Description of the Basin

The Upper Hudson Basin is the largest in New York State (NYS) in terms of size, covering all or part of 20 counties and about 7.5 million acres (11,700 square miles) from central Essex County in the northeastern part of the State, southwest to central Oneida County in north central NYS, southeast down the Hudson River corridor to the State's eastern border, and finally terminating in Orange and Putnam Counties. The Basin includes four major hydrologic units: the Upper Hudson, the Mohawk Valley, the Lower Hudson, and the Housatonic. There are about 23,000 miles of mapped rivers and streams in this Basin (USGS Watershed Index). Major water bodies include Ashokan Reservoir, Esopus Creek, Rondout Creek, and Wallkill River (Ulster and Orange Counties) in the southern part of the Basin, Schoharie Creek (Montgomery, Greene, and Schoharie Counties) and the Mohawk River (from Oneida County to the Hudson River) in the central part of the Basin, and Great Sacandaga Lake (Fulton and Saratoga Counties), Saratoga Lake (Saratoga County), and Schroon Lake (Warren and Essex Counties) in the northern part of the Basin. This region also contains many smaller lakes, ponds, creeks, and streams encompassing thousands of acres of lentic and lotic habitat. And, of course, the landscape is dominated by one of the most culturally, economically, and ecologically important water bodies in the State of New York - the Hudson River.

For hundreds of years the Hudson River has helped bolster New York State's economy by sustaining a robust commercial fishery, by providing high value residential and commercial development, and by acting as a critical transportation link between upstate New York/New England and the ports of New York City. The Hudson has provided consumptive and non-consumptive recreational benefits in the form of fishing, hunting, trapping, boating, and wildlife viewing, and serves as an invaluable connection to the Nation's history and culture. Finally, the Hudson River provides crucial fish and wildlife habitat such as nursery and spawning grounds for a diverse array of fish species. It functions as an important migratory corridor for passerine birds, raptors, and waterfowl, and it contains estuarine marshes and tidal flats teeming with biodiversity.

From a terrestrial perspective, the Upper Hudson Basin is comprised of four ecoregions (as defined by The Nature Conservancy). The Northern Appalachian Boreal Forest ecoregion in the northern part of the Basin is primarily made up of the Adirondack Mountains, a six-million-acre park, a large part of which falls within this basin. The Great Lakes ecoregion represents the Mohawk Valley, which runs from west to east, cutting across the center of the basin and ending at the northern terminus of the Taconic Highlands. The Lower New England/Northern Piedmont ecoregion includes all of the Taconic Highlands in far eastern NYS from Washington County south through Putnam County, and almost all of the Hudson River Valley from Warren County south. Finally, the High Allegheny Plateau covers the mountainous regions west of the Hudson River, from the Mohawk Valley south, including the Helderbergs, Catskills, Shawangunks, and Hudson Highlands.

With about 2.3 million people, the Upper Hudson Basin is second in human population only to the Lower Hudson River/Long Island Bays basin (U.S. Census Bureau, 2002). There are three main population centers in the basin: Newburgh

(population 28,259; Orange County) and Poughkeepsie (population 29,871; Dutchess County) in the lower Hudson Valley, Albany (population 95,658; Albany County), Schenectady (population 61,821, Schenectady County), Troy (population 49,170; Rensselaer County), and Saratoga Springs (population 26, 286, Saratoga County) in the central part of the watershed, and Utica (60,651; Oneida County) in the Mohawk Valley. Mean population density in the Upper Hudson is 206 people per square mile, but density varies widely from 3.1 people per square mile in Hamilton County in the Adirondacks, to 715 people per square mile in Schenectady County in the central part of the Basin (U.S. Census Bureau, 2002).

Even though the population centers are spread throughout the region, the majority of the human population in this Basin is condensed between Albany County and Putnam County. This area is one of the most densely populated areas in the country and is the fastest growing region of the State (U.S. Census Bureau, 2002) for several reasons, including its proximity to major metropolitan areas, economically and aesthetically desirable residential and commercial real estate, and easy access to the River and rail lines for industrial businesses. As a result, tremendous pressures have been placed on the health and sustainability of the region's natural resources. These pressures are likely to continue. Most new housing units in the Hudson Valley are expected to be outside of traditional population centers and future growth could have a disproportionate effect on reptile, amphibian, and mammal diversity (Smith et al., 2004).

