lists of public land holdings have been provided here (Northeast Lake Ontario-St. Lawrence Tables 6-9) to offer a spatial context (i.e., location, size) for these large pieces of habitat and to recognize their importance in the implementation of the conservation recommendations that follow. The species and habitats found on these parcels provide an excellent opportunity for research, survey, and inventory efforts. Finally, these properties give public and private natural resource

managers the chance to partner with the agency that administers the land to help deliver habitat and population management actions designed to benefit SGCN.

These lists are not meant to be a comprehensive catalogue of all publicly held or designated lands in the NELO-SLR Basin. Many parcels owned by local governments provide benefits to SGCN (e.g., town parks, green belts), and many privately held parcels have been designated as protected through perpetual conservation easements and fee acquisitions, and other methods (Audubon's Important Bird Area program also identifies many of the most important bird habitats in NY, and although it doesn't protect them, it does provide the opportunity to enhance conservation efforts). These private lands are usually acquired because of their unique biological character and/or highly imperiled status and should not be overlooked during more targeted conservation planning efforts. Local land trusts, such as the Adirondack Land Trust, and private groups, such as The Nature Conservancy that own and/or administer these lands are important partners in the conservation of fish and wildlife species of concern.

Species of Greatest Conservation Need and their Critical Habitats

DEC staff members who compiled the SGCN information in the State Wildlife Grants (SWG) database were asked to indicate habitats associated with critical life stages and activities for those species. During the analysis for each basin, a listing of species occurring in the basin and the critical habitats associated with their life cycle at the system and sub-system levels were extracted from the database (Northeast Lake Ontario-St. Lawrence Tables 10 and 11). The habitat classifications in the database were adapted from the New York Natural Heritage Program's Ecological Communities of New York State, Second Edition. In most cases, the habitats were simplified from the many vegetation associations listed in the community classifications. In the case of the Lacustrine and Riverine systems, the subsystems were modified to reflect the classifications most often used by fisheries managers in DEC (e.g., cold water-shallow). These critical habitats do not comprise a comprehensive listing of all habitat associations found in the basin; rather they are a subset of the habitats deemed critical to SGCN that occur in the basin.

Each of these systems and subsystems are further refined into a habitat category in the SWG species database and can be viewed in the taxa reports appended to this strategy. The habitat categories are excluded here for the sake of simplicity but were considered during the basin analysis. A complete listing of habitat types used in the preparation of the CWCS can also be found in the appendix.

Overall Trends in the Basin

Biodiversity Trends

From the alpine forests and boreal wetlands of the Adirondacks, to the agricultural grasslands and emergent marshes of the St. Lawrence Valley, and the coastal marshes, bays, and tributaries of Lake Ontario and the St. Lawrence River, both natural and anthropogenic forces have shaped the landscape and biodiversity of the NELO-SLR Basin. New York Natural Heritage Program (NYNHP) element occurrence records, the Breeding Bird Atlas, Breeding Bird Survey, Partners in Flight's ranking system, and the North American Bird Conservation Initiatives planning efforts all indicate that this Basin is of critical importance to bird diversity in New York State. More than half of all bird species of greatest conservation need are found within this Basin (Northeast Lake Ontario-St. Lawrence Table 3) occupying the diverse range of habitat types, including boreal forests, deciduous forests, early successional forest/shrublands, grasslands, wooded and emergent marshes, and island and coastal habitats. In addition, NYNHP data indicate that the coastal and inland emergent wetlands of the St. Lawrence Valley are of vital importance to rare amphibians and reptiles, and the region's extensive rivers and tributaries support rare fish like sturgeon, rare mollusks such as yellow lamp mussel, and rare invertebrates such as the odonate, extra-striped snaketail. The highest diversity of fish is found in Lake Ontario and the St. Lawrence River, but river mouths of the Black, Oswegatchie, Raquette, St. Regis and Salmon Rivers also contain high-quality habitat. Six of the fish SGCN are found here, and all of the extirpated fish SGCN are historic to these two larger waters.

While this Basin tends to be high in species richness, trends and changes in land use, as well as many other environmental and social changes that are incompatible with some wildlife have taken their toll on populations of SGCN. Of the 111 SGCN in this Basin, 35% are declining (Northeast Lake Ontario-St. Lawrence Table 2). The majority (80%) of these are birds, with early successional forest/shrubland birds (29%) and grassland birds (23%) making up the largest shares of declining avifauna. Ten percent of the insects designated as SGCN are declining, and all of these are butterflies. Populations of some rare, threatened, and endangered animal species and rare natural communities in the NELO-SLR Basin are declining as a result of habitat alteration/conversion, habitat degradation, invasions of non-native species, and other factors. Many of these declining species specialize in a few select habitats or foraging guilds, and in so doing, inhibit their ability to adapt to declining habitat quantity and quality.

More troublesome still is the 45% of SGCN whose status we do not know (Northeast Lake Ontario-St. Lawrence Table 2). About one-third of these are birds, one-quarter of which are boreal forest birds. Reptiles and amphibian species of concern make up about 25% of species of unknown status, and the majority (31%) is lake/river reptiles. About 20% of insect species of greatest conservation need have an unknown status, and all of these are odonates. Anecdotal evidence and preliminary data suggest that these species may be rare and/or declining, but without sufficient data on their distribution and abundance, it is exceedingly difficult to assess the need for or try to combat threats to their populations and habitats.

Changing Human Population, Land Use, and Habitat Quality

As described above in the description of the Basin, this region has the second largest land area and the lowest population density of any basin in the state. From 1990-2000, population growth in the six counties that make up the heart of the Basin (Jefferson, St. Lawrence, Franklin, Lewis, Herkimer, and Hamilton) ranged from -2% in Herkimer County to 10% in Franklin County (U.S. Census Bureau, 2002); however, Franklin County is the outlier in this group, as the remaining five counties experienced little or no growth during this period. Similarly, it is estimated that between 2000 and 2015, the increase in human population will be in Franklin County, but the other counties in the Basin are expected to have negligible increases (St. Lawrence County) or population reductions (Jefferson, Hamilton, Lewis, Herkimer counties; New York Statistical Information System, Cornell Institute for Social and Economic Research, 2002). Growth in Fort Drum and the supporting area is going to be substantial. Current plans already call for a disruption of 120 acres of Fort Drum property. Fort Drum contains many unique habitats with significant bird diversity which may be affected by this base expansion.

Despite the relatively small human population compared to other watersheds, human population growth and the development (e.g., residential, industrial, roads) that accompanies it are still a problem for some areas within the NELO-SLR Basin. Pendall (2003) concludes that, as land consumption has outpaced population growth, upstate New York has urbanized hundreds of thousands of acres of farm and forest land since 1980. While development may bring economic prosperity to a region, development without growth can actually be economically detrimental (Pendall, 2003). Furthermore, it is important that any development that occurs be sustainable and compatible with wildlife. Sprawl that has occurred in the NELO-SLR Basin has fragmented sensitive habitats and threatens the rare species that depend upon them.

The NELO-SLR Basin has a complex natural and human history. Land use in the Basin over the last several centuries resembles that of New York State; forest followed by intense agriculture (primarily the St. Lawrence Valley) and silviculture (throughout the Basin, but particularly in the Adirondacks), and now a return to forested land (Stanton and Bills, 1996). Records indicate that in 1910, on average, more than 50% of the NELO-SLR Basin was classified as farmland (i.e., row crops, pasture, hay land)(Stanton and Bills, 1996). By the 1990's this trend had completely reversed itself, and today more than 70% of the watershed is classified as forest (Stanton and Bills, 1996; MRLC data, 2005).

Forest composition and trends in the Adirondacks have been shaped by humans through commercial timber harvest and production, resulting initially in removal of dominant white pine, hemlock, and old-growth spruce, and then a gradual shift to a greater proportion of the forest comprised of northern hardwoods as softwoods continued to be preferentially harvested. Although the total acreage of Adirondack forests has increased steadily since 1900, harvest and removal of timber has also increased by nearly 90% since 1968 (Pashley et al., 2000). Still, Forest Preserve lands exceed 3.2 million acres in the Adirondacks, and over time

these areas will become natural forest communities as no logging is allowed. Silvicultural harvest on private lands today is too often by means of poorly planned selective cutting (called high grading), that negatively influences forest health and tree species composition. High grading is not considered to be sustainable forestry, and should be avoided. Sustainable silvicultural methods (both even-aged and uneven-aged) provide critical habitat for many species of early successional forest birds.

Twelve-thousand years ago, the receding glaciers and flood waters that followed shaped the St. Lawrence Valley. In recent centuries, European settlers cleared the forests and drained many of the wetlands of the St. Lawrence Valley. Agriculture took hold in the more fertile soils here, and by the mid-Nineteenth Century 75% of the land in the Valley had been cleared for row crops and pasture. As settlers abandoned the less productive portions of this land in search of more productive soils, forest regrowth has been repeatedly harvested, such that the forests present today are commonly third or fourth successions of growth (Thompson et al., 2002). Furthermore, selective cutting of maple, hickory, basswood, and butternut have reduced tree-species diversity in the remaining forest fragments of the St. Lawrence Valley.

The nature of the remaining agricultural land of the basin has changed as well. Cropland diversity has decreased, and smaller farms have been consolidated into larger units. The number of farms dropped dramatically between 1910 and 1992, but the average farm sizes more than doubled (Stanton and Bills, 1996). These larger farms also began to implement more intensive agricultural practices. Fields are mowed and planted earlier and more often, which precludes successful nesting and greatly limits productivity of grassland species. Further, adjacent edge habitats in the form of grasslands, woodlands, and strip cover (e.g., fencerows, hedgerows) have either been lost outright or dramatically altered in size and shape. These combined losses of habitat were a critical factor in the declines of grassland birds, and may also have played a role in the decline of migratory species, such as Neotropical migratory birds that breed in the Basin, as well as negatively affecting resident wildlife communities. There may also be advantages to the larger field sizes resulting from removal of hedgerows. Several grassland species of birds are area sensitive, preferring larger field sizes. If the larger fields are put into set-asides, they have the potential for providing prime habitat for these species.

Similar to the rest of NYS, wetland habitats declined dramatically in the Basin from 1900 until the 1970s. During this time, it was common practice to drain marshes for agriculture and other land-use practices. The Freshwater Wetlands Act protected many of these habitats, and wetland losses have been slowed dramatically since 1975. With the exception of the Adirondack Park, only wetlands larger than 12.4 acres, or certain wetlands of unusual local significance, are regulated. In addition, draining wetlands for agriculture is exempted from the law and still occurs. In the Adirondack Park, all wetlands larger than one acre, and any wetland adjacent to a water body are protected. From the 1980 through the 1990, the Adirondacks experienced a small net gain in wetlands. Today wetlands are incrementally destroyed and wetland complexes fragmented by smaller, more numerous projects. Many remaining wetland communities, particularly in the St. Lawrence Valley and along the coast of the St. Lawrence River and eastern Lake Ontario, have been reduced to small, isolated fragments whose quality is

threatened by siltation, runoff from agriculture and development, and introduction of invasive species.

Overall water quality in the NELO-SLR Basin is good, and significant improvements have been made over the past few decades, but there are still issues that need to be addressed. DEC has engaged in extensive surveys of macroinvertebrate communities in rivers and streams in the state in an effort to assess 30-year trends in water quality. Within the NELO-SLR Basin, about 45% of the streams and rivers sampled were classified as non-impacted (very good water quality). About 37% were classified as slightly impacted (good water quality). Many of the slightly impacted sites were associated with the Black River. Contaminants included non-point nutrient input, industrial runoff, wastewater treatment facility discharge, and toxics such as polycyclic aromatic hydrocarbons (PAHs). An industrial complex centering on aluminum production and located in Massena is the source of several slightly impacted sites on both the Grasse and St. Lawrence rivers. The U.S. Environmental Protection Agency identified the St. Lawrence River at Massena as an "Area of Concern" and developed a Remedial Action Plan (RAP) in 1995. Since that time, the RAP has worked to assess and improve conditions here for both people and wildlife. The remaining 18% of macroinvertebrate sample sites in the basin were classified as moderately impacted (poor water quality). This was due to agricultural runoff and toxics, such as polychlorinated biphenyls (PCBs) and PAHs, in tributaries of the Black River such as Kelsey Creek and Mill Creek and some sites on the St. Lawrence River.

Significant changes have occurred in the Lake Ontario ecosystem over the last century due to the effects of toxic pollution and habitat loss resulting from the rapid development of the Lake Ontario Basin (Lakewide Advisory Network, 1998). Steady progress has been made toward cleaning up the waters of Lake Ontario. Efforts to restore the health of the Lake, such as the Great Lakes Water Quality Agreement, have resulted in the reduction of contaminants and the rebounding of many species of wildlife, such as colonial waterbirds, affected by contaminants. Treatment facilities on Lake have been regionalized, thus significantly reducing the number of discharges into the Lake (DEC Division of Water, 2002). Phosphorus reductions in the Lake have resulted in a far less productive and oligotrophic status.

Dramatic changes in the Lake Ontario fish community have been underway for several decades, and several species are extirpated or extinct. The predator fish community has been supplemented with major programs stocking salmonids, but these species have also been depleted by cormorants. Fish communities are being altered by invasive species and habitat degradation. The number of fish-eating gulls and cormorants in Lake Ontario has increased dramatically in the last 20 years. This is likely related to the banning of DDT and the reduction of other toxics entering the Lake. The rebound of these species, especially cormorants, can cause competition with SGCN for habitat and food resources.

Human effects on stream and riparian habitat have been intense and wide ranging. Water-level fluctuations are a natural phenomenon in the Great Lakes due to natural climatic variability. Wetland plant communities, which provide habitat for a multitude of invertebrates, amphibians, reptiles, fish, birds, and mammals, have evolved to adapt to, and depend on, water-level changes. However, humans have altered the flow of streams and rivers for flood control,

bridges and roads, power generation (dams), agriculture, and development. This has resulted in loss of floodplains and riparian buffers; increased river channel instability; altered hydrology (decreased water storage, conveyance); decreased water quality (including increased sedimentation); and reduced and fragmented fish and wildlife habitat. Since 1960, water levels and flows of Lake Ontario and the St. Lawrence River have been regulated at the Moses-Saunders Power Dam (St. Lawrence County). In the winter of 2000, the International Joint Commission (IJC) launched a five-year bi-national study to review the current criteria in the Orders of Approval for regulation of Lake Ontario-St. Lawrence River levels and flows. The study will recommend changes to the 1956 criteria currently in use for Lake Ontario-St. Lawrence River regulation. The study will assess how water-level fluctuations affect interests within the basin, including fish, wildlife, and their habitats, while also looking at how lake levels affect recreation, economic, and other social concerns

While water quality has improved in many parts of the Basin thanks to the efforts of government and private agencies, some of the more alarming trends related to water quality, such as atmospheric deposition (acid rain, mercury) and invasive species (plants and animals) have effected almost every water body. In the Black River watershed 90% of the lake impairment, 30% of the river impairment and all of the Great Lake's shoreline impairment is attributed to atmospheric deposition (DEC, Division of Water, 2002). In the St. Lawrence watershed, atmospheric deposition has been documented in more than 150 lakes, and it is assumed to affect many more lakes that have not been monitored (DEC, Division of Water, 2002).

Invasive species have been degrading aquatic and terrestrial habitats for more than 100 years (e.g., common carp in the late 19th Century), with significant increases in the last few decades. In the scientific literature complied by the International Association for Great Lakes Research, it is reported that more than 160 non-native invasive species are found in the Great Lakes, with 12 species appearing to have entered since 1990 alone. Even more problematic for Adirondack ponds is the spread of native species like yellow perch and smallmouth bass to higher elevations.