Despite these stresses, the Upper Hudson Basin remains an ecologically vital area with high plant and wildlife diversity across a landscape that ranges from the extensive hardwood and boreal forests of the Adirondacks and Catskills to the grasslands and agricultural habitats of the Mohawk and Hudson River valleys to the fens and bogs of the Taconic Highlands and lower Hudson Valley. The predominant habitat type within the watershed is forest (about 70%), including deciduous, coniferous, and mixed forest habitats (Upper Hudson Figure 1, Upper Hudson Table 1). Anthropogenic uses dominate about 25% of the Basin (Figure 1, Table 1). This includes residential and commercial/industrial development (5%), agriculture (row crops 7%, pasture, hay land 10.7%), lawns and golf courses (0.7%), and barren areas (quarries, strip mines, gravel pits 0.1%). The remaining land cover (5%) is classified as emergent wetlands, wooded wetlands, and open water (Upper Hudson Figure 1, Upper Hudson Table 1). These habitats accommodate 158 Species of Greatest Conservation Need (SGCN; Upper Hudson Table 2). This is about 1/3 of the 537 species designated as SGCN in New York State (Upper Hudson Table 3), and includes 52 bird species, 51 insect species, 27 amphibian and reptile species, 11 marine fish species, 7 mammal species, 5 mollusk species, 4 freshwater fish species, and 1 species of crustacean. There are 53 species that historically occurred in the Basin, but are now believed to be extirpated (Upper Hudson Table 4).

Critical Habitats of the Basin and the Species That Use Them

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 level was extracted from the database (Upper Hudson Tables 12 and 13). 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 DEC fisheries managers (e.g., cold water - shallow). These critical habitats are not a comprehensive listing of all habitat associations found in the basin, rather it is 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 Appendix B.

The habitats of the Upper Hudson Basin are as diverse as any other basin in New York State. This diversity is due to factors such as the range in elevation from lowlands to high peaks, a diversity of soils and bedrock geology, and gradients of fresh to salt water (Penhollow et al.,2002).

Forested Habitats

Forested habitats are found throughout the Upper Hudson Basin in varying degrees of health and contiguity. For the purposes of this document, the forested habitats will be broken up into six general regions: the Adirondack Mountains in the north, the Catskill and Shawangunk Mountains in the southwest, the Pine Bush in the central part of the Basin, the Hudson River Valley (including the Helderbergs and the Hudson Highlands) running from north to south down the center of the Basin, and the Taconic Mountains stretching from north to south in the far eastern part of the Basin. The Hudson River Estuary Program compiled much of the information that follows (Upper Hudson Table 5; Penhollow, et al., 2002).

The Adirondack Mountains in the north and the Catskill Mountains in the southwest part of the Basin are comprised of the largest, intact stretches of forest (including some first growth) in the State. Predominant vegetation types in these two regions are beech-maple forests, hemlock-northern hardwood forest, and spruce-fir forests. The habitats found in the six-million acre matrix of public and private lands of the Adirondack Park support boreal forest birds such as spruce grouse and Bicknell's thrush, early successional birds such as Canada warbler, raptors such as long-eared owl, northern harrier, and peregrine falcon. Abandoned mines and natural caves provide bat habitat and support listed species

such as the Indiana bat and small-footed bat. The Catskill Mountains support regionally significant populations of forest interior nesting birds including Bicknell's thrush in high altitude spruce-fir forests, bald eagle, timber rattlesnake, and rare plant communities.

The Shawangunks, located south of the Catskills and west of the Hudson River, contain a forest matrix of chestnut-oak forest (chestnut oak, red oak), hemlock-northern hardwood forest, and pitch pine-oak heath rocky summit interspersed with vernal pool and wetland habitat. The forest habitats are important migratory corridors for raptors and other migratory birds. Timber rattlesnake, northern copperhead, eastern hognose snake, and five lined skink occur at several locations.

The Albany Pine Bush in the central part of the Basin is the largest remaining inland pine barrens in the State and is one of the most endangered landscapes in the northeastern United States. This area was created 15,000 years ago as the glacier receded and deposited large amounts of fine glacial sand into a massive lake covering the capital region. Today, this area is referred to as Glacial Lake Albany and covers an expanse from Albany County north through portions of Warren County. The Albany Pine Bush contains globally rare pitch pine-scrub oak barrens and pine barrens interspersed with grass and sedge communities. This area supports the endangered Karner blue butterfly and its host plant blue lupine, as well as other rare butterflies and moths, as well as rare reptiles and amphibians.

The north-central part of the Hudson River Valley (south of the Mohawk Valley, Albany through Ulster Counties) is comprised of a diverse array of forest types including red maple-black gum swamp, chestnut-oak forest, Appalachian oak-hickory forest, and pitch pine-oak heath rocky summit. The area includes the Helderberg escarpment to the north and the Potic Mountain ridge to the south. This area contains hardwood and conifer (plantation) forests, young regenerating forests, old fields, shrublands, and reverting farmland. Some of the species of interest include American woodcock, brown thrasher, prairie warbler, blue winged warbler, and northern goshawk. Limestone caves on the Helderberg Escarpment provide habitat for bat species including Indiana bat. The Hudson Highlands in the southern part of the Hudson River Valley (Orange, Dutchess, and Putnam Counties) are a relatively undeveloped corridor of forests, wetlands, and grasslands of regional importance to breeding and migratory birds, resident herps, and rare plant communities. Important habitats include Appalachian oak-hickory forest, chestnut-oak forest, and oak-tulip tree forest. Species indicative of large, contiguous areas of undisturbed forests include timber rattlesnake and warblers and thrushes such as cerulean warbler. The area also contains mines used as bat hibernacula, including for the Indiana bat and small footed bat.

The Taconic Mountains encompass large areas of contiguous, high quality, northern hardwood forest, and it serves as a recharge area for numerous rich fens. The far northern extent of this region in Rensselaer County contains a diverse mix of wetland and upland communities including spruce-fir swamp, hemlock-northern hardwood forest, and spruce flats. The high quality, large, contiguous nature of this area provides habitat for forest interior bird species and large mammals (e.g., fisher, river otter). Important habitats in the Taconics from Rensselaer County southwards include hemlock-northern hardwood forest and

Appalachian-oak hickory forest. This area supports a diverse population of resident and migratory bird species as wintering and breeding habitat, and as a migratory corridor for passerine birds and raptors. Rare herptile species found here include bog turtle and timber rattlesnake.

Wetland and Other Aquatic Habitats

Much of the wetland, river, stream and lake habitat in the Basin is embedded in a forested matrix and is distributed through the Basin. There are over 270 miles of low-gradient river habitat that is deep and wide. High-gradient coldwater streams are also prevalent in the basin. The following descriptions attempt to provide a general feel for the wetlands and other aquatic habitats in the watershed.

The Adirondack region contains an estimated 2,800 ponds and lakes, miles of pristine headwater streams, and a diverse mix of wetland communities including spruce fir swamp, shallow emergent marsh, sedge meadow, and boreal wetlands. Over 1/3 of New York State's wetlands are found in the Adirondacks. This region also has unique habitats such as the ice meadows found along the Hudson River 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 support herpetofauna such as blue-spotted and Jefferson salamanders. The ponds and lakes in the Adirondacks provide habitat for rare fish species such as round whitefish and heritage strain brook trout, reptiles such as the wood turtle, foraging sites for raptors such as osprey, and are the stronghold for nesting common loons in the State.

The central and south central portions of the basin have diverse wetland communities from high elevation marshes such as spruce fir swamp and boreal wetland communities to vernal pools to shallow emergent marsh at lower elevations. All are of regional importance to breeding and migratory birds, resident herps, and rare plant communities. Where wetland complexes are still relatively intact species that require large, contiguous areas of undisturbed wetland and upland habitats such as wood turtle and river otter can be found. The Hudson River estuary at Troy provides the only riverine spawning areas for shortnose sturgeon, while Cohoes Falls might have been important 150 years earlier. Other rare wildlife found here includes sedge wren, least bittern, Jefferson salamander, and blue spotted salamander.

The wetland complexes of Columbia, Dutchess, Putnam, and Ulster Counties in the lower Hudson Valley are a hot spot for amphibian and reptile biodiversity in New York State. A network of four major wetland complexes in Dutchess County (Milan Window, Stissing Mountain, La Grange/East Fishkill, East Park/Hyde Park) provide important habitat for the most diverse turtle community in the State including Blanding's turtle, bog turtle, spotted turtle, wood turtle, and box turtle. Northern cricket frog, blue spotted salamander, marbled salamander, four toed salamander, and Eastern ribbonsnake are also found here, as well as the only consistent overwintering site by golden eagles. Important habitats include red maple-hardwood swamps, floodplain forest, deep emergent marsh, rich sloping fen, and medium fen communities. The Black Creek and Swarte Kill watersheds contain wetland and upland habitat complexes important to amphibians and breeding waterfowl, including northern cricket frog. Important habitats include mature hemlock-northern hardwood forest, red maple hardwood swamp, Appalachian oak-hickory forest, beech-maple mesic forest, and one of the largest

dwarf shrub bogs in the Hudson River Valley. Finally, the Harlem Valley calcareous wetlands found in the valleys and adjacent ridges of the Taconic Highlands contain high quality habitat for wetland dependent species and some of the best bog turtle habitat in the Hudson River Valley. Important habitats include red maple-hardwood swamp, floodplain forest, fens, and shallow emergent marsh. The area is comprised of two wetland complexes, the Northeast Ancram fen complex to the north, and the Great Swamp area to the south.