Threats

DEC staff members who compiled the SGCN information in the CWCS planning database were asked to indicate threats to SGCN and their habitats. During the analysis for the Basin, a listing of threats for each species occurring in the NELO-SLR Basin was extracted from the database. The threats and summary figures compiled here (Northeast Lake Ontario-St. Lawrence Table 12) are not listed in order of importance. The magnitude of a threat is measured by several variables, including the species life history traits (i.e., its vulnerability), population trends, specific habitat type and geographic locale, and others. The information provided does not quantify the magnitude of a particular threat. It is intended only to paint a broad picture of the proportion of species/species groups to which a particular threat was assigned, and the frequency with which a particular threat was mentioned in the database. For example, climate change, causing a change in species range, distribution, or migration, was identified as a threat for 9% of the SGCN species groups in the Basin. However, it is likely that climate change affects (or will affect in the future) all species and their habitats. Furthermore, the purpose of this information is not to compare the severity of one threat against another.

Rather than go through each of the 38 threats listed in Northeast Lake Ontario-St. Lawrence Table 12, some of the more prominent threats to species of greatest conservation need in the NELO-SLR Basin have been combined into a few broad categories and summarized here. The most significant threats were determined by reviewing information from the CWCS database, scientific literature, and conservation plans for the Basin.

Habitat Loss and Fragmentation

Anthropogenic changes like development (residential and commercial, roads, power lines), dredging, and wetland draining, and natural changes such as succession reduce not only habitat quantity, but the quality of habitat as well by disrupting the function of remaining habitat patches. Examples of the loss of habitat function include loss of connectivity to patches of similar habitat (or different, yet complementary habitats), loss of metapopulation dynamics in small, isolated patches ("sink" habitats), increased negative edge effects (increased susceptibility to predation), and reduction in the types of species the patch can support ("area-sensitive" species).

Almost 18% of the NELO-SLR Basin is comprised of habitats that have been significantly altered by humans [residential and commercial development, agriculture (row crops, haylands), parks and golf courses, and barren habitats (quarries, strip mines, gravel pits)]. Many of these habitats are maintained by suppressing ecological processes such as vegetative succession and fire; however, the reverse is also true. Late and early successional forest habitats may suffer because of a reluctance of the public to engage in the active management of these habitats. The result is large, homogenous forest tracts with lower structural, vegetative, and species diversity than would be encountered in forests with both natural disturbances (e.g., fire, wind throws) and active management (variable cutting regimes). A goal for the heavily forested sections (greater than 70 % forested) of this Basin would be to incorporate more structural and vegetative species diversity into forests and shrub habitats. It is generally agreed upon by

those that study wildlife-habitat relationships that sustainable silviculture practices executed in areas of high percent forest cover do not generally result in the type of fragmentation being portrayed here. For example, recent studies indicate that forest interior birds will utilize cut-over areas extensively for portions of their life cycle (Audubon New York, 2004). While this is true, it is also important to increase the size and connectedness of habitat patches where feasible. This concept also applies to grassland habitats. The St. Lawrence Plain and Lake Ontario Plain represent one of the most important agricultural grasslands in the northeastern United States. It is important that extensive grassland habitats remain unfragmented, and that small patches of remnant grassland be evaluated to determine whether they are sink habitats to help guide further management actions. Further, there is a critical need to counter the detrimental effect of more intensive agriculture on grassland-nesting species.

Early successional forest and shrubland habitats are also in serious decline throughout the watershed. Land development is reducing habitat, natural succession is turning many of these habitats into forests, and shrublands are sometimes converted into agricultural fields. The rate of farmland abandonment has also slowed, further reducing the potential for new habitats to form. There is a critical need to increase active management for these habitats and the species that rely on them. A serious threat to these habitats and the species that rely on them is the lack of adequate management due to misconceptions about the benefits of sustainable forestry practices for wildlife. A variety of silvicultural techniques should be used to increase habitat and structural diversity across the landscape. Habitat management methods should include both even-aged and uneven-aged (at various levels of intensity) silvicultural techniques. Proper management of utility right of ways can also add to the diversity of shrubland habitats. Silvicultural methods need to be properly planned and implemented using sustainable forestry.

Degraded Water Quality, Atmospheric Deposition, and Altered Hydrology

Many of the SGCN in this Basin rely upon aquatic habitats during some stage of their life cycle (e.g., natal sites, foraging sites). Research by DEC staff has identified the degradation of water quality and the acute and chronic effects of contaminants in aquatic habitats as a significant threat to wildlife. Degraded water quality includes siltation, nutrient runoff, temperature increases, toxics (e.g., pesticides, heavy metals), lowered dissolved oxygen, and altered hydrology (dams, water withdrawal, ground water extraction). In addition, contaminants enter aquatic and terrestrial systems through atmospheric deposition and affect both habitat and population levels.

Water quality problems in Lake Ontario tributaries and nearshore waters are related to eutrophication and siltation caused by excess nutrients and runoff from agricultural operations and on-site disposal systems. Levels of toxic contaminants in the Lake Ontario ecosystem have decreased significantly, and wildlife such as colonial waterbirds have overcome most of the contaminant-induced effects of the 1970s and 80s; however, bioaccumulative toxics persist in sediment, water, and biota at levels of concern for some fish species such as lake trout and salmon, and for predators such as bald eagles, snapping turtles, mink, otters, and humans (Lakewide Advisory Network, 1998).

Another significant water quality issue in this basin is PCBs in the St. Lawrence River and Lake Ontario. The source of contamination for much of the St. Lawrence is attributed to priority organics (primarily PCBs) from Lake Ontario sediments (DEC, Division of Water, 2002). PCB contamination negatively affects reproduction and survival of mammals such as river otter and raptors such as bald eagles. Ongoing remediation activities described in the Remedial Action Plan for the St. Lawrence River/Massena are expected to reduce some of these effects.

Mercury contamination is thought to be a result of atmospheric deposition. Mercury is released from anthropogenic sources (coal burning plants, etc.) and is carried via wind currents from sources in the Midwest and deposited onto terrestrial and aquatic habitats through rain, snow, or dust. If mercury is converted to methylmercury, it can be consumed by organisms, move up the food chain, and increase in concentration as it does so (Evers, 2005). Traditionally, high levels of mercury were correlated with decreased productivity and survivorship of common loons (Schoch and Evers, 2002), but recent findings suggest that mercury contamination is a much larger threat to human and ecological health. A recent report by Evers (2005), compiling data from 21 peer-reviewed journal articles, shows elevated mercury levels in almost every taxa including fish (e.g., brook trout, yellow perch), crayfish, salamanders, waterbirds (e.g., common loon), forest songbirds (e.g., Bicknell's thrush), and furbearers (mink and otter). The report goes on to state that not only does mercury pose a threat to fish and the humans consuming them, but also to wildlife living in habitats as diverse as mountain tops and small headwater streams. Particularly high mercury levels were observed in the Adirondack Mountains. Mercury can have adverse effects on individual animals living in this region, as well as population-level effects through changes in behavior, reproduction, and body chemistry (Evers, 2005).

Another significant threat in the NELO-SLR Basin that has negative consequences for wildlife is the declining pH of Adirondack water bodies due to acid deposition. Utility-plant pollution laden with nitric and sulfuric acid from industrial sites in the Midwestern United States (Ohio, Illinois, Indiana, and Pennsylvania) is carried northeast via wind currents, and deposited in the form of precipitation onto the Adirondack Mountains. Thin, acidic soils and nutrient-poor water bodies in these areas make them particularly susceptible to acidification. Despite reductions in emissions that have resulted from the Clean Air Act, the Adirondacks are now more sensitive to acid deposition due to the accumulation of acids and the loss of buffering capacity in the soil (Schoch, 2002). The effects of acid deposition can be seen in the damaged spruce-fir forests of the high peaks of the Adirondacks, reduced fish numbers and reproductive success in ponds with a pH of <5, and decreased foraging and reproductive success of nesting common loons (Environmental Protection Agency, 2004; Schoch, 2002; Simonin, et al., 2005). Acid deposition also affects waters in the St. Lawrence and Black River watersheds. Acid deposition has been documented in more than 300 lakes and ponds in these two watersheds, while episodic acidification of smaller headwater streams has also been documented during periods of snowmelt/runoff (DEC, Division of Water, 2002).

Altering the flow of riparian habitats with dams and bridges, and for flood control, agriculture, and development (roads, residential, commercial) can directly and

indirectly affect fish and wildlife. Movement of populations of aquatic species such as fish and freshwater bivalves is inhibited, and habitat for all species dependent on lotic systems is lost outright or degraded through decreased conveyance and increased sedimentation. Changes in water levels and flows resulting from the construction and operation of the Moses-Saunders Power Dam are implicated in the impairment of critical fish habitats in the St. Lawrence River. Flooding of fast-water river stretches impairs spawning habitat for species such as lake sturgeon (LaPan, et al., 2002). In addition, maintenance of Lake Ontario water levels results in substantial water level changes, discouraging the establishment of wetlands and submerged aquatic vegetation in the nearshore zone (LaPan, et al., 2002). Throughout the Basin, wetlands and tributaries that are flooded by dams have diminished value as spawning and nursery habitats for warm water fish.

Stream and road bank erosion, erosion of coastal soils, and erosion from agricultural fields are significant sources of sand/sediment. Once in lotic habitats, sediment fills in gravel spawning beds, decreasing salmonid spawning success, limiting macroinvertebrate production, and increasing winter mortality of fish and invertebrates such as mussels. Excessive sand and sediment loads also contribute to the formation of significant sedimentation deltas at the mouths of many tributary segments. Such deltas can restrict fish migration into the tributaries and present opportunities for the establishment of non-native aquatic vegetation.

Invasive Species

Invasive exotic and invasive native plants and animals diminish the quality of upland and aquatic habitats throughout the Basin. In wetlands and other aquatic habitats, species like purple loosestrife, Eurasian water milfoil, and common reed with little value to wildlife, displace native plant species and disrupt ecological processes. Purple loosestrife thrives on moist, disturbed soils and often invades following construction activity. It can form dense, impenetrable stands that are unsuitable as cover, food, or nesting sites for a wide range of wildlife. It also outcompetes many rare wetland plants. Eurasian water milfoil occupies an extensive range throughout the Great Lakes and tributaries. This species forms dense mats of vegetation that degrade the structure and function of aquatic habitats.

Invasive aquatic animals degrade habitat quality and/or directly affect fish and other aquatic species. Zebra mussel densities have increased dramatically since their discovery in the Great Lakes in 1988. Zebra mussels have affected water supplies, crowded out native mussels species, and reduced the biomass of other benthic animals in many areas. Since 1999, a severe outbreak of type E botulism has been documented along the shores of Lake Erie, and more recently, Lake Ontario. The severity of type E botulism-caused mortality documented during the current outbreak along Lake Erie and Lake Ontario could threaten, or eliminate, sub-populations of common loon with fidelity to these water bodies for migration. It is suspected that invasive exotic zebra and quagga mussels are ingesting *Clostridium botulinum* bacteria and then, in turn, are being eaten by an exotic fish species, the round goby. Common loon and lake sturgeon feed on round gobies, thereby becoming infected with botulism. Many other invasive species exist in Lake Ontario, including the spiny water flea (*Bythotrephes cederstroemi*) and fish hook water flea (*Cercopagis pengoi*), Rusty crayfish (*Orconectes rusticus*), common carp, and alewives (Manninen, 2005).

In upland habitats, invasive exotic plants and insects introduced through human activity threaten to reduce biodiversity. For example, exotic insects like viburnum leaf beetle lack any natural predators and threaten to alter the composition of young forest stands. Several forest pathogens and insect pests may affect forested habitats. Some of these pests have yet to reach the NELO-SLR Basin from southern NYS (e.g., hemlock wooly adelgid, Japanese long-horned beetle), but northward movement of the distribution of these species has been observed.

Invasive native species present in locations or numbers not historically found can be detrimental to some SGCN. These invasive native species can out compete the species of concern for forage or nest sites, can pose a predation threat (e.g., perch preying upon round whitefish or heritage strain brook trout), or can reduce habitat quality by altering vegetative composition and structure. This type of range expansion by native species should be of issue only if it does not represent a natural range expansion and is due to anthropogenic causes. A case in point is double-crested cormorants on Lake Ontario and other waterbodies in the region. This species was first documented breeding in New York State in 1945 on Gull Island in eastern Lake Ontario. During the 1960' cormorant populations in the Great Lakes were devastated by the effects of chemical contaminants (primarily pesticides) on reproduction. Pollution control, in addition to the protective status granted by the Migratory Bird Treaty Act, has allowed populations of cormorants to soar to historic highs. Cormorant populations have increased in abundance to the point where they are affecting other colonial-nesting waterbirds by taking over nest sites or by destroying woody vegetation needed for nesting. Affected species include common terns and black-crowned night herons. In addition, DEC and Cornell University have conducted long-term studies linking cormorants to declines in smallmouth bass in eastern Lake Ontario. In response to concerns about conflicts with other colonial-nesting birds, DEC initiated cormorant control measures at several locations during the 1990s. As part of the Final Environmental Impact Statement on Double-crested Cormorant Management in the United States (2003) prepared by the USFWS, and the management of double-crested cormorants to protect public resources in New York: Statement of Findings (2004) prepared by DEC, cooperating agencies are working to evaluate the effect of cormorant control measures and to monitor the status of island-nesting colonial waterbirds and native fish species relative to the abundance and distribution of double-crested cormorants.

Incompatible Silvicultural and Agricultural Practices

Agricultural and silvicultural products are both important to the economy of the NELO-SLR Basin and have historically provided good habitat for many species, but they have also degraded habitat for many species. Unfortunately, agricultural and silvicultural practices may lack ecologically based objectives and thus may be detrimental to wildlife.

Trends in modern farm operations toward more intensive use (increased field size, loss of edge habitats, erosion due to conventional tillage, intensive grazing, earlier and more frequent mowing/haying of fields) can have negative consequences for wildlife and their habitats in regions where agriculture (e.g., row crops, pasture/hay land) makes up a significant portion of the landscape as seen in the St. Lawrence Valley, Black River Valley, and East Ontario Plain. In addition, runoff from agricultural operations can increase contaminant, nutrient, and

sediment loads in adjacent aquatic habitats negatively affecting the SGCN that reside there. In the forested landscapes that predominate the Adirondacks, forestry operations that do not comply with best management practices (BMPs) or that are poorly planned and executed can damage habitat function and reduce habitat quality for SGCN that reside there. It is important to develop and implement farm and forestry practices that are both ecologically and economically sustainable.

Human-Wildlife Interaction

A variety of threats to SGCN in the Basin derive from direct interactions with humans. These include vehicle and structure collisions and illegal and unregulated harvest. Species that are most susceptible to these threats are those that disperse across the landscape like migrating birds and bats, and herpetofauna traversing from the upland to wetlands. Fragmentation of habitats by structures, such as power lines and roads, can be a significant source of mortality. Some wildlife is sensitive to any human disturbance, particularly during critical nesting periods. Examples include common loons and common terns.

Anecdotal evidence and preliminary data gathering efforts have suggested that wildlife collisions with human-created structures like wind turbines, communications towers, buildings, and power lines can have significant population-level effects depending on their height and location. The U.S. Fish and Wildlife Service (USFWS) and others are currently investigating the effects of these types of structures on wildlife populations (specifically, migratory birds), but as human populations within the Basin continue to increase, these structures have the potential to become a more significant hazard to SGCN.

Many of the amphibian and reptile species of conservation concern have no protected status, though protective state legislation is pending. Killing, collection/translocation, and the (illegal) sale of herpetofauna in the pet trade pose a significant threat to rare and declining reptile and amphibian species. Furthermore, public misconceptions about reptiles, particularly snakes, may drive the killing and/or collection of these animals. Pending state legislation will provide protections to many species of amphibians and reptiles, including SGCN.

Climate Change

Climate changes the threat with the greatest potential to affect fish and wildlife on a scale much larger than just this basin. Large quantities of carbon released into the atmosphere by human activities have increased the amount of carbon dioxide in the air and trapped the sun's heat. This has resulted in an increase in the global temperature at a rate faster than anything that has been observed for at least 10,000 years (Millennium Ecosystem Assessment Board, 2005). Habitats in the Adirondacks, such as the lowland boreal, may be particularly susceptible to climate change. The total warming in the Adirondacks during the past 100 years has been about 4° F, and the rate of warming since 1970 has been 13° F/century (Jenkins, in review). Warming trends may affect the distribution patterns of plants and animals that inhabit boreal habitats and may extirpate some plants and animals that cannot adapt or move to more suitable areas.

The stressors described above vary in their significance across different regions within the Basin. For the purposes of summarizing threats, the prominent hazards

for three different regions within the Basin are listed here (not in order of significance):

Many SGCN within the NELO-SLR Basin are in decline, and some of the species that once occurred in the Basin have been extirpated. Many critical habitats of the Basin have been fragmented, and the quality of the remaining patches of isolated habitat have been compromised by altered or suppressed habitat processes, barriers to movement (e.g., dams, roads), and invasions of exotic species. Aquatic habitats have been compromised by point and non-point source pollution, water extraction, and sedimentation. Ensuring the sustainability of the ecological systems of this Basin will be a challenge and will require cooperation among a diverse group of stakeholders, comprehensive land-use planning that incorporates ecologically based objectives, and proactive management to protect systems in good health and restore systems that have been degraded.

Priority Issues in the Basin

ADIRONDACK MOUNTAINS

Atmospheric deposition
Habitat loss and fragmentation
Incompatible forestry practices
Invasive species
Human disturbance (collection, recreation)
Climate Change*

ST. LAWRENCE VALLEY/BLACK RIVER VALLEY/E. ONTARIO PLAIN

Habitat loss and fragmentation
Degraded water quality and altered hydrology
Incompatible agricultural practices
Invasive species

ST. LAWRENCE RIVER/E. LAKE ONTARIO COASTAL HABITATS

Habitat loss and fragmentation
Degraded water quality and altered hydrology
Incompatible agricultural practices
Invasive species
Human disturbance (recreation)

***Climate change is listed here only for the Adirondacks, but will likely affect all areas.**

Vision, Goals and Objectives for the Basin

Vision

The Northeast Lake Ontario - St. Lawrence River Basin will be part of a healthy and sustainable ecosystem.

Traditional and non-traditional public and private conservation partners will work in a coordinated fashion to gather the most accurate, comprehensive data on species of greatest conservation need (SGCN) within the basin in a format that can easily be shared among natural resource managers and disseminated to the public to raise awareness of the issues facing species of concern and their habitats.

These conservation partners will also work in a coordinated manner to manage populations and habitats over a large spatial and temporal scale. This will be done through comprehensive planning, land conservation, adaptive management, and rigorous evaluation.

The result of these efforts will be healthier and secure animal populations, habitats, and communities. Loss of SGCN to extinction will be slowed or halted. Species that currently are common will remain common, and populations of threatened/endangered/special concern species will improve to the point where they can eventually be de-listed.

Goals and Objectives

- Establish a conservation framework within the NELO-SLR Basin through which public and private stakeholders interested in wildlife conservation can work cooperatively toward the management, enhancement, and protection of the basin's at-risk biodiversity.

- Ensure that no at-risk (threatened/endangered) species becomes extirpated from the Basin.

- Manage animals, habitats, and land use practices to produce sustainable benefits for species of conservation concern.

- Maintain knowledge of species and their habitats in sufficient detail to recognize long-term population shifts.

- Fill "data gaps" for those species where population status, distribution, and habitat needs are unknown.

- Identify, manage, protect, maintain, and restore habitat/natural communities over as broad a spatial scale as possible. Work to keep large forest, wetland, and grassland complexes unfragmented, and to restore fragmented habitats where feasible to increase patch size and connectivity.

- Work with land managers to incorporate wildlife-based objectives into traditional land-management activities such as forestry and agriculture that still allow these activities to be economically sustainable.

- Develop a "stepped down," more targeted plan for the basin that expands upon the recommendations made here. This plan may focus on specific species and habitats, where and when management actions will occur, who will execute those actions, and how they will be implemented "on the ground."

Priority Strategies and Actions for Basin-wide Implementation

The following recommendations do not appear in any priority order. All of these recommendations are intended to be of high priority to implement in this basin in the coming 5 to 10 years for the benefit of the most critical SGCN in the state. See the discussion of "*Development of Conservation Recommendations for Species of Greatest Conservation Need and their Habitats*" and their prioritization in the Introduction. All of the recommendations for SGCN found in this basin can be viewed in Appendix A.

Some of the following recommendations refer to work that has already been initiated under the first two rounds of State Wildlife Grant funding (State Fiscal Years 2003 and 2004, Northeast Lake Ontario-St. Lawrence Table 13). Those interested in implementing one of the actions below should be sure to consult the data generated by these studies before engaging in their own conservation endeavors.

Data Collection Recommendations for Critical Species

Data collection (research, surveys, and inventories) is a crucial first step for the majority of SGCN in the NELO-SLR Basin. Many of the conservation actions in the following categories (e.g., planning, land acquisition, etc.) should not or can not be done until critical data gaps are addressed for particular species and their habitats. Once we know more about a species' abundance, distribution, life history, and habitat needs, we can begin to decide where, when, and how conservation actions can be implemented.

A number of priority species and groups need population, habitat, and life history research to address critical data gaps. This information will help more clearly identify threats and establish baseline information for these species. This type of data collection will address multiple threats to many species, which are listed below by species group.

Beach and Island Ground-Nesting Birds

- Conduct annual surveys for common terns to track population status at known breeding locations. Breeding Bird Atlas (BBA, 2000-04) records indicate that, along with Long Island, the coastal portions of western Jefferson and St. Lawrence counties are a stronghold for breeding populations of this species in New York State. Information from this effort should be incorporated into the conservation plan for common terns being developed under the 2003 State Wildlife Grant.
- Monitor the status of NYS's only known Caspian tern colony on Lake Ontario Islands WMA (Little Galloo Island, Jefferson County).

Boreal-Forest Birds

- Develop a long-term monitoring program to determine population and habitat trends of boreal forest birds and to determine threats to these species. The highest priority species in the group are the New York State endangered spruce grouse and the declining olive-sided flycatcher and bay-breasted warbler. The status of the following species is unknown: Cape May warbler, rusty blackbird, Tennessee warbler, three-toed woodpecker.

- Incorporate the results of the 2004 State Wildlife Grant study on boreal forest birds into future monitoring efforts and data analyses.

BREEDING WATERFOWL

- Conduct more intensive surveys for common goldeneye in the Adirondacks to estimate overall abundance, document habitat use, and design a long-term monitoring program (e.g., every 5 years).
- Conduct field studies to document life history and habitat use by blue-winged teal breeding in the St. Lawrence Valley region of New York.

COMMON LOON

- Monitor breeding population trends and productivity including:
  - Northeast Lake Ontario-St. Lawrence Table 2 census of adult population using repeated standardized surveys;
  - Survey a specified sample of lakes annually or every few years to document population trend;
  - Verify breeding by the presence of recently used nests or flightless young;
  - Determine breeding chronology and outcome (chicks not considered fledged until at least 4 weeks old), and
  - Utilizing volunteer observers, implement simultaneous counts to provide an index of lake occupancy and productivity and refine statewide population totals.
  - Research migration routes and staging areas of the Adirondack population.
- Research wintering distribution and ecology of Adirondack population.
- Monitor migratory trends in distribution and abundance utilizing Christmas bird counts.
- Research the energetic requirements of adults and young, recruitment patterns of young and non-breeders into breeding populations, effects of intra-specific competition on breeding status and success, site fidelity and territory turnover patterns, duration of pair bonds, and pattern of lake colonization or recolonization.
- Research the life history of juveniles between fledging and their return to northern lakes.
- Research and utilize radio transmitter technology on loons to determine chick survival and juvenile movement patterns and behavior, and identify migration patterns, stopover sites, and wintering habitats.
- Continue the banding and marking of individual birds to determine loon movement patterns, behavioral ecology, and demography.

COMMON NIGHTHAWK

- Develop survey methodology to determine population trends for this species. BBA (2000-04) records indicate that this species was observed in several blocks throughout the basin with a concentration of confirmed breeding observations in eastern Jefferson County (Fort Drum) and St Lawrence County.

DECIDUOUS/MIXED FOREST BREEDING BIRDS

- Conduct targeted monitoring of cerulean warblers to determine precise population trends. BBA (2000-04) records indicate that this species was observed in several blocks in Jefferson, St. Lawrence, and Lewis counties, with a concentration of confirmed and probable breeding observations in northern Jefferson and southwestern St. Lawrence counties.

- Identify cerulean warbler habitat characteristics of areas being occupied and critical habitat focus areas within this basin.

EARLY SUCCESSIONAL FOREST/SHRUBLAND BIRDS

- Complete an inventory and analysis for high priority focus species that identifies core habitats (highest abundance) and geographic areas (where appropriate). For this basin, this includes golden-winged warbler, Canada warbler, and whip-poor-will. Canada warbler needs to be surveyed in riparian zones and wet woodlands.
- Develop a long-term monitoring program for golden-winged warblers. In particular, monitor status and trends of golden-winged warblers along the "front" of blue-winged warbler invasion northward.
- Incorporate the results of the 2003 and 2004 State Wildlife Grant studies on golden-winged warbler habitat needs into future monitoring efforts and data analyses.

FOREST-BREEDING RAPTORS

- Determine the population status of long-eared owls in this basin. Surveys should initially focus on occupied sites in Jefferson, St. Lawrence, and Franklin counties (Breeding Bird Atlas, 2000-04).
- Determine the presence and breeding of golden eagle within this basin, and, if observed, document habitat use (i.e., migration, breeding, wintering, etc.).

FRESHWATER MARSH NESTING BIRDS

- Initiate baseline population surveys to determine abundance and distribution of high-priority species, and periodically re-survey to detect trends. Refine monitoring techniques to better detect population trends and determine the cause of observed changes. Focus species include American and least bitterns, pied-billed grebe, and black tern. Initially, surveys efforts should focus on marsh habitats in Jefferson and St. Lawrence counties (BBA 2000-04), then should be expanded throughout the basin.
- Identify and prepare a catalog of key migratory staging, molting areas, and wintering grounds.
- Prepare a catalog, where possible, of breeding sites identifying and mapping sites at a course scale to select sites worthy of monitoring.
- Evaluate habitats by a variety of techniques at multiple scales to better understand the micro- and macro habitat features important to nest site selection.
- Conduct studies of habitat use, prey availability, and diet at migratory staging and molting areas and wintering grounds to assess possible threats and limiting factors for high-priority species.
- Investigate aspects of behavioral ecology, such as mate selection, mate fidelity, spacing behavior, coloniality, dispersal, and post-fledging parental care.
- Incorporate the results of the 2004 State Wildlife Grant study on marsh birds into future monitoring efforts and data analyses.

GRASSLAND BIRDS

- Complete an inventory of potential grassland habitat for species present, distribution, and relative abundance of priority species within this basin. These include Henslow's sparrow, northern harrier, sedge wren, short-eared owl, and upland sandpiper. Survey efforts will focus on grassland areas defined as potential focus areas by the SWG study efforts. This effort will include grasslands throughout the St. Lawrence Valley, from Jefferson County through northwestern Clinton County.

- Develop and implement supplemental monitoring programs for grassland bird species that are not adequately sampled by the Breeding Bird Survey to determine precise population trends and evaluate effectiveness of conservation efforts. Use long-term trend data to determine effectiveness of grassland conservation efforts.
- Incorporate the data generated by the two tasks above into the New York State Grassland Bird Management Plan currently being developed under the 2003 State Wildlife Grant.

High-Altitude Conifer Forest Birds

- Continue the Mountain Birdwatch monitoring protocol on all Adirondack peaks where Bicknell's thrush is known to occur. Implement other long-term monitoring if needed to determine population trend.
- Evaluate the long-term viability of Bicknell's thrush as a part of New York State's breeding avifauna.

Osprey

- Annually or periodically monitor the population (or certain regions of the population) to determine the number of territorial pairs and reproductive outcome. Record notable new aspects of the species' ecology, especially those pertaining to any local declines. This task should focus on the Adirondacks and the shores of eastern Lake Ontario and the St. Lawrence River (Jefferson and St. Lawrence counties).
- Ensure that information on all new osprey nests is submitted to the Natural Heritage Program.

Mooneye

- Monitor the status of this species in Black Lake and identify critical habitats.

Pugnose Shiner

- As little is known about where this species lives in large water bodies, life history studies need to be done, and sampling techniques must be improved in order to carry out surveys.

Heritage-Strain Brook Trout

- The NELO-STL watershed is home to a large percentage of the described heritage strains of brook trout (Keller, 1979). Works needs to be completed to determine the genetic status of what we are currently calling Little Tupper strain and Horn Lake strain. An additional three strains, which have been previously described and are believed to potentially have gone extinct, need to be investigated. Genetic analysis, using modern methodology, needs to be completed not only for fish found in waters that have previously been described as having heritage strain fish, but also for other waters that have wild brook trout without a clear history of non-heritage hatchery blood lines.

Lake Sturgeon

- Identify existing critical habitats for lake sturgeon(e.g., spawning, juvenile, adult) and determine their current status.

Herpetofauna

- Conduct periodic surveys of known sites of occurrence for western chorus frog in order to detect population trends. New York State Herpetile Atlas (DEC, 2005) data indicate that the eastern Lake Ontario and St. Lawrence Valley region is one of two strongholds for this species in NYS (the other being the Lake Plains region in western NYS).

- Conduct surveys to determine the status of Blanding's and spotted turtles in this basin. Re-survey occupied sites to detect population trends over time. Herp Atlas (DEC, 2005) records for Blanding's turtle indicate that the St. Lawrence Valley (primarily Jefferson and St. Lawrence counties) is one of two strongholds for this species in NYS (the other being the lower Hudson Valley). The spotted turtle was observed in only four blocks in the basin: two from the east Lake Ontario plains region (Jefferson County) and two from the St. Lawrence Valley/Adirondack transitional region (Lewis County - St. Lawrence County border).
- Conduct periodic re-survey of known sites of occurrence for blue-spotted and Jefferson salamanders in order to detect population trends. There are Herpetile Atlas (DEC, 2005) records for these species throughout the basin.
- Conduct a periodic re-survey of known sites of occurrence for wood turtle and eastern ribbonsnake in order to detect population trends. Herp Atlas (DEC, 2005) records for wood turtles indicate that this species is distributed throughout the basin. The eastern ribbonsnake was observed in northern Jefferson/southern St. Lawrence County and northern and eastern Franklin County.
- Develop standardized population survey protocols, and implement protocols at all known and potentially suitable sites to document the extent of occupied habitat.
- Develop standardized habitat survey protocols, and implement survey protocols at all known and potentially suitable sites, to document the character, quality and extent of occupied habitat.
- Document life history parameters specific to New York populations of these species, including age and sex ratios, longevity, age at sexual maturity, survivorship of young, predator-prey relationships, and wetland/upland habitat requirements.
- Incorporate the results of the 2003 and 2004 State Wildlife Grant studies on high-priority amphibian species into future monitoring efforts and data analyses.