There are 30 areas within the Basin designated as Significant Coastal Fish and Wildlife Habitat by the Department of State in consultation with DEC (Upper Hudson Table 6). These areas encompass over 25,000 acres and are primarily concerned with marshes and tributaries of the Hudson River from Albany County southward. Highlights include North and South Tivoli Bays in Dutchess County, Hudson River Miles 44-56 in Putnam County, and Ramshorn Marsh in Greene County. Tivoli Bays is the largest undeveloped, tidal freshwater wetland complex on the Hudson River, and supports species such as osprey, least bittern, wood turtle, and spotted turtle. This area is of statewide significance for research and regional significance for recreational and educational uses. The stretch of the Hudson River in Putnam County (miles 44-56) is an extensive area of deep, turbulent river channel with strong currents and rocky substrates. This expanse supports a bald eagle wintering area and is part of the important nursery for shortnose sturgeon. Ramshorn Marsh is one of the largest freshwater tidal, forested wetlands in the Hudson Valley, a rare ecosystem type in New York State and the world. The marsh supports such species as least bittern and wood turtle, and a commercial shad fishery of regional significance. Tributaries that drain into these significant coastal habitats are critical nursery areas for very high numbers of American eel.

The Hudson River begins as a small mountain lake on the side of Mt. Marcy and travels 315 miles to New York Harbor. Halfway along its course (at the federal dam at Troy) it becomes an estuary providing spawning and nursery grounds for commercially valuable fish, crabs, and shellfish. About 100 miles of the upper estuary are fresh water. The entire estuarine portion of the Hudson River watershed straddles the Upper Basin and Lower Hudson-Long Island Bays Basin and is 5,300 square miles, has 65 tributaries, encompasses 14 counties, 242 municipalities, and is home to more than 8 million people. The entire estuary supports more than 200 species of fish. SGCN include Atlantic sturgeon, shortnose sturgeon, American eel, American shad, alewife, blueback herring, rainbow smelt, tomcod, and associates of estuarine submerged aquatic vegetation (SAV) the common pipefish, threespine stickleback, and fourspine stickleback. Current Hudson River Estuary Program funded studies are looking at blue crab and American eel habitat use in the Hudson. Recently, wild fish and hatchery raised sturgeon were outfitted with sonic tags to track their movements and study their use of Hudson River habitats. Atlantic sturgeon was once so plentiful and commercially popular it was known as “Albany Beef”. Since then, declines have lead to a moratorium on fishing sturgeon adopted in New York in 1996 and coast-wide soon after.

Grassland and Shrubland Habitats

Conservationists often think of areas in the St. Lawrence Valley and the Lake Plains when considering management actions for grassland-dependent wildlife in New York State; however, the Upper Hudson Basin contains natural and human-

created (i.e., pasture, hay land) grassland habitats that support grassland species of conservation concern. Work done by DEC and New York Natural Heritage Program (NYNHP) for the Grassland Reserve Program (USDA Farm Bill) indicates that there are significant grassland habitats and associated plant and animal communities (e.g., butterflies, birds) throughout the Hudson River corridor. An example is the Shawangunk grasslands in Orange and Ulster Counties. This area is important for grassland birds including northern harrier, upland sandpiper, and short eared owl. Furthermore, areas with significant amounts of agriculture in the Hudson (e.g., Dutchess, Columbia, Rensselaer, and Washington Counties) and Mohawk (e.g., Montgomery County) valleys can provide habitat for grassland-dependent species, although agricultural practices incompatible with wildlife may reduce the value of these habitats. Old fields and upland meadows in these agricultural areas can be winter roosting habitat for northern harrier and short-eared owl. Bobolink and eastern meadowlark will breed in hayfields, while upland sandpiper, vesper sparrow, and grasshopper sparrow breed spottily in larger tracts. Shrub-dominated fields in agricultural landscapes are important for rare shrubland-nesting birds. According to the Audubon Society, the Upper Hudson Basin falls within a “responsibility” zone for conservation of shrubland nesting birds. These species have less stringent area requirements and conservation is compatible with agricultural preservation and grassland conservation efforts.