OTHER BUTTERFLIES

- Within this basin, determine the population status and distribution of high priority butterfly species, including mottled duskywing and Olympia marble.
- Determine the best management regimes for species in each locality.
- Establish the duration of all life stages, the precise habitat needs of all life stages, and how this information should be coordinated with management actions.
- Identify important food plants and determine the relationship between food availability and species numbers.

ODONATES

- Complete the statewide inventory of odonates and their habitats as outlined in the 2003 State Wildlife Grant. "Hot spots" of odonate diversity within this basin should be identified and targeted for management action based on species richness, acuteness of threats, and overall value to odonates and other SGCN.

FURBEARERS

- Assess potential marten habitat outside of the core marten range in the central Adirondacks, and evaluate limiting factors affecting range expansion. Model habitats to identify corridors to promote genetic exchange.

- Assess effects of mercury toxicity on marten and otter.

INDIANA BAT

- Continue to survey new potential hibernacula as they are discovered.
- Survey winter populations.
- Survey for Indiana bats using vocalization detectors and mist netting at sites that are geographically similar but that have differences in the density of development over large areas.
- Identify the specific summer habitat requirements for the Indiana bat by radio-tracking 1% or more of the hibernating reproductive females from winter to summer range.
- Conduct marking studies during the summer maternity, fall swarm, and spring emergence that will detect differences in mark retention and survival rates for PIT tags, and at least two types of wing bands.
- Live trap and mark Indiana bats during the fall swarm, fall entry, and spring emergence at one hibernaculum to determine the arrival and departure periods of Indiana bats by age and sex.
- Complete three years of roost temperature monitoring at all Indiana bat sites using continually monitoring temperature probes.

TREE BATS

- Conduct surveys of migrants to determine the timing, distribution, species composition and elevation of migrating bats. This is likely to include combinations of acoustical monitoring, radar, and visual monitoring.
- Conduct summer surveys of tree bats that will include capturing individuals and acoustical monitoring.
- Research threats to critical habitats and populations.

FRESHWATER BIVALVES

- Conduct surveys to determine the distribution and abundance of mussel species-at-risk in the NELO-SLR Basin. High-priority species in this basin include elktoe and yellow lamp mussel.
- Research the best survey methods both for detection of rare species and evaluation of population status and trends.
- Conduct research to determine habitat parameters necessary for good populations of each species of at-risk listed mussels.
- Research all parameters of mussel habitat requirements including temperature, substrate, fish, flow, food, etc.
- Determine fish hosts for species where this is not known for populations living in the NELO-SLR Basin.
- Determine or confirm breeding phenology and habitat conditions necessary for successful breeding for listed mussels (e.g.. mussel density, pop. level of fish host, temp, flow).

Data Collection Recommendations for Habitats

GENERAL HABITAT REQUIREMENTS FOR SGCN

Before other conservation actions can be taken to combat the harmful effects of habitat loss and fragmentation, data need to be collected on specific habitat requirements of SGCN (e.g., landscape scale characteristics like patch size and juxtaposition, microhabitat characteristics like stem density and ground cover), population processes (e.g., minimum viable population, metapopulation

dynamics, source/sink dynamics), and how, when, and where habitat management and/or restoration should occur. Specific recommendations include:

Beach and Island Ground-Nesting Birds

- Conduct and/or coordinate habitat research projects that would help define preferred habitat in order to guide restoration efforts and focus habitat protection efforts for common terns.

Deciduous/Mixed-Forest Breeding Birds

- Conduct and/or coordinate habitat research to study area sensitivity and habitat requirements of cerulean warblers.

Early Successional Forest/Shrubland Birds

- Research the possible causes for declines of Canada warbler and the effectiveness of forest management regimes in opening up the canopy and promoting ground growth and thickets beneficial to this species. BBA (2000-04) data indicate that this species is found throughout the basin, primarily south and east of the more open habitats of the St. Lawrence plain (Tug Hill Plateau northeast through the Adirondacks). These may be areas to focus a research effort.
- Research the possible causes for declines and determine the habitat requirements of whip-poor-will and golden-winged warbler. Develop habitat management guidelines that will help to guide management efforts. The St. Lawrence plain is a critical area for golden-winged warblers as populations in southern portions of the state have declined. Our knowledge of whip-poor-will distribution and habitat requirements is inadequate.

Freshwater Marsh Nesting Birds

- Conduct controlled experiments to see which management actions are effective locally in producing habitat suitable for marsh birds.
- Conduct demographic studies at selected sites across the species breeding range to identify "source" and "sink" populations, thus the regions most important for maintaining a breeding population. This research should also document such parameters as survival, age at first breeding, recruitment, dispersal, and the factors that affect them using color-banded or radio-tagged birds.
- Further evaluate the effectiveness of artificial nest platforms for increasing nest success or densities of black tern, emphasizing placement of platforms where nest substrates appear to be limiting or where terns may be encouraged to nest in areas of low disturbance.
- High priority marsh birds within this basin include American and least bitterns, pied-billed grebe, and black tern. BBA (2000-04) data show concentrations of observations of these species from the east Lake Ontario plain (Jefferson County) northeast through wetlands in the St. Lawrence Valley (St. Lawrence and Franklin counties).

Grassland birds

- Conduct studies to determine the habitat requirements and potential benefits of various management techniques, such as prescribed fire, mowing, haying. Conduct demographic studies at selected sites across the species breeding range to identify "source" and "sink" habitats and populations, thus the habitats and regions most important for maintaining a breeding population.

This research should also document such parameters as survival under various management regimes, age at first breeding, recruitment, dispersal, and the factors that affect them. These efforts should focus on grasslands of the St. Lawrence Valley (Jefferson County through northern Clinton County). High priority-species include Henslow's sparrow, northern harrier, sedge wren, short-eared owl, bobolink and upland sandpiper. Results of this research should be integrated into the New York State Grassland Bird Management Plan being developed by DEC and others under the 2003 State Wildlife Grant.

High Altitude Conifer Forest Birds

- Develop a study to determine if management (creation of habitat, such as regenerating fir waves) can be an effective management tool for Bicknell's thrush. This relatively rare high elevation (above 2800 feet in Adirondacks) species utilizes forest disturbances that create dense regrowth. Vermont Institute of Natural Science and BBA (2000-04) data show concentrations of this species in southern Franklin County and north-central Hamilton County. It should be noted, however, that the majority of Bicknell's thrush habitat is likely within the forest preserve and regenerating fir wave through artificial management may be prohibited. Therefore, any study should focus on suitable locations outside the preserve.

Other Butterflies

- Investigate the metapopulation dynamics of those species which appear to have distinct populations. Highlight species include mottled duskywing and Olympia marble.

Freshwater Bivalves

- Research population dynamics of listed mussel species including connectivity of populations or sub-populations and genetic distinctness of populations or sub-populations. High priority species within this Basin include elktoe and yellow lamp mussel.

Human Alteration of the Landscape and Interspecific Interactions

Landscapes that have been heavily manipulated by humans may have disrupted predator-prey cycles. Anthropogenic activities such as development and pesticide application may serve to directly reduce prey populations. In addition, human-altered habitats may favor generalist predators by creating long, linear-edge habitats and small habitat patches (with a high edge:interior ratio) that allow predators to hunt in a more efficient fashion. Changes in prey abundance and predator communities can affect survivorship of both young and adult animals (i.e., increased predation, poor nutrition increasing susceptibility to disease, predation, etc.), thus contributing to species declines. Investigating predator-prey dynamics in relatively large blocks of contiguous habitat (e.g., large forest tracts in the Adirondacks, large grassland or wetland complexes in the St. Lawrence Valley) provides insight into how to repair ecological processes in human-altered habitats. Specific data collection recommendations include:

Freshwater Marsh-Nesting Birds

- Investigate diet and nutrition in relation to breeding habitat quality and prey populations (including insects, fish, and herpetofauna of freshwater wetlands) and how this translates into nesting and fledgling success for high-priority marsh birds (American bittern, least bittern, pied-billed grebe, black tern).

This could include investigating the effects of pesticides on prey diversity and abundance. As wetlands are scattered throughout the basin, this study should take place where and when opportunity allows; however, the marsh complexes associated with eastern Lake Ontario and the wetlands and adjacent uplands of the St. Lawrence Valley may provide excellent opportunities for research.

Osprey

- Determine the relationship between habitat quality, osprey survivorship, and changes in fisheries populations due to recreational and commercial harvest, changes in water quality, and effects of wildlife such as cormorants. This research should focus on occupied habitats in the Adirondack Park and the shores of eastern Lake Ontario and the St. Lawrence River (Jefferson and St. Lawrence counties).

Habitat Availability

- Document land use and land coverage changes on both public and private land that can be interpreted into habitat availability. For example, housing developments often take hayfield grassland habitats.

WATER QUALITY

Many of the SGCN in this basin rely upon aquatic habitats during some stage of their life cycle (e.g., natal sites, foraging sites, etc.). Conservation partners have identified the degradation of water quality and the acute and chronic effects of contaminants in aquatic habitats as a significant threat to wildlife. Degraded water quality includes siltation, nutrient runoff, temperature increases, toxics (e.g., PCBs, mercury, pesticides, heavy metals), lowered dissolved oxygen, and altered hydrology (dams, water withdrawal, groundwater extraction). It is important to quantify the effects of these threats on the survival of SGCN before regulatory, management, or other actions can be taken to alleviate these problems. Specific data collection recommendations to address these issues include:

Common Loon

- Monitor chemical contaminants and heavy metals in adults and eggs on a regular basis.
- Monitor pH levels in lakes within the Adirondack Park and other acid deposition-affected areas, survey forage base, and research the effects of lake acidification on breeding loons.
- Determine the biological consequences of chemical and heavy metal toxicity.

Freshwater Marsh-nesting Birds

- Periodically monitor the levels of contaminants in marsh birds and their eggs to assess trends and determine effects on eggshell thinning, behavioral modification, chick development, nesting success, and juvenile survival. High-priority species include American bittern, least bittern, pied-billed grebe, and black tern.

Round Whitefish

- Continue research from the 2003 State Wildlife Grant to determine the causes of population declines and losses within the Adirondack region, especially the effect of acid rain.

Other Butterflies

- Determine the actual sensitivity of species to chemical formulations, particularly diflubenzuron and other commonly used agricultural pesticides. High-priority species include mottled duskywing and Olympia marble.

Freshwater Bivalves

- Research effects of pesticides and other chemicals, including ammonia, on all life stages of freshwater bivalves: sperm/egg, glochidia, larva, adults.
- Research flow requirements of freshwater bivalves and model the effects of flow changes both in volume and timing. High-priority species for these actions include elktoe and yellow lamp mussel.

EXOTIC INVASIVE SPECIES

Invasive exotic plants and animals diminish the quality of upland and aquatic habitats throughout the Basin. In wetlands and other aquatic habitats, plant species like purple loosestrife and Eurasian water milfoil with little value to wildlife displace native plant species and disrupt ecological processes. Zebra mussels decimate native mussels by attaching to their shells and inhibiting breathing and feeding. In upland habitats, invasive exotic plants and insects introduced through human activity threaten to reduce biodiversity. For example, exotic plants like honeysuckle and buckthorn out-compete native trees and shrubs and alter the composition and function of upland plant communities. In all habitat types, disturbances associated with residential and commercial development increase the risk of new occurrences of invasive exotic plants and animals. It is important to engage in early detection for these exotic species (where they are not found) and quantify their effects (where they already exist) on SGCN and critical habitats to minimize the potential detrimental effects of exotic species on species survival and habitat quantity and quality. Specific recommendations include:

Common Loon

- Investigate the causes of type E botulism, the link to non-native mollusks and fish, and how outbreaks can be prevented or minimized.
- Continue aerial and beach transect surveys during the fall to determine effects of type E botulism on water birds utilizing the Great Lakes as stopover sites during migration.

Early Successional Forest/Shrubland Birds

- Determine effects of viburnam leaf beetle on early successional forest/shrub habitats and species utilizing them. The location will depend upon the intensity and scope of the infestation, life-history traits and management objectives for the SGCN to benefit from the action and logistics (funding, cooperating partners, feasibility of using a particular method in a specific locale). High priority species include golden-winged warbler, Canada warbler, American woodcock, and whip-poor-will.

Round Whitefish

- One of the possible reasons for the decline in round whitefish populations is predation by invading yellow perch and smallmouth bass on whitefish eggs and juveniles. Continue studies to determine the effects of invasive predatory fish on round whitefish.

Pugnose Shiner

- Inventory the habitat requirements of this species, and quantify the effect of invasive plants such as Eurasian water milfoil.

Freshwater Bivalves

- Conduct research on control of exotic bivalve species (e.g., zebra mussels, quagga mussels) that compete with native mussels and exotic crustaceans or fish which may prey on them. High-priority species include elktoe and yellow lamp mussel.

Wetland Habitats and Species

- Identify invasive species (including purple loosestrife, Eurasian water milfoil) which have the potential to negatively affect marsh habitats and quantify the effect on habitat quality for appropriate SGCN. In addition, investigate which control methods (biological vs. chemical vs. mechanical) are the most effective based on a particular species' habitat requirements and life history traits. This action should focus on:
  - Freshwater Marsh-Nesting Birds - American bittern, least bittern, pied-billed grebe, black tern
  - Freshwater Wetland Amphibians - western chorus frog, four-toed salamander
  - Lake/River Reptiles - eastern ribbon snake, wood turtle
  - Uncommon Turtles of Wetlands - spotted turtle, Blanding's turtle
  - Vernal-Pool Salamanders - blue-spotted salamander, Jefferson salamander

Native Invasive Species

Natural and/or anthropogenic forces may create a situation where populations of native species expand to levels and locations not historically observed. This is the case with double-crested cormorants on Lake Ontario. Cormorant populations have increased to the point where they are affecting other colonial nesting waterbirds by taking over nest sites or by destroying woody vegetation needed for nesting. Affected species include common tern (beach and island ground-nesting birds) and black-crowned night heron (colonial nesting herons). In response to concerns about conflicts with other colonial-nesting birds, DEC initiated cormorant control measures at several locations during the 1990s.

- Cooperating agencies (DEC, USFWS) should continue to work to evaluate the effect of cormorant control measures and to monitor the status of island-nesting colonial waterbirds and native fish species relative to the abundance and distribution of double-crested cormorants.

Land Management Practices

Agricultural and silvicultural practices may lack ecologically based objectives, thus may sometimes be detrimental to wildlife. Trends in modern farm operations (increased field size, loss of edge habitats, erosion due to conventional tillage, intensive grazing, earlier and more frequent timed mowing/haying of fields) can have negative consequences for wildlife and their habitats in regions where agriculture (e.g., row crops, pasture/hayland) makes up a significant portion of the landscape as seen in the St. Lawrence Valley (Jefferson County through Clinton County). In the forested landscapes that dominate the basin, forestry

operations that do not comply with best management practices or that are poorly planned and executed can damage habitat function and reduce habitat quality for SGCN that reside there. Specific recommendations to investigate these issues include:

Deciduous/Mixed Forest Breeding Birds

- In areas occupied by Cerulean warblers (generally outside the Adirondacks), determine the effects of various cutting regimes (partial harvest, clear cut, etc.) and size and shape of the area harvested on "forest interior" birds, including cerulean warbler.

Early Successional Forest/Shrubland Birds

- Evaluate which cutting regimes (partial harvest, clear cut, etc.) provide the maximum benefit for the greatest number of early successional bird species. This work should take into account all of the SGCN in this group (American woodcock, black-billed cuckoo, blue-winged warbler, brown thrasher, Canada warbler, golden-winged warbler, prairie warbler, ruffed grouse, whip-poor-will, willow flycatcher).

Forest Breeding Raptors

- Experiment with different timber management techniques in order to find out which are compatible with forest-breeding raptors and which methods provide the maximum benefits for forest-breeding raptors. This includes trying different cutting regimes (partial harvest, clear cut, etc.), different buffer distances between harvest sites and occupied nests, and fire management where appropriate. This should be done in both deciduous and coniferous forests and should take into account all of the SGCN in this group (Cooper's hawk, long-eared owl, northern goshawk, red-shouldered hawk, sharp-shinned hawk).

Grassland Birds

- Evaluate the effects of specific farming and management practices, such as: timing of mowing, intensity of grazing, frequency of mowing, mowing versus haying versus prescribed fire, and width of buffer strips on productivity of all SGCN in this group (bobolink, Henslow's sparrow, Eastern meadowlark, grasshopper sparrow, horned lark, northern harrier, sedge wren, short-eared owl, upland sandpiper, vesper sparrow).
- These efforts should focus on the regions within the basin with the highest concentrations of grasslands: east Lake Ontario plains (Jefferson County) and the St. Lawrence Valley (St. Lawrence County through Clinton County). Results of this research should be integrated into the New York State Grassland Bird Management Plan being developed by DEC and others under the 2003 State Wildlife Grant.

Structure Collisions

- Targeted efforts should be made in the unique landscapes of the NELO-SLR Basin to determine the magnitude of this threat for SGCN based on land use and development trends (number and distribution of structures), human population distributions, and other characteristics unique to this basin. SGCN should be included in this action include migratory birds (early successional forest/shrubland birds, deciduous forest birds, forest-breeding raptors) and

bats (Indiana bat, small-footed bat, tree bats). An important component of this effort that has already been initiated is the 2004 State Wildlife Grant Project, "Use of Radar to Document Bird and Bat Migrations in New York State. "

Planning Recommendations

Existing Planning Efforts

The NELO-SLR Basin crosses both state and international boundaries. Conservation decisions regarding Lake Ontario, the St. Lawrence River, and the landscape within which they are embedded require interstate and international cooperation. Fortunately, this region has several ongoing planning endeavors that involve a diverse array of public and private partners and that cross both state and international borders. Examples of these efforts include:

- St. Lawrence-Champlain Valley Ecoregion Biodiversity Conservation Plan (The Nature Conservancy)
- Great Lakes Water Quality Agreement and the Lakewide Management Plan for Lake Ontario (USEPA, Environment Canada, DEC, Ontario Ministry of the Environment)
- International Joint Commission's Council of Great Lakes Research Managers and the Great Lakes - St. Lawrence Research Inventory
- Great Lakes Research Consortium (more than 2 dozen universities in NYS and Canada)
- U.S. Policy Committee for the Great Lakes and the Strategic Plan for the Great Lakes Ecosystem (federal and state agencies, tribal governments)
- Great Lakes Basin Ecosystem Team (U.S. Fish and Wildlife Service)
- North American Bird Conservation Initiative Planning
- Partners in Flight Bird Conservation Planning
- NYS Grassland Planning Group

Conservation partners interested in engaging in land-use planning for this watershed should first consult the work of these entities.

Recommended New Planning

This comprehensive, strategic wildlife conservation strategy for the NELO-SLR Basin is intended as a framework for conservation planning in this region of New York State. The next step, within 2-5 years, is to develop a "stepped down ," more targeted plan for the basin that expands upon the recommendations made here. This plan may focus on specific species and habitats, where and when management actions will occur, who will execute those actions, and how they will be implemented "on the ground." Some of the challenges in developing this more specific targeted plan will be to:

- Analyze and apply all of the information generated by the State Wildlife Grant research, survey, and inventory efforts and incorporate them into plans at varying spatial and temporal scales.
- Incorporate many of the on going planning efforts being conducted by government agencies (e.g., unit management plans, New York State Grassland Bird Management Plan, North American Waterbird Plan) and NGOs.
- Coordinate the diverse array of stakeholder groups that will need to be involved in land-use planning for SGCN, particularly groups that may not have been traditionally involved in a large scale conservation planning process (e.g., economic development groups, town boards, local land trusts, etc.).

There is a clear need for a habitat mosaic management plan for early successional forests/shrub habitat, mature forest stands, grasslands, and wetlands in this

basin. Of the 111 SGCN occurring in the basin, 10 depend on barrens and woodlands, 43 depend on forested habitat, 39 depend on grasslands, and 20 depend on mineral soil wetlands. Some species depend on all 4 of these habitat types at some point in their life cycles. All of these habitats have competing needs and priorities among both wildlife (habitat quality and quantity) and people (timber, agriculture, residential and commercial development, water). The balance and active cooperative management of all of these habitat types among a diverse array of stakeholders is integral to the health and abundance of many of the SGCN currently living in this basin.

COOPERATIVE MANAGEMENT

Land management needs to be carried out with the cooperation of many agencies. Key partners to include are DEC, NYSOPRHP, USFWS, USGS-BRD, NRCS, and local governments. Private lands comprise 85% of the total land area of the state. Use of cooperative management programs like Farm Bill programs coordinated by the USDA and NRCS, such as the Wildlife Habitat Incentive Program (WHIP) USFWS's Partners for Wildlife Program, DEC Landowner Incentive Program (LIP), and various conservation programs administered by non-governmental organizations (e.g., such as the Adirondack Land Trust, The Nature Conservancy TNC , Ducks Unlimited, Inc., Ruffed Grouse Society) will be important to achieve effective habitat protection and enhancement for many SGCN.

FOREST LANDS

More than 70% of the NELO-SLR Basin is forested. An opportunity to integrate the needs of many SGCN that rely on a variety of forested habitat types in both large-scale management plans and smaller plans may address only one species, habitat type, or geographic area (e.g., wildlife management area, a private forest tract). Wildlife biologists and researchers should develop habitat management guidelines for forest stages important to SGCN that include patch size and distribution in the landscape, timing of management actions, and microhabitat characteristics. These guidelines should be considered by forest managers on public lands and made available to private forest owners interested in wildlife management. Some specific planning recommendations for species in forested habitats include:

- Develop a management plan that provides guidance on maintaining, enhancing, and restoring early successional forest/shrub habitat for the suite of early successional forest/shrubland birds. High-priority species include Canada warbler, golden-winged warbler, American woodcock, and whip-poor-will.

- Investigate the feasibility of managing forests in the basin with controlled burning. Draft a fire-management plan in accordance with these findings. This would benefit many SGCN, including deciduous-forest birds, early successional forest/shrubland birds, and forest- breeding raptors.

- Develop a management plan for high-altitude conifer forest birds (i.e., Bicknell's thrush). The results of the 2004 State Wildlife Grant study on boreal forest birds should be incorporated into this work.

AQUATIC HABITAT

More than 11% of the NELO-SLV Basin is classified as aquatic habitat. About 8% of this is classified as wetlands, the majority of which are wooded wetlands. The

proportion of wooded wetlands in this basin is among the highest in the state, and includes the extensive lowland boreal wetlands of the Adirondacks. The remaining 3% classified as "water" is comprised of more than 14,000 miles of rivers and streams, over 1,000 ponds and lakes, and roughly 1/3 of the NYS share of the shoreline of Lake Ontario. Many SGCN within this watershed rely on these critical aquatic habitats during some stage in their life cycle. It is important that these habitats and the species that depend upon them be incorporated into land use planning on both the landscape and local scale for conservation efforts to succeed. As with forested habitats, wildlife biologists and researchers should develop habitat management guidelines for wetland types important to SGCN that include patch size and distribution in the landscape, timing of management actions, and microhabitat characteristics. These guidelines should be considered by land managers on public lands and made available to private wetland owners interested in wildlife management. Some specific planning recommendations for species in these habitats include:

- Continue participation in the North American Waterbird Plan, North American Bird Conservation Initiative plans, and other regional planning efforts. Focus on and refine recommendations for common loon and freshwater marsh-nesting birds (American bittern, least bittern, pied-billed grebe, black tern).

- Work with USFWS, USDA APHIS Wildlife Services, and state agencies on the development of the "second phase" of the population management plan for the Interior Great Lakes population of double-crested cormorants. The plan should include the potential effects of cormorants on SGCN such as colonial-nesting herons (e.g., black-crowned night heron, cattle egret) and other island ground-nesting birds (e.g., common tern), and how to alleviate negative effects before they limit populations of at-risk species.

- Develop a monitoring/control plan that includes measures to detect invasive species problematic to freshwater bivalves in the NELO-SLV Basin and actions that will be taken to control invasive species before they become threats. There are several existing management plans in the basin with components related to the management of invasive species (Northeast Lake Ontario-St. Lawrence Table 14). The planning effort for freshwater bivalves could be incorporated into, or modeled after, these on-going efforts.

INVASIVE SPECIES

Public and private conservation partners should continue to coordinate and expand the development of a monitoring and control plan for invasive exotic species in wetlands (e.g., purple loosestrife) in the Adirondacks, St. Lawrence Valley, and coastal marshes of eastern Lake Ontario, including guidelines for various control methods (e.g., mechanical control, chemical control, biological control), and the compatibility of these control measures with SGCN life history and habitat requirements. This planning effort could be incorporated into, or modeled after, programs such as the Adirondack Invasive Plant Program (DEC, NYSDOT, Adirondack Park Agency, Adirondack Nature Conservancy) and should incorporate the needs of:

- Freshwater Marsh-Nesting Birds - American bittern, least bittern, pied-billed grebe, black tern
- Freshwater Wetland Amphibians - western chorus frog
- Lake/River Reptiles - Eastern ribbon snake, wood turtle
- Uncommon Turtles of Wetlands - spotted turtle, Blanding's turtle
- Vernal-Pool Salamanders - blue-spotted salamander, Jefferson salamander

LAKE STURGEON

Develop and implement a lake sturgeon management plan that continues efforts to return this species back to its full range and abundance. Threats that should be addressed include exploitation of stocks, construction of dams that cut off spawning and nursery areas, and habitats degraded by runoff from development and channelization. Target waters in this Basin are tributaries of Lake Ontario and the St. Lawrence River.

GRASSLANDS

About 6% of the NELO-SLV lands are grasslands, and almost 17% is classified as open habitat (pasture, hay lands, and row crops) that is potentially valuable if managed in a sustainable manner that considers the needs of grassland-dependent wildlife. When developing management plans for grasslands and the species that depend upon them in NYS, natural resource managers focus on the St. Lawrence Valley as a "hot spot" of grassland species diversity. Furthermore, the St. Lawrence Valley is comprised of extensive agricultural grasslands interspersed with freshwater wetlands and tributaries. This combination makes the region unique in the northeastern U.S. and the critical combination of grasslands and wetlands support many resident and migratory SGCN that are rare or declining elsewhere in the Northeast. The planning process for the conservation and management of grasslands in this basin should focus on both public and private lands and include the benefits of this habitat to grassland birds, such as bobolink, Henslow's sparrow, northern harrier, sedge wren, short-eared owl, and upland sandpiper. Results of local planning efforts should be integrated into the New York State Grassland Bird Management Plan being developed by DEC and others under the 2003 State Wildlife Grant. Specific recommendations include:

- Complete the New York State Grassland Bird Management Plan currently being developed by DEC and others (State Wildlife Grant, 2003).

- As part of the grassland bird plan mentioned above, develop habitat management guidelines and action plans for priority-focus grassland bird species. In addition, investigate the feasibility managing grasslands in the basin with controlled burning. Draft a fire-management plan in accordance with these findings.

- Work with public land managers, including NRCS, USFWS, DEC and others, to better direct funding and other resources to the highest priority areas and projects for grassland habitat management. The ability to focus funding sources in core priority grasslands will be vital. If the funding sources from NRCS can not be adequately focused in priority areas, then this will cripple the

ability to conserve the most critical grassland areas and will result in continued declines in grassland birds even within these focus areas.

Land Protection Recommendations

This category of actions encompasses a variety of protection mechanisms such as easements, cooperative agreements, fee title acquisition, donations, development rights acquisition, and others. The type of protection should be determined by the interested parties based on their means and conservation goals. Interested parties may be one or more government entities or non-governmental organizations. For many of the following species and species groups, the first step will be to gather accurate information on where species are located within the basin and the location and status of the critical habitats upon which they rely. Land acquisition priorities for this basin identified in the New York State Open Space Conservation Plan that will benefit SGCN should be implemented as part of the protection and management of these species.

Habitat Loss and Degradation

A common threat to many SGCN in this basin is the loss of habitat due to anthropogenic changes like development (residential and commercial, roads, powerlines) and wetland dredging and draining, and natural changes such as succession. These changes result in loss of habitat quantity and often disrupt the function of remaining habitat. Connections between patches of similar habitat types (or different yet complementary habitats) are needed for migration and dispersal. Isolated habitat patches do not allow for effective metapopulation dynamics and make species vulnerable to extirpation from a variety of causes. Reduction of patch size also results in increased negative edge effects, increased susceptibility to predation, reduction in population, and reduction in the types of species the patch can support. In addition, habitats fragmented by roads and power lines increase direct mortality of animals due to collisions. Specific recommendations include:

Forested Habitats

Because much of the forested habitat in the Adirondack Mountains is protected by rules governing development in the Adirondack Park and by large tracts of public land administered by DEC, OPRHP, the Adirondack Park Agency, and others, public and private entities interested in acquiring habitat for SGCN that use late successional forests should direct their limited resources to the St. Lawrence Valley and other parts of the basin outside of the Adirondack Park where development pressures pose a relatively greater threat to species of concern and their habitats. For early successional forest and shrub habitats, it is critical that private lands within the Adirondacks be managed to provide for these habitats. Because state land within the Adirondack Park is forest preserve, there is even greater need to manage private lands to benefit early successional forest species. Another alternative that merits support and expansion is the recent trend toward buying easements on working forests. Easements protect the land from fragmentation due to development but still leave the land open to forest management. This is a unique opportunity for maintaining early successional forest habitats within the Adirondack Park. Target species are:

- Deciduous/Mixed-Forest Breeding Birds - protect core areas for cerulean warblers in the basin from human development. Although this species is increasing in NYS, it is declining across its range. Protecting areas important to this species within the state may be a way to conserve critical breeding populations. Key habitats include large, mature deciduous forests. There are

several probable and confirmed breeding observations from the BBA (2000-04) effort in southwestern St. Lawrence and northern Jefferson counties.