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 have been designated with some protective status by State agencies such as the Office of Parks, Recreation and Historic Preservation (OPRHP) and DEC. These areas include State Parks, State Forests and Forest Preserve Lands, Wildlife Management Areas (WMA), and Bird Conservation Areas (BCA), and total over 1.9 million acres distributed throughout the Upper Hudson. The majority of protected land is in large forest tracts (primarily State Forests, Wilderness Areas, Wild Forests, and Primitive Areas) located in the Adirondack and Catskill mountain ranges. The Upper Hudson Basin contains more protected habitat in the form of public lands than any basin in the State.

Lists of public land holdings have been provided here (Upper Hudson Tables 7-10) to provide 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. In addition, forest preserve lands and state park preserves, due to their protected status, can act as intact blocks of relatively healthy habitat where conservation partners can observe ecological processes over long time scales and gain insight into how to address conservation dilemmas in landscapes that have been heavily altered by human activity. Public lands can serve as the nexus for regional conservation efforts and act as population source areas. Finally, these properties provide opportunities for partnerships that help to deliver habitat and population management actions designed to benefit SGCN.

There are 29 state designated Critical Environmental Areas (CEA) in the Basin, over half of which are in Dutchess County (Upper Hudson Table 11). CEAs are traditionally designated by DEC to protect drinking water supplies (surface waters or ground water aquifers), but other government agencies may designate CEAs for reasons such as preservation of farmland, wetland, and mountain habitat (Buttercup Farm Sanctuary, Dutchess County), protection of waterfowl (Ryder Pond and Cagney Marsh, Dutchess County), protection of migratory & nesting birds (Bontecou Lake, Dutchess County), and protection of rare plant and animal communities (Snake Hill, Dutchess County). As with the State parks, State forests, WMAs, and BCAs mentioned above, CEAs may be important areas to focus management actions. These actions can take the form of population and habitat surveys, land protection initiatives (e.g., conservation easements), or habitat management/restoration efforts, and offer an excellent opportunity to for local governments and land use groups to get involved.

These lists are not meant to be a comprehensive catalogue of all publicly held or designated lands in the Upper Hudson Basin. There are many parcels owned by local governments that provide benefits to SGCN (e.g., town and county parks, green belts), and there are many privately held parcels that have been designated as protected through perpetual conservation easements, fee acquisitions, and other methods (e.g., Audubon's Important Bird Areas). 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 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.

Overall trends in the basin

Biodiversity Trends

The Hudson River Estuary Program states that the "Hudson River Estuary Area of Biological Concern", a region stretching from Albany County in the north through New York City in the south (about 6,400 square miles), has higher biodiversity than can be expected by chance alone for a land area of similar size within the State of New York (Smith et al., 2001). The habitats of the Mohawk Valley and Adirondacks are outside the scope of their program, but the diverse habitats and species found in these northern regions as well, reinforce the importance of the Upper Hudson Basin to Species of Greatest Conservation Need. NYNHP database records indicate that the Upper Hudson Basin is of critical importance to reptile and amphibian diversity in New York State. Almost 2/3 of all reptiles and amphibians of greatest conservation need are found within this Basin (Upper Hudson Table 3). Additionally, NYNHP data indicate that the Hudson River Valley and extensive forests of the Catskills and Adirondacks are of vital importance to rare birds and mammals. The region's extensive rivers, tributaries, and marshes support giant fish like sturgeon, and rare insects such as odonates, stoneflies, and tiger beetles.

While this biodiversity is impressive, trends in land use that are incompatible with wildlife have taken their toll on populations of SGCN. Of the 156 SGCN in this Basin, 34% are declining (Upper Hudson Table 2). The majority (53%) of these are birds, with early successional forest/shrubland birds (32%) and grassland birds (21%) making up the largest shares of declining avifauna. Twenty-five percent of the reptiles and amphibians designated as SGCN are declining, and almost half (46%) of these are woodland/grassland snakes. Insects make up 15% of declining species of concern, about 75% of which are rare butterflies. Many of these declining species specialize in a few select habitats or foraging guilds, and as a result, their population sizes readily diminish with declining habitat quantity and quality. Yet other SGCN depend upon the habitats increasing in occurrence throughout the Basin (e.g., deciduous/mixed forest breeding birds, boreal forest birds, forest breeding raptors). An important step for this plan will be to define a goal for how extensive each habitat type should be in this basin.

More troublesome still is the 54% of SGCN whose status we do not know (Upper Hudson Table 2). Most of these are insects, over half of which are odonates. Reptiles and amphibian species of concern make up about 17% of species of unknown status, and the majority of these are lake/river reptiles. Anecdotal evidence and preliminary data suggest that these species may be rare and/or declining, but without sufficient data on their distribution, abundance, and habitat requirements it is exceedingly difficult to try to combat threats to their populations and habitats.