- Early Successional Forest/Shrubland Birds - Implement a Landowner Incentive Project for early successional birds that will direct funds toward conserving and creating habitat for early successional forest/shrub birds. Target species include:
  - Golden-winged warbler - primarily second growth, but also brushy hillsides, old fields, and stream edges. Much of the focus on this species has centered on the possible negative consequences for golden-winged warblers when they interact with the more numerous blue-winged warblers (hybridization, competition). BBA data (2000-04) indicate that the St. Lawrence Valley (specifically northern Jefferson County and southwestern St. Lawrence County) is a high-priority area for golden-winged warblers in NYS, and is a region that is still outside of the blue-winged warbler "hybridization front." Results of the 2003 and 2004 State Wildlife Grant studies investigating this issue should guide restoration occurs for this species.
  - Canada Warbler - deciduous woodlands with thick understory, cut over areas and riparian thickets. BBA (2000-04) data indicate that this species is found throughout the Adirondack Park and in transitional areas between the park and the St. Lawrence Valley.
  - Whip-poor-will - habitat needs to be more fully defined but includes early successional forests, open woodlands, from moist lowland deciduous forests to montane forests and pine-oak woodlands. BBA data (2000-04) indicate that along with the lower Hudson Valley and the Champlain Valley, the transitional region between the Adirondacks and the east Ontario plain/St. Lawrence Valley (northeastern Jefferson and southwestern St. Lawrence counties) is an important region for this species in NYS.
- High-Altitude Conifer Forest Birds - the sole SGCN in this group is Bicknell's thrush. This relatively rare species is often associated with the high peaks of the Adirondack Park and is found in this basin in southern Franklin and northern Hamilton counties (BBA, 2000-04).
- Vernal-Pool Salamanders - vernal pools, dotted across the forested landscape, form an extensive system of small, unregulated wetlands that provide critical wildlife habitat. This group serves as a good transition between "forested habitats" and the next habitat affiliation "freshwater wetlands," as vernal-pool salamanders use both habitat types - vernal pools within forest stands and mineral soil wetlands. Securing habitats in large blocks that contain both forests and wetlands will be critical to the survival of this species group and many other SGCN. The results of the 2003 and 2004 State Wildlife Grant work on high-priority reptile and amphibian species should help guide acquisition projects. Target vernal pool salamanders include:
  - Blue-spotted Salamander and Jefferson Salamander - New York State Herpetile Atlas (1990-99) data show records for these species in the St. Lawrence Valley from Jefferson County through Clinton County.

Wetlands and Other Aquatic Habitats

Wetland habitats are scattered throughout the basin. The wetlands of the western Adirondacks tend to be lowland boreal habitats, such as conifer swamps, low bog

forests, and open sphagnum bogs. Wetlands in the St. Lawrence Valley tend to be embedded in a matrix of more open habitats such as agricultural grasslands. And then there are the coastal wetlands and embayments of the St. Lawrence River and eastern Lake Ontario. Conservation partners interested in acquiring wetland habitats should focus their resources on wetlands that support high biodiversity, provide habitat for one or more rare or declining species, are under immediate threat of development/conversion, or have other unique ecological characteristics. Other important aquatic habitats include relatively undisturbed stretches of major river systems, such as Crooked Creek and Crooked Creek Marsh along the St. Lawrence River, and unique habitat, such as the dune systems of eastern Lake Ontario (Jefferson County). The sand dunes of Lake Ontario have received significant conservation attention from both public and private conservation organizations. Specific recommendations include:

- Beach and Island Ground-Nesting Birds - protect nesting and foraging habitat and associated upland buffers for common tern through acquisition, and easement, and through regulatory constraints on development. The eastern shores of Lake Ontario and the islands and shores of the St. Lawrence River represent a stronghold for this species in NYS (the northwestern boundaries of Jefferson and St. Lawrence counties; BBA, 2000-04). Key habitats include islands or coastal beaches with sparse matted vegetation and grassy areas.
- Freshwater Marsh-Nesting Birds - Secure habitats critical to species survival by acquisition of easements by other land protection mechanisms. The results of the 2004 State Wildlife Grant work on marsh birds should help guide acquisition projects. Target species include:
  - American bittern - freshwater and brackish marshes with emergent vegetation. BBA (2000-04) data show concentrations of observations of this species in northeastern Jefferson County and central St. Lawrence County.
  - Least bittern - freshwater marshes with emergent vegetation. The vast majority of BBA (2000-04) observations for this species within this basin are in the St. Lawrence Valley from the east Ontario plains of central Jefferson County through St. Lawrence County.
  - Pied-billed grebe - well-vegetated lakes, ponds, and marshes. BBA (2000-04) observations for this species are spread throughout the basin, with several observations in the St. Lawrence Valley (primarily Jefferson and St. Lawrence counties).
  - Black tern - freshwater marshes, slough, wet meadows. Almost half of all the BBA (2000-04) blocks where this species was observed in NYS were within the NELO-SLV Basin. Most of these atlas blocks are on the eastern shore of Lake Ontario and central St. Lawrence County (in and around Upper and Lower Lakes Wildlife Management Area).
- Freshwater Wetland Amphibians - Secure habitats critical to species survival by acquisition of easements or by other land-protection mechanisms. The results of the 2003 and 2004 State Wildlife Grant work on high-priority reptile and amphibian species should help guide acquisition projects. Target species include:
  - Western chorus frog - this species can be found in a variety of habitats, including marshes, wet meadows, and other relatively open wetland habitats. Less frequently they can be found in fallow agricultural fields and wooded swamps. New York State Herpetile Atlas (1990-99) data indicate that along with the Lake Plains (western NYS the St. Lawrence Valley

(primarily Jefferson and St. Lawrence counties), is an important region of the state for this species.

- Uncommon Turtles of Wetlands - Secure habitats critical to species survival by acquisition of conservation easements for wetlands and adjacent uplands.The results of the 2003 and 2004 State Wildlife Grant work on high-priority reptile and amphibian species should help guide acquisition projects. Target species include:
  - Blanding's turtle - shallow marshy waters and ponds. Along with the lower Hudson Valley, the St. Lawrence Valley is an important region of NYS for this species (from the eastern bays of Lake Ontario northeast through St. Lawrence County, Herp Atlas, 1990-99).
  - Spotted Turtle - marshy meadows, small bogs and swamps. This species was observed in only three Atlas blocks in this basin: one from west-central Jefferson County and two from the Lewis-St. Lawrence County border (Herp Atlas, 1990-99).
- Freshwater Bivalves - In key locations, acquire development rights to protect water quality for listed mussel populations, such as tributaries of Lake Ontario, and major river systems ,such as the Black, Grass, and St. Lawrence rivers. High-priority species in this basin include elktoe and yellow lamp mussel. The elktoe is found in clean, clear small-to-large sized streams and small to medium rivers with swift currents. The yellow lamp mussel prefers small to large rivers with moderate to fast flow and a sand and gravel substrate. Acquisition efforts should coincide with zebra mussel and quagga mussel monitoring efforts to protect critical habitats under threat from invasive exotic species.

Grasslands

The lands owned by public agencies in the basin are primarily forest and wetland. There is a need to acquire, through fee title or easements, grasslands, especially adjacent to existing protected grasslands. This would enable better management and protection of these habitats for grassland-dependent wildlife.

Alvars are grasslands and shrublands that develop on shallow soils with limestone geology and that support rare plant communities. They are a habitat type unique not only to this basin, but on a state and global level as well. Most alvars are concentrated in Jefferson County and are a high priority for conservation. The Nature Conservancy has protected almost 4,000 acres of alvars including Chaumont Barrens and Three-Mile Creek Barrens, but conservation partners need to continue efforts to protect this rare habitat type. Specific recommendations include:

- Grassland Birds - Acquisitions focusing on grassland bird habitat should be directed toward protecting existing grasslands or acquiring and restoring grassland habitats within proximity to existing grasslands to avoid creating sink habitats. These efforts should focus on the regions within the basin with the highest concentrations of grasslands, the east Ontario plains and St. Lawrence Valley, and should reflect the recommendations of priority grassland focus areas being developed by the New York State Grassland Bird Management Plan (State Wildlife Grant, 2003). Target species include:
  - Henslow's sparrow - old fields and meadows, preferably moist, with a combination of grass, forbs. May use unmowed hayfields, but abandons

them when cut. There is a concentration of BBA (2000-04) observations for this species in the open habitats of north-central Jefferson County.

- Northern harrier - open grasslands and grasslands adjacent to wetlands. BBA (2000-04) data indicate that this species is closely associated with the open habitat of the St. Lawrence Valley, from Jefferson County through northern Clinton County.
- Sedge wren - grasslands and grassy uplands adjacent to wetlands with sedges. The majority of BBA (2000-04) observations for this species in NYS are from the St. Lawrence Valley (primarily central Jefferson County through central St. Lawrence County).
- Short-eared owl - grasslands, meadows, and grassy uplands adjacent to marshes. During the BBA (2000-04) effort, this species was observed in only 22 blocks statewide, six of which were in this basin. Short-eared owls were observed in the open habitats of Jefferson County (five blocks) and northeast St. Lawrence County (one block). Wintering habitat is another key factor and need. Winter habitat is characterized by tall standing grass with high *Microtus* populations.
- Upland sandpiper - grasslands, dry meadows and old fields with little woody vegetation. The stronghold for this species in NYS as indicated by BBA (2000-04) data is north-central Jefferson County.

Management and Restoration Recommendations

Implementation of management and restoration actions for SGCN will require large-scale cooperative effort among public and private stakeholders, where each organization contributes its strength to the management system-from coordination to data collection and implementation, monitoring/evaluation-so that habitat and species-management goals can be achieved at the basin level. DEC, the government entity responsible for conservation of the state's fish and wildlife resources, should take the lead in coordinating such an endeavor. Wildlife and land managers should ensure that BMPs are followed and if none are described for a specific activity to develop and implemented new management plans. Additionally, many of the current BMPs need to be reexamined for effectiveness, becoming living documents.

HUMAN-WILDLIFE INTERACTIONS

These actions either directly address the behavior of people (e.g., posting of signs, gating) or the behavior of wildlife (e.g., providing safe travel corridors) in order to prevent conflicts. Specific recommendations include:

Beach and Island Ground-Nesting Birds

- Where feasible, protect common tern nesting areas from human disturbance by posting signs and fencing.

Lake/River Reptiles

- Manage the variety of adverse influences which might reduce lake/river habitat suitability for eastern ribbon snakes and wood turtles, including excessive disturbance by watercraft and fishing practices which incidentally take lake/river reptiles in significant numbers.

Uncommon Turtles of Wetlands

- Conduct a variety of habitat management activities where needed, including management of human access in order to preserve wetland suitability for spotted turtles and Blanding's turtles. Turtle species experience significant road mortality when migrating from over-wintering to egg-laying locations. Develop and implement mitigation measures to manage turtle population losses to vehicular roadkill.

Vernal-Pool Salamanders

- Develop and implement measures to manage reductions of wetland habitat quality caused by off-road vehicles by restricting or prohibiting their use in sensitive habitats. High-priority species include blue-spotted and Jefferson salamanders.

Indiana bat

- Work with public and private landowners to erect gates to regulate access at selected existing and newly discovered Indiana bat hibernacula (e.g., Glen Park, Jefferson County).

HABITAT LOSS AND DEGRADATION

Anthropogenic changes like development (residential and commercial, roads, power lines), dredging, and wetland draining, and natural changes, such as

succession, reduce not only habitat quantity, but the quality of habitat as well by disrupting the function of remaining habitat patches. Examples of the loss of habitat function include loss of connectivity to patches of similar habitat (or different yet complementary habitats), loss of metapopulation dynamics in small, isolated patches ("sink" habitats), increased negative edge effects (increased susceptibility to predation), and reduction in the types of species the patch can support ("area sensitive" species). Habitat management can help ameliorate these problems by either improving the quantity and/or quality of existing habitat or by restoring habitat where it has been lost. Specific recommendations include:

Forested Habitats

Forest is the predominant habitat type within the NELO-SLR Basin. Where and when management actions occur in forested habitats will depend upon the species (e.g., where it is found, forest tract size, unique microhabitat characteristics), acuteness of threats to key forested habitats, and logistics (e.g., funding, cooperating partners).

Boreal-forest Birds

- Work with private landowners to implement land-management strategies that favor spruce grouse, olive-sided flycatcher, bay-breasted warbler, and other species dependent on early successional boreal forests. Within this basin this action should focus on areas within the Adirondack Park (portions of St. Lawrence, Franklin, Essex, Hamilton, and Herkimer counties).

Deciduous/Mixed Forest Breeding Birds

- Minimize the effects of fragmentation of habitats due to human development. This will benefit species dependent upon large, intact expanses of forest, as well as species that utilize smaller patches.

Early Successional Forest/Shrubland Birds

- Increase the amount of early successional forest and shrub habitat on public and private land throughout the basin through sound timber management. High-priority species include golden-winged warbler, Canada warbler, American woodcock, and whip-poor-will.

Forest Breeding Raptors

- Maintain appropriate breeding habitat for long-eared owls around occupied nest sites. BBA (2000-04) data show breeding records for this species in only six blocks in the basin. These blocks are spread across Lewis, Jefferson, St. Lawrence, and Franklin counties.

Wetlands and Other Aquatic Habitats

Thousands of lakes, ponds, creeks, and streams are distributed across the Adirondacks and St. Lawrence Valley, as well as hundreds of miles of shoreline along eastern Lake Ontario and the St. Lawrence River. Management actions should focus on public and private lands that support high biodiversity, provide habitat for one or more rare or declining species, are under immediate threat of development/conversion, or have some other unique ecological characteristics. Specific recommendations include:

Beach and Island Ground-Nesting Birds

- Where possible, re-establish high-quality common tern foraging habitats by manufacturing sand flats, mudflats or overwash fans, or by allowing such formations to build naturally. Also, ephemeral pool creation adjacent to beach-nesting habitat for common terns should be pursued.
- Where possible, common tern-nesting habitat should be expanded to create new nesting opportunities for this species. This should be accomplished through dredge spoil management, input into beach re-nourishment projects, and de-vegetation of formerly suitable sites.

Breeding Waterfowl

- If nesting structure is determined to be a limiting factor, install nest boxes to increase populations or productivity of common goldeneye in appropriate locations in the Adirondacks.
- Maintain or increase abundance and suitability of emergent marsh habitats for breeding black ducks in the Adirondack region of the NELO-SLR Basin. Where appropriate, look to improve timber management practices as a means for maintaining appropriate habitat.

Common Loon

- Use artificial nesting platforms to improve nesting success, where feasible, on lakes that lack natural islands and have poor shoreline nesting habitat, fluctuating water levels, or a history of low productivity.
- Where water-level control structures exist (typically on publicly owned lands), maintain constant water levels during peak nesting period, except where it would be detrimental to species dependent upon water flows below the structure. Where they do not exist, prohibit water extraction from critical nesting habitats for anthropogenic activities. This should focus on nesting locations in the Adirondack Park and along eastern Lake Ontario and the St. Lawrence River (Jefferson and St. Lawrence counties).

Freshwater Marsh-Nesting Birds

- Use the Farm Bill, USFWS Wildlife Habitat Incentives Program (WHIP) Partners for Wildlife Programs, and DEC's Landowner Incentive Program to manage and restore marsh habitats on private lands. It is crucial to adapt wetland management practices throughout the basin so they can simultaneously benefit waterfowl (common goldeneye, blue-winged teal, American black duck), marsh birds (American bitterns, least bitterns, pied-billed grebe, black tern), and other water birds.
- Where water-level control structures exist (typically on public owned lands), maintain constant water levels during peak nesting period, except where it would be detrimental to species dependent upon water flows below the structure. Where they do not exist, prohibit water extraction from critical nesting habitats for anthropogenic activities.

Osprey

- Nest platforms should be maintained and new ones placed when and where appropriate.

American Eel

- Develop a management plan for the inland populations of this species in the basin. This should be part of a broader statwide plan for the management and recovery of American eels.

Lake Sturgeon

- Where feasible, spawning habitat should be restored in the St. Lawrence River.

Mooneye

- Restoration of spawning areas may be accomplished with cobble and rubble placed in streams like that done for walleye spawning. Examples near Black Lake include the Oswegatchie River at Ogdensburg and Fish Creek at Pope Mills.

Freshwater Wetland Amphibians

- Manage the variety of factors which might be limiting wetland habitat suitability for high-priority amphibian species (western chorus frog). As with marsh birds, use the Farm Bill, USFWS Wildlife Habitat Incentives Program (WHIP) and Partners for Wildlife Programs, and DEC's Landowner Incentive Program to manage and restore marsh habitats on private lands in the eastern part of the basin with the highest amphibian diversity and the direst threats.