Changing Human Population, Land Use, and Habitat Quality

As described in the description of the Basin and its critical habitats, this region contains an extraordinary diversity of ecosystems that are still in relatively good health. But, the Upper Hudson Basin also contains some of the fastest developing

communities in New York State. From 1990-2000, the fastest growing counties in the Basin were Putnam County (14%), Orange County (11%), and Dutchess County (8%) in the southern part of the region, and Saratoga County (11%) and Greene County (8%) in the north-central Upper Hudson (U.S. Census Bureau, 2002). These areas of high human population growth coincide with locations of some of the most sensitive habitats and the rare species that depend upon them (e.g., bog turtles in fens in Dutchess and Putnam Counties). Between 2000 and 2015, it is estimated that the greatest increases in human populations will be in the lower Hudson River corridor; specifically, in the increasingly suburban Orange (13% by 2015) and Putnam (12% by 2015) counties, as well as the relatively rural Ulster (11% by 2015) and Sullivan (12% by 2015) counties (New York Statistics Information System, Cornell Institute for Social and Economic Research, 2002). Saratoga County, in the foothills of the Adirondacks, is not far behind with an estimated population increase of 9% by 2015.

Historically, land use in the Basin resembles that of New York State overall-forested followed by intense agriculture, and now a return to forested land (Stanton and Bills, 1996). Records indicate that in 1910, on average, over 70% of the Upper Hudson Basin was classified as farmland (i.e., row crops, pasture, hay land; Stanton and Bills, 1996). By the 1990s this trend had completely reversed itself, and today over 70% of the watershed is classified as forest (Stanton and Bills, 1996; MRLC data, 2005). The nature of the remaining agricultural land has changed as well. Cropland diversity has decreased and smaller farms have been consolidated into larger units. Consequently, 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. This loss of habitat not only affects resident wildlife communities but may also have played a role in the decline of migratory species such as Neotropical migratory birds that breed in the basin.

Wetlands habitats declined dramatically from 1900 until the 1970s. It was common practice to drain marshes for agriculture and other land use practices. Hudson River marshes, in particular, were often used as municipal landfills (Hudson River Estuary Action Plan, 2001). State and federal laws passed in the 1970s protected these habitats, and wetland losses have been slowed dramatically. Results of the New York Freshwater Wetlands Status and Trends Study (2000) are that from the 1980s through the 1990s the Adirondacks experienced a small net gain in wetlands, whereas a net loss of about 2% was observed in the Hudson Valley. Wetland losses were the result of conversions to agriculture and development (residential, commercial, roads). While wetland quantity has remained relatively steady over the past 20 years, siltation, runoff from agriculture and development, and introduction of invasive species has degraded many wetland systems.

Water quality for humans and wildlife in the Basin ranges from pristine, such as the headwaters of streams in the Catskills, to poor in some urban centers. The most prominent case is the contamination of the Hudson River with polychlorinated biphenyls (PCB). PCBs entered the river system through direct discharge from factory sites from the 1940s until 1977 (Baker et al., 2001). These compounds are persistent in the environment, attach strongly to soils and river sediments, and readily accumulate in fish, wildlife, and humans (National Research Council, 2001). PCB contamination negatively affects reproduction and

survival of mammals such as river otter and raptors such as bald eagles. Levels of PCBs in the Hudson River are among the highest in the United States (Baker et al., 2001), so in an attempt to correct this problem, the Environmental Protection Agency will begin dredging the Hudson River in 2007 to remove contaminated sediments.

Another significant trend in the Upper Hudson Basin with negative consequences for wildlife is the declining pH of Adirondack and Catskill water bodies due to acid rain. Air pollution laden with nitric and sulfuric acid from coal-fired electrical generating plants in the Midwestern United States (Ohio, Illinois, Indiana, Pennsylvania) is carried northeast via wind currents, and deposited in the form of precipitation onto the Adirondack and Catskill mountain ranges. The thin, acidic soils and the nutrient-poor water bodies in these areas make them particularly susceptible to acidification. Despite the reductions in emissions that have resulted from the Clean Air Act, the Adirondacks and other affected areas 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 rain can be seen in the damaged spruce-fir forests of the high peaks of the Adirondacks, reduced heritage strain brook trout 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).