Lake and River Reptiles

- Manage uplands adjacent to aquatic habitat in order to provide adequate and secure nesting habitat sites and to provide dispersal routes for migrating animals. High-priority species include eastern ribbonsnake and wood turtles.

Uncommon Turtles of Wetlands

- Develop and implement mitigation strategies to manage adverse effects of habitat fragmentation. This includes conducting a variety of habitat management activities where needed, including management of vegetation succession in order to preserve wetland suitability for spotted turtles. Management actions should focus on occupied (and adjacent) habitats in the basin for Blanding's and spotted turtles.

Freshwater Bivalves

- Develop an outreach program to private landowners through DEC's Landowner Incentive Program to initiate projects to prevent or repair effects from land use on mussels and to restore degraded habitat areas to allow for recolonization or reintroduction of listed mussels.

Grasslands

Most of the grasslands in the NELO-SLR Basin are in private ownership. If management of this habitat type is to be successful, public and private agencies must work closely with private landowners to protect, restore and manage grassland habitats. As mentioned above for other habitat types, conservation partners should be cognizant of how a particular grassland fits in to the landscape (e.g., patch size and shape, distance to other grasslands and the quality of those grasslands, etc.), species and habitat diversity, the scope of the threats facing a particular grassland tract (e.g., development pressures), and logistics (e.g., funding, cooperating partners). Knowing this information will help guide where

and when management and/or restoration takes place. Finally, management and restoration actions should reflect the recommendations of priority grassland focus areas being developed by the New York State Grassland Bird Management Plan (State Wildlife Grant, 2003). Specific recommendations to benefit SGCN include:

Grassland Birds

- Increase the amount of grassland habitat on public and private land in regions within the basin with the highest concentrations of grasslands (east Lake Ontario Plain, St. Lawrence Valley). As mentioned above, use the Farm Bill, such as Wildlife Habitat Incentives Program (WHIP) and USFWS Partners for Wildlife Programs, and DEC's Landowner Incentive Program to aid in this effort. High-priority species include Henslow's sparrow, northern harrier, sedge wren, short-eared owl, and upland sandpiper.

Common Nighthawk

- Increase use of prescribed fire in natural fire-adapted communities. Where this species is found in human-altered habitats (e.g., suburban, urban environments), evaluate feasibility of artificial nest structures on roof tops.

INVASIVE SPECIES

Invasive exotic plants and animals diminish the quality of upland and aquatic habitats throughout the basin. In wetlands and other aquatic habitats, species like purple loosestrife, Eurasian water milfoil, and Phragmites australis with little value to wildlife, displace native plant species and disrupt ecological processes. In upland habitats, invasive exotic plants and insects introduced through human activity threaten to reduce biodiversity. In all habitat types, new residential and commercial development increases the risk of new occurrences of invasive exotic plants and animals. It is important to look for these exotic species in critical habitats and to minimize the potential adverse effect they may have on habitat quantity and quality. Presently two invasive-plant interagency groups are working to control the spread of invasives within the area (Adirondack Park Invasive Plant Program, St. Lawrence-Eastern Lake Ontario Weed Management Program). The groups have formed active interagency and volunteer staff teams working to control invasive plants. Specific recommendations to benefit SGCN include:

- Reduce the spread and colonization of new sites by invasive exotic species (e.g., purple loosestrife), and where feasible, control invasive species which are known to have detrimental effects on aquatic wildlife through biological, chemical, or mechanical means. The location and method (biological vs. chemical vs. mechanical) will depend upon the exotic species being targeted, life history traits and management objectives for the SGCN to benefit from the action, scale of the infestation, and logistics (funding, cooperating partners, feasibility of using a particular method in a specific locale). Specific actions should be tied to a statewide or basin-wide invasive species management plan.
- Based on the research and the monitoring/control plan to address the effect of exotic bivalves and crustaceans on freshwater bivalves (see "Data Collection" and "Planning" above), implement a management program for invasive species, such as zebra mussel, quagga mussel, and other invasive mussel species.
- Native Adirondack strains of brook trout, referred to as Heritage strains, were historically abundant in head water lakes and ponds in the watershed.

Competing and population non-native fishes have caused severe declines in their abundances.

- Where feasible, pond reclamations should be conducted to eliminate non-native fishes and restore brook trout.
- Natural barriers should be enhanced or barriers constructed at appropriate locations to prevent the spread/reintroduction of non-native fishes.

RESTORATION OF ECOLOGICAL PROCESSES

A byproduct of landscapes that have been heavily manipulated by humans is disrupted ecological processes in the form of more abundant and diverse predator communities, and the ability of predators to hunt in a more efficient fashion (e.g., foraging along linear edge habitats, foraging in small habitat patches with a high edge:interior ratio). Specific management recommendations to counteract this threat include:

Beach and Island Ground-Nesting Birds

- ❖ Encourage landowners to control predators that represent significant threats to the viability of species-at-risk such as common tern. Options to be considered include direct predator control, allowing hunting and/or trapping during legally specified seasons, and habitat modification to remove roosting or denning sites of nest predators. The mechanism for predator control by landowners should be chosen in consultation with DEC.

Common Loon

- ❖ Reduce predator caused breeding failure, where problematic, by increasing hunting or trapping participation.
- ❖ Evaluate the extent to which management actions can reduce nest and chick losses. This will depend upon the ability of people to access important loon habitats, many of which may be on private lands.

Grassland Birds

- ❖ Manipulate habitat structure and composition through restoration and/or management (e.g., grassland patch size and shape) to reduce nest losses to predators.
- ❖ Evaluate the extent to which management actions can reduce nest losses. This action should focus on areas within the basin with the highest concentration of grasslands under strong development pressures. Highlight species include northern harrier, sedge wren, short-eared owl, and upland sandpiper.

Freshwater Marsh-Nesting Birds

- ❖ Reduce predator caused breeding failure, where problematic, by increasing hunting or trapping opportunities and by manipulating habitat structure and composition through restoration and/or management (e.g., wetland size, shape).
- ❖ Evaluate the extent to which management actions can reduce nest and chick losses. This action may be most easily accomplished on public owned wetlands, but if successful, should be expanded to private lands throughout the basin. Highlight species include American bittern, least bittern, pied-billed grebe, and black tern.

Uncommon Turtles of Wetlands

- Reduce predator caused breeding failure, where problematic, by manipulating habitat structure and composition through restoration and/or management (e.g., wetland size, shape).
- Evaluate the extent to which management actions can reduce egg losses. This action may be most easily accomplished on protected wetlands (public and privately owned wetlands in the Adirondacks and WMAs in the St. Lawrence Valley), but if successful, should be expanded to private wetlands where species occur (e.g., spotted turtles, Blanding's turtles).

Vernal Pool Salamanders

- Develop and implement measures to manage reductions of wetland habitat quality and increased predation on adults, young, and eggs caused by introductions of fish and other predatory species. Management actions should focus on habitats occupied by blue-spotted and Jefferson salamanders.

Restoration of Ecological Processes

Almost 18% of the NELO-SLR Basin is comprised of habitats that have been significantly altered by humans (residential and commercial development, agriculture [row crops, hay lands], parks and golf courses, and barren habitats [quarries, strip mines, gravel pits]). Many of these habitats are maintained by suppressing ecological processes such as vegetative succession and fire; however, the reverse is also true. Mature and early successional forest habitats may suffer because of a reluctance of the public to engage in the active management of these habitats. The result is large, homogenous forest tracts with lower structural, vegetative, and species diversity than would be encountered in forests with both natural disturbances (e.g., fire, wind throws) and active management (variable cutting regimes). Where ecologically, socially, and economically feasible, private and public conservation partners should work to restore habitat function through mechanical or natural means. Specific recommendations include:

Boreal Forest Birds

- Review DEC's wildfire management policies for Forest Preserve lands. Investigate opportunities to work with public and private land managers to execute fire management for boreal-forest bird species such as spruce grouse, olive-sided flycatcher, bay-breasted warbler, and other species dependent on boreal forests. Within this basin this action should focus on high elevation areas of the Adirondack Park.

Early Successional Forest/Shrubland Birds

- Determine the feasibility of maintaining, restoring, and enhancing fire-adapted early successional ecosystems through the use of prescribed fire. This habitat type exists throughout the basin. Highlighted species include golden-winged warbler, Canada warbler, and whip-poor-will.

Grassland Birds

- Restore habitat function and manipulate habitat structure and composition through mowing, and investigate the feasibility of using prescribed fire. Highlighted species include Henslow's sparrow, northern harrier, sedge wren, short-eared owl, and upland sandpiper.

WATER QUALITY

Many of the SGCN in this basin rely upon aquatic habitats during some stage of their life cycle. Conservation partners have identified the degradation of water quality and the acute and chronic effects of contaminants in aquatic habitats as a significant threat to wildlife. Degraded water quality can be a result of atmospheric deposition (e.g., acid rain, mercury), siltation, nutrient runoff, temperature increases, toxics (e.g., pesticides, point and non-point source pollution), lowered dissolved oxygen, and altered hydrology (dams, water withdrawal, ground water extraction). Specific recommendations to counter this threat include:

Freshwater Marsh Nesting Birds

- Improve the quality of existing wetlands by minimizing draw downs during peak nesting periods and by installing vegetated buffers between developed sites (housing, commercial, agriculture, etc.) and adjacent marsh habitats to minimize the effects of runoff from these sites. Management actions should focus on occupied (and adjacent) habitats in the parts of the basin with the highest concentrations of wetlands and/or that contain the highlighted species American bittern, least bittern, pied-billed grebe, and black tern.

Freshwater Wetland Amphibians

- Manage the variety of factors which might be limiting wetland habitat suitability for resident amphibian species, including management of toxicants, adverse hydrological alterations, and anthropogenic inputs of sediments. Highlighted species include the western chorus frog. Management actions should focus on occupied (and adjacent) habitats in the parts of the basin with the highest amphibian diversity and the direst threats (wetlands along Lake Ontario and the St. Lawrence River).

Lake and River Reptiles

- Manage the variety of adverse influences which might reduce lake/river habitat suitability for reptiles of concern (eastern ribbonsnake and wood turtle), including management of toxicants and adverse hydrological alterations. Management actions should focus on occupied (and adjacent) habitats.

Uncommon Turtles of Wetlands

- Conduct a variety of habitat management activities where needed, including maintenance of hydrological regimes and curtailment of contaminant inputs in order to preserve wetland suitability for these species (e.g., Blanding's turtles, spotted turtles). Management actions should focus on occupied (and adjacent) habitats in the St. Lawrence Valley.

Freshwater Bivalves

- Manage areas of important mussel populations, where identified, by controlling degradation factors (e.g. controlling livestock access, point source or non-point source pollution, flow alteration, etc.).

POPULATION RESTORATION

If suitable habitats exist that can produce sustainable benefits for a particular species of conservation concern, a viable management option for rare and rapidly declining species may be population restoration. These efforts are often expensive

and require a great deal of expertise and logistical support. The lead agency will probably be DEC for most of these ventures; however, as seen in successful cases of reintroduction in New York State, such as wild turkeys and river otters, the support of public and private groups outside DEC is essential to the success of the reintroduction effort. Specific recommendations to benefit SGCN include:

Lake/River Reptiles

- Pending the results of State Wildlife Grant (2003) surveys for the presence of spiny softshell turtles within tributaries of Lake Ontario, employ restoration techniques for the spiny softshell at selected sites as needed, including captive breeding, head starting, nest protection, and repatriation/relocation strategies. Restoration efforts, if needed, should focus on suitable habitats in proximity to locations where this species is observed.

Uncommon Turtles of Wetlands

- Employ restoration techniques for Blanding's turtles at selected sites as needed, including captive breeding, headstarting, nest protection, and repatriation/relocation strategies. Restoration efforts, if needed, should focus on suitable habitats in proximity to locations where this species is observed.

Eastern Sand Darter

- Examine possibilities for introductions to St. Lawrence tributaries like the Oswegatchie River.

Lake Sturgeon

- Evaluations of hatchery rearing and experimental plantings should be conducted in the Oswegatchie and St. Regis rivers and Black Lake.

Round Whitefish

- Pending the results of the 2003 State Wildlife Grant study on round whitefish in the Adirondacks, enhance remnant stocks of this species through artificial propagation and restoration to additional historic waters.

Freshwater Bivalves

- Where appropriate, reintroduce listed mussels into suitable habitat within their historic range. NYNHP element occurrence records for this species group in this basin are found in the St. Regis River and Grasse River sub-watersheds (northeastern St. Lawrence County).

Information Dissemination Recommendations

The sharing of information between natural resource managers and public and private groups is one of the most powerful tools in wildlife conservation. It allows people to make informed decisions about activities that may help or harm SGCN. For example, land-use objectives may conflict with the needs of wildlife. By providing accurate, complete information to stakeholders on a species (or a species group) and its critical habitats, we can begin to institute land use practices that have ecological objectives that are compatible with traditional economic and social objectives.

Information dissemination may take many forms including education and outreach programs, development of fact sheets, web site design and delivery, literature review and compilation of existing reports studies development and dissemination of best management practices, and technical guidance for land managers.

HUMAN-WILDLIFE INTERACTIONS

Human behavior that directly affects wildlife (e.g., direct or indirect harassment, uncontrolled collection and/or harvest, collisions, entanglement/impingement) can be mitigated through education and outreach. An informational campaign directed at a particular natural resource user group may be a more cost-effective and efficient method for exacting change than implementing a regulatory, legislative, or management action. Specific recommendations include:

- To reduce the detrimental effects of human disturbance on beach and island ground-nesting birds (i.e., common tern), freshwater marsh-nesting birds (i.e., American bittern, least bittern, pied-billed grebe, black tern), and osprey, develop signs and/or displays informing the public of the presence of these species, their respective threats and critical conservation issues, and the need for protection, and post where appropriate.

- Improve public understanding of common loon conservation issues, including the effect of human disturbance on loon nesting success. Post interpretive signs at boat ramps, beaches, campgrounds and other public access points, particularly in the Adirondack Park. Areas to be stressed are personal water craft usage and limitation of wakes from all water craft. Where appropriate, possible horsepower restrictions should be put into effect on small lakes. Produce and distribute informational brochures, posters, press releases and other educational materials. Provide educational programs to schools, lake associations and other groups.

- Enhance public education to limit killing, collection/translocation, and the (illegal) sale of herpetofauna in the pet trade. High-priority species include:

    - Lake/River Reptiles - eastern ribbonsnake, wood turtle, spiny softshell, northern map turtle
    - Uncommon Turtles of Wetlands - Blanding's turtle, spotted turtle, stinkpot
    - Woodland/Grassland Snakes - black ratsnake, smooth greensnake

- Address the negative effects of invasive exotic species on freshwater bivalves by developing signs for markets dealing in aquatic SGCNs, explaining the dangers of releasing exotic invasive animals into New York State. Also, post educational signs at boater access points to reduce introduction of zebra and quagga mussels into water bodies.

- Develop outreach materials on the effects of greenhouse gasses and their influence on global warming. It can change aquatic and terrestrial temperature regimes which are important for many SGCN, like heritage strain brook trout, american eel, furbearers (e.g., otter) and high altitude conifer forest birds (i.e., Bicknell's Thrush).

- Enhance public education to dissuade killing of bats roosting on human structures. The Indiana bat is known to occasionally use structures such as houses and sheds for roosting. Public education efforts to prevent the killing of endangered bats would reduce any illegal taking of this species under federal and state statutes.

HABITAT LOSS AND FRAGMENTATION

The most obvious remedy for habitat loss and fragmentation may be land protection and restoration, but providing information to public land managers, private developers, and others is an important first step in slowing or preventing further habitat loss.

- In an effort to reduce habitat loss, develop a series of GIS geographic information system based modules that help provide the public with the knowledge to appreciate and understand SGCN need and their habitats.The modules, with interactive maps embedded in appropriate sections of text, would focus on the fish, wildlife, and natural resources associated with the diverse landscapes and water bodies of the NELO-SLR Basin and the opportunities to observe and learn about them and the network of public lands owned and managed for natural resource conservation. Information on the natural history and ecology of SGCN, and on management concerns for these species and their habitats, should be included along with an efficient means to identify specific lands where New York State residents could participate in wildlife conservation opportunities.

- Public misconceptions about cutting timber may result in a homogenous forested landscape with relatively little structural and vegetative species diversity. It is important to educate the public to the benefits and need for early successional forest management and restoration, including even-aged forest stand management and the development of multiple seral[10] stages across a forested landscape. This educational program should focus on both public and private lands and include the benefits of this habitat to early successional forest/shrubland birds, such as golden-winged warbler, Canada warbler, and whip-poor-will. Information should also be made available to public and private landowners to encourage land management strategies that favor boreal-forest birds such as spruce grouse, olive-sided flycatcher, and other species dependent on early successional boreal forests.

[10] Sere = the entire sequence of ecological communities successively occupying an area from the initial stage to the climax.

- Provide information and technical guidance to utilities agencies to manage rights-of-way in a manner that will provide maximum benefit to early successional forest/shrubland birds such as those mentioned above.

- Develop an outreach program to educate public and private land managers on the need for, and wildlife benefits of, grasslands. Also provide technical guidance on how to conserve and/or manage grasslands. Targets for these actions include providing breeding and foraging habitat for grassland birds and upland nesting habitat (grasslands adjacent to wetlands) for breeding waterfowl like blue-winged teal.

AGRICULTURAL AND SILVICULTURAL PRACTICES

Traditional agricultural and silvicultural practices may lack ecologically based objectives, thus may be detrimental to wildlife. Providing information on SGCN and their habitats to public and private land managers will allow them to develop farming or timber harvest operations that are compatible with the needs of wildlife.

- Promote the establishment of buffer areas around agricultural fields and developments adjacent to marsh habitats. Species that would benefit from this action include freshwater wetland amphibians (e.g., western chorus frog), are freshwater marsh- nesting birds (e.g., American bittern, least bittern, pied-billed grebe, black tern), and various odonates.

- Several SGCN reside in forested habitats. When selecting a forest management regime (e.g., light thinning, partial harvest, clear cut, etc.), it may be difficult for public and private forest managers to coordinate the wide array of habitat needs of these species with their timber-management goals. It is important that informational materials be developed for forest managers that explain the habitat needs of species that rely on various forested habitats (i.e., varying seral stages, vertical structure, tree and shrub species composition, etc.) and how to accommodate SGCN with seemingly competing habitat requirements. This information should then be available to land-management partners developing/modifying best management practices (BMPs) in an effort to minimize the potential negative effects of poorly planned and executed forestry practices on wildlife. This should be accomplished for the following high-priority species:
  - Deciduous/Mixed-Forest Breeding Birds - cerulean warbler
  - Early Successional Forest/Shrubland Birds - golden-winged warbler, Canada warbler, American woodcock, whip-poor-will
  - Forest-Breeding Raptors - long-eared owl
  - Vernal-Pool Salamanders - blue-spotted salamander, Jefferson's salamander
  - Tree Bats - Eastern red bat, hoary bat,

- Provide information to farmers and grassland owners about the benefits of grasslands, threats to this habitat type, and species of conservation concern that use grasslands. Furthermore, provide information and technical guidance on how to incorporate wildlife management objectives into farming practices to maximize the benefits for wildlife (e.g., timing and frequency of

mowing/haying, use of prescribed fire, integrated pest management, etc.) while still allowing farmers to accomplish their harvest goals.

These efforts should focus on the regions within the basin with the highest concentrations of grasslands. This educational program should focus on both public and private lands and include the benefits of this habitat to grassland birds, such as Henslow's sparrow, northern harrier, sedge wren, short-eared owl, and upland sandpiper, and other birds of open habitats such as common nighthawk.

STRUCTURE COLLISIONS

Provide technical guidance to state and private entities planning the siting and installation of tall structures (e.g., wind mills, cell towers, and power lines) that are likely to adversely affect populations of migrating birds and bats. The U.S. Fish and Wildlife Service (USFWS) is currently investigating the effects of these types of structures on wildlife. Final guidelines developed by the USFWS should be consulted when considering the placement and installation of wind mills, cell towers, etc. In addition, a pilot study funded by the 2004 State Wildlife Program will focus on landscape scale pathways of migratory birds and bats in Lewis, Jefferson, and Oswego counties. Ultimately, when key migratory pathways are discovered, this information should be disseminated to state and private planning groups and incorporated into the siting and installation of tall structures. SGCN need that will benefit from this action include various migratory birds (early successional forest/shrubland birds, deciduous-forest birds, etc.) and bats (tree bats, Indiana bat).

Regulatory and Legislative Recommendations

Regulatory and legislative proposals will likely be made at the statewide level, although local governments may have opportunities to modify or create laws and regulations to enhance local protection of SGCN. For example, local zoning and land use policies can be used to discourage sprawl and habitat fragmentation.

Prevention Of Habitat Loss

- Pursue protection of wetlands less than 12.4 acres that provide habitat for SGCN under the 'unusual local significance' provisions of Article 24 of the Environmental Conservation Law (ECL) and enhance protection of upland buffer adjoining these wetlands. Some of the priority species that will benefit from this action include freshwater wetland amphibians (i.e., western chorus frog), uncommon turtles of wetlands (i.e., spotted turtles, Blanding' turtles), and vernal-pool salamanders (i.e., Jefferson and blue-spotted salamanders). Include review of all wetland sites currently or historically used by endangered, threatened, or rapidly declining freshwater marsh-nesting birds, regardless of wetland size. Priority species include American bittern, least bittern, pied-billed grebe, and black tern.

- Increase regional permit review of potential impacts to native freshwater bivalve species from development and highway projects in the basin.

- Afford protected stream status under ECL §608.2 to Class D non-navigable stream segments that provide habitat for SGCN.

- Examine the need to issue general permits for all regulated activities under ECL §608.5 on navigable stream segments that provide habitat for SGCN.

- Identify and protect known common loon nesting areas with focus on the Adirondacks.

Human-Wildlife Interactions

- The best strategy for minimizing illegal collection of herpetofauna of conservation concern may be to implement pending legislative provisions which designate the following as protected species:
  - Freshwater Wetland Amphibians - four-toed salamander
  - Lake/River Reptiles - eastern ribbonsnake, spiny softshell
  - Uncommon Turtles of Wetlands - spotted turtle, Blanding's turtle, stinkpot
  - Vernal-Pool Salamanders - blue-spotted salamander, Jefferson salamander
  - Woodland/Grassland Snakes - black ratsnake, smooth greensnake

Water Quality

- Continue implementation and enforcement of existing regulations to abate NPS pollutants, erosion, sedimentation, and hydrological alterations in order to better protect critical stream segments that provide habitat for SGCN. Enhance this protection through the promotion of additional best management practices through partnership with other state and local agencies.

INVASIVE SPECIES

- Enforce regulations restricting the importation and stocking of non-native fish that feed on freshwater bivalves (e.g., black carp).

SPECIES PROTECTION STATUS

For many SGCN, particularly invertebrate species, there is a lack of information on abundance, distribution, and population trends; however, preliminary data suggest that these species may warrant protective status. It is important to complete more thorough investigations into the population status, trends, and threats to these species to determine whether regulatory action is needed.

- A comprehensive statewide inventory of odonates (dragonflies and damselflies) was selected for State Wildlife Grant funding in 2003. This project will document the current distribution of odonate species in New York State and direct more intensive sampling in selected habitats, areas with expected high odonate diversity, or habitats of rare species. The project will include general surveys conducted by volunteers as well as directed surveys that target specific species, habitats, or poorly known areas of the state. Recommendations for official state endangered, threatened, and special concern listing are an anticipated result of the statewide inventory. High - priority species include:
  - Odonates of Bogs/Fens/Ponds - ebony boghaunter, forcipate emerald, incurvate emerald, subarctic bluet
  - Odonates of Lakes and Ponds - lake emerald
  - Odonates of Rivers/Streams - arrow clubtail, brook snaketail, extra-striped snaketail, rapids clubtail
  - Odonates of Small Forest Streams - ocellated emerald

Incentives

An incentive program geared toward private landowners will be a key first step in engaging the public about the importance of their lands to SGCN. So much of the critical habitats for these species exists on private lands that landowner cooperation will be the ultimate deciding factor on whether species declines can be halted. Their cooperation at the level needed for meaningful change will probably hinge on some form of enrollment process and financial and/or logistical support similar to that used in Farm Bill programs coordinated by the USDA and NRCS, such as the Wildlife Habitat Incentive Program (WHIP) and USFWS Partners for Wildlife Program, DEC Landowner Incentive Program, and various conservation programs administered by non-governmental organizations (e.g., local land trusts, The Nature Conservancy, Ducks Unlimited, Inc., etc.).

- Cooperate with NYS farmers and grassland owners to establish the best possible nesting and foraging opportunities for grassland birds (e.g., Henslow's sparrow, northern harrier, sedge wren, short-eared owl, and upland sandpiper) and common nighthawk. Incentives focusing on grassland bird habitat should be directed toward protecting existing grasslands or restoring grassland habitats within relative close proximity to existing grasslands to avoid creating sink habitats. These efforts should focus on the regions within the basin with the highest concentrations of grasslands.

- Incentive-based programs are often associated with agricultural habitats, but they may be a valuable mechanism for addressing conservation concerns in other ecotypes. Conservation partners should cooperate with private landowners to encourage land-management strategies that favor spruce grouse, olive-sided flycatcher, and other boreal-forest birds.

Literature Cited and Sources Consulted

Andrle, R.F. and J.R. Carroll. 1988. The Atlas of Breeding Birds in New York State (1980-85). Cornell University Press. Ithaca, NY. 551 pp.

Audubon New York. 2004. Wildlife and forestry in New York northern hardwoods: a guide for forest owners and managers. Audubon New York. Albany, NY. 40 pp.

Bode R.W., M.A. Novak, L.E. Abele, D.L. Heitzman, and A.J. Smith.. 2004. Thirty-year trends in water quality of rivers and streams in New York State based on macroinvertebrate data: 1972-2002. DEC Division of Water. Albany, NY. 384 pp.

Evers, D.C. 2005. Mercury connections: the extent and effects of mercury pollution in northeastern North America. BioDiversity Research Institute. Gorham, ME. 24 pp.

Jenkins, J. In Review. The state of the Adirondack lowland boreal, part I: composition & geography. The Nature Conservancy-Wildlife Conservation Society. 54 pp.

Keller, W.T. 1979. Management of wild and hybrid brook trout in New York lakes, ponds and coastal streams. DEC Bureau of Fisheries Management Plans, Albany, New York.

Lake Ontario Lakewide Advisory Network. 1998. Lakewide management plan for Lake Ontario, stage 1: problem definition. Lake Ontario Lakewide Advisory Network. 104 pp.

LaPan, S.R., A. Mathers, T.J. Stewart, R.E. Lange, S.D. Orsatti. 2002. Fish-community objectives for the St. Lawrence River. Great Lakes Fisheries Commission Special Publication 2002. 25 pp.

Manninen, C. 2005. Great Lakes Information Network Invasive Species Homepage. http://www.great-lakes.net/envt/flora-fauna/invasive/invasive.html

Millennium Ecosystem Assessment Board. 2005. Living beyond our means: natural assets and human well-being, statement from the board. Millennium Ecosystem Assessment. 20 pp.

New York Statistics Information System. 2005. New York State data: projection data by county. Cornell Institute for Social and Economic Research. http://www.nysis.cornell.edu/

DEC. 2005. New York State Amphibian and Reptile Atlas Interim Data. DEC. Albany, NY. http://www.dec.state.ny.us/website/dfwmr/wildlife/herp/index.html

DEC. 2005. New York State Breeding Bird Atlas Interim Data. DEC. Albany, NY. http://www.dec.state.ny.us/apps/bba/results/

DEC. 2004. Management of double-crested cormorants to protect public resources in New York: statement of findings. DEC. Albany, NY. 17 pp.

DEC. 2003. New York State Regulatory Freshwater Wetland Statistics. DEC. Albany, NY. http://www.dec.state.ny.us/website/dfwmr/habitat/wetstats.pdf

DEC. 2002. New York State water quality 2002. DEC Division of Water. Albany, NY. 160 pp.

Pashley, D.N., C.J. Beardmore, J.A. Fitzgerald, R.P. Ford, W.C. Hunter, M.S. Morrison, K. V. Rosenberg. 2000. Partners in flight: conservation of the land birds of the United States. American Bird Conservancy. The Plains, VA. 91 pp.

Pendall, R. 2003. Sprawl without growth: the upstate paradox. The Brookings Institution. Washington, DC. 12 pp.

Rosenberg, K. V. 2000. Partners In Flight Landbird Conservation Plan: Physiographic Area 18: Saint Lawrence Plain, Draft Version 1.0. American Bird Conservancy.

Schoch, N. 2002. The Common Loon in the Adirondack Park: An Overview of Loon Natural History and Current Research. WCS Working Paper No. 20. 64 pp.

Schoch, N. and D. C. Evers. 2002. Monitoring Mercury in Common Loons: New York
Field Report, 1998-2000. Report BRI 2001-01 submitted to U.S. Fish Wildl. Serv. and New York State Dept. Environ. Conservation. BioDiversity Research Institute, Falmouth, ME. 13 pp.

Simonin, H.A., J.R. Colquhoun, E.A. Paul, J. Symula and H.J. Dean. 2005. Have Adirondack stream fish populations changed in response to decreases in sulfate deposition? Transactions of the American Fisheries Society. 134: 338-345

Stanton, B.F. and N.L. Bills. 1996. The return of agricultural lands to forest: changing land use in the twentieth century. Cornell University. Ithaca, NY. 132 pp.

Stewart, T.J., R.E. Lange, S.D. Orsatti, C.P. Schneider, A. Mathers, M.E. Daniels. 1999. Fish-community objectives for Lake Ontario. Great Lakes Fisheries Commission Special Publication 99-1. 56 pp.

Thompson, E., K. Moss, D. Hunt, P. Novak, E. Sorenson, A. Ruesink, M. Anderson, A. Olivero, C. Ferree, and S. Khanna. 2002. St. Lawrence – Champlain Valley Ecoregion biodiversity conservation plan, first iteration. The Nature Conservancy. Arlington, VA. 30 pp.

U.S. Census Bureau. 2002. 2000 Census of Population and Housing, Summary Population and Housing Characteristics, PHC-1-34, New York.. U.S. Department of Commerce. Washington, DC. 613 pp.

U.S. Environmental Protection Agency. 2004. Acid rain program 2003 progress report. U.S. EPA. Washington, DC. 17 pp.

U.S. Fish and Wildlife Service. 2003. Final environmental impact statement on double-crested cormorant management in the United States. U.S. Department of Interior. Washington, DC. 165 pp.

U.S. Fish and Wildlife Service. 2000. St. Lawrence wetlands and grasslands management district. U.S. Fish and Wildlife Service. Richville, NY. 9 pp.

Tables and Figures

Tables

Figures