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 Upper Hudson Basin, about 90% of the streams and rivers sampled were classified as non-impacted or slightly impacted (very good water quality or good water quality, respectively). About 10% of streams and rivers sampled were classified as moderately or severely impacted (poor or very poor water quality, respectively). Over 80% of the sites classified as moderately or severely impacted were from the lower Hudson watershed including sites on the Hudson River (from Albany/Troy south), lower Esopus Creek, and the Wallkill River. Overall, researchers have observed improvements in the health of the upper stretches of the Hudson River (upstream of Albany and Troy) and the Mohawk River over the past 30 years as shown by increased macroinvertebrate diversity; however, both river systems have locations that continue to be classified as moderate to severely impacted due to non-point nutrient enrichment, runoff from residential and commercial development, and invasive species such as zebra mussels. Most freshwater mussel species are adapted to specific flow regimes in streams and rivers and the effects of recreational rafting water releases in the Indian River and Hudson River on macroinvertebrate communities are unknown.

Threats

DEC staff members who compiled the SGCN information in the SWG 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 Upper Hudson was extracted from the database. The threats and summary figures compiled here (Upper Hudson Table 14) 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 other rationales. The information provided does not quantify the magnitude of a particular threat. The information provided is intended only to paint a broad picture of the proportion of species/species groups to which a particular threat applies, and the frequency with which a particular threat was mentioned in the database. The purpose of this information is not to compare the severity of one threat against another.

The most significant threats were determined by reviewing information from the CWCS database, the scientific literature, and conservation plans for the Basin. Prominent threats to species of greatest conservation need in the Upper Hudson Basin include:

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 a patch or landscape can support (“area sensitive“ species).

Almost 25% of the Upper Hudson Basin is currently comprised of habitats that are significantly altered by humans. 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 public reluctance or ability to engage in active management of these habitats.

Degraded 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). 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 (from in stream and upland erosion), nutrient runoff, temperature increases, toxics (e.g., pesticides, heavy metals), lowered dissolved oxygen, altered hydrology (e.g., water withdrawal, ground water extraction), and physical modifications (e.g., channelization, riparian removal, berms). Potential new threats from dioxin, polycyclic aromatic hydrocarbons

(PAH), and endocrine disruptors require more study to determine their effects on wildlife.

Some of the significant water quality issues in this basin include PCBs in the Hudson River and Schroon Lake, and mercury pollution in the Adirondacks. PCB contamination negatively affects reproduction and survival of tomcod, river otter, and bald eagle. Mercury is released from anthropogenic sources (such as coal burning plants) and is carried via wind currents from sources in the Midwest and deposited onto terrestrial and aquatic habitats through rain, snow, or dust. There may also be local sources of naturally occurring mercury. If mercury is converted to methylmercury it can be consumed by organisms, and increase in concentration as it moves up the food chain (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). According to the report, mercury also poses a threat 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).

Incompatible Silvicultural and Agricultural Practices

Farming and forestry practices may lack ecologically based objectives, and can be detrimental to wildlife. Trends in modern farm operations (increased field size, loss of edge habitats, erosion due to conventional tillage, intensive grazing, poorly timed 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 parts of Orange and Ulster Counties west of the Hudson River, east of the Hudson River in portions of Dutchess County north through Washington County, and throughout the Mohawk Valley (Oneida, Herkimer, and Montgomery Counties). In the forested landscapes that predominate the Upper Hudson Basin, forestry operations that do not comply with best management practices and that are poorly planned and executed can damage habitat function and reduce habitat quality for SGCN that reside there.

Invasive Species

Invasive exotic plants and animals diminish the quality of upland and aquatic habitats throughout the Basin. In wetlands and other aquatic habitats, large patches of species like purple loosestrife and common reed with limited value to wildlife, displace native plant species and disrupt ecological processes. Numerous non-indigenous aquatic species have been introduced into the waters of New York State, but so far only a relatively small number could be classified as aquatic nuisance species (ANS). Many introduced species have become naturalized, and show relatively few adverse effects. Others are present in very small numbers, and it is not clear if introduced populations will survive or result in detectable adverse effects. Marine species are probably under-represented, because marine ANS have

not been studied as much in New York as freshwater ANS. Those species recognized as candidates for ANS designation are listed in Table 18.

In upland habitats, invasive exotic plants and insects introduced through human activity threaten to reduce biodiversity. For example, exotic insects like Hemlock wooly adelgid and Asian longhorn beetle lack any natural predators and threaten to alter the composition of forest stands. In the Hudson River, zebra mussels have caused a 57% reduction in the biomass of other benthic animals (Bode et al., 2004). From Yonkers to Troy, zebra mussels have consumed more oxygen from the Hudson River (from their respiration) than was added back to the river as a result of the post-Clean Water Act improvements in sewage treatment plants (Strayer et al., 1996, D.L. Strayer pers. comm., May 2005). Although this oxygen depletion probably does not impair water quality (unlike sewage discharges), it demonstrates the magnitude of effects that can be posed by some invasive species. In all habitat types, new residential and commercial development increases the risk of new occurrences of invasive exotic plants and animals.

Native species present in locations or numbers not historically found can be detrimental to some SGCN. These invasive or overabundant native species can out compete the species of concern for forage or nest sites (e.g., sand shiner vs. comely shiner, or blue-winged vs. golden-winged warblers), can pose a predation threat (e.g., perch preying upon round whitefish), or can reduce habitat quality by altering vegetative composition and structure (e.g., black locust invading Karner blue butterfly habitat, deer overbrowse limiting forest regeneration).

Human-Wildlife Interactions

There are a variety of threats to SGCN in the basin 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. Often fragmentation of habitats by structures, such as power lines and roads and the entrainment of fish in power plant cooling intakes, are a significant source of mortality. There have been critical population losses to American eel and blueback herring from barriers to fish migration as locks and dams, and from deaths due to hydropower turbine blades.

Anecdotal evidence and preliminary survey data have suggested that wildlife collisions with human-created structures (e.g., wind turbines, communications towers, and power lines) can have significant population-level effects. As human populations within the Basin continue to increase, these structures will likely become a more significant hazard to SGCN.

Many of the amphibian and reptile species of conservation concern have no protected status. 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.

The best estimate of Atlantic sturgeon stock size in the Hudson at the start of records during the late 1800s was around 6,000 mature females. Current estimates are around 300 mature females. The Atlantic sturgeon fishery was closed in all U.S. Atlantic coastal states and in Federal waters, but losses continue

as a bycatch in other ocean fisheries. NY State ended harvest in 1996 and stock recovery in the Hudson since then has been slow. Management action has also been taken to decrease ocean harvest of American shad. American shad stocks are at a historic low, both in the Hudson River and in many other Atlantic coastal rivers. Alewife abundance has declined substantially throughout the estuary and the species is becoming relatively rare. It is an important prey species and a popular recreational and commercial fish. Threats include over harvesting of adults on the spawning grounds for bait in the recreational and commercial fisheries, loss of access to historic spawning grounds, and degradation of spawning and juvenile habitat, primarily in inshore areas. More information is needed for these species to document stock response and identify continued problems.

Climate Change

The greatest potential to affect fish and wildlife on a scale much larger than this Basin is climate change. 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 observed for at least 10,000 years (Millennium Ecosystem Assessment Board, 2005). In the Upper Hudson basin, where boreal ecosystems are at the southern edge of their range, this threat places entire forest communities and their flora and fauna at risk of extirpation within management time frames; however, researchers studying this issue in the Adirondacks have not been able to reach consensus on the methods used to study climate change at a local scale, thus making predictions about future effects difficult (Jenkins, in review; Stager and Martin, 2002). 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. Climate change is likely to affect local hydrologic cycles that support the world-renowned amphibian and reptile diversity of the Hudson Valley, particularly as human demands for water supply increase in this region. The effects of climate change also include changes in the timing of natural processes and the frequency of natural discturbances.

Priority Issues in the Basin

The Upper Hudson Basin is geographically diverse and there are varying priority stressors in different areas within the basin. The prominent hazards for six different regions within the basin are listed here:

ADIRONDACKS:
Atmospheric deposition (i.e., acid rain and mercury)
Incompatible residential and commercial development
Incompatible forestry practices
Invasive and overabundant species
Human disturbance (collection, recreation)
Climate Change*

HUDSON VALLEY:
Habitat loss and fragmentation
Degraded water quality & altered hydrology (dams)
Incompatible commercial & residential development
Incompatible forestry and agricultural practices
Invasive and overabundant species
Human disturbance (poaching, collection)
Climate change*

CATSKILLS/SHAWANGUNKS:
Atmospheric deposition (i.e., acid rain and mercury)
Incompatible residential and commercial development
Incompatible forestry practices
Invasive and overabundant species
Human disturbance (collection, recreation)

MOHAWK VALLEY:
Habitat loss and fragmentation
Degraded water quality
Incompatible commercial & residential development
Incompatible forestry and agricultural practices
Invasive and overabundant species

ALBANY PINE BUSH:
Habitat loss and fragmentation
Incompatible residential and commercial development
Succession
Invasive and overabundant species

TACONICS:
Habitat loss and fragmentation
Incompatible residential development
Incompatible agricultural & forestry practices
Invasive and overabundant species
Human disturbance (poaching, collection)

Climate change is listed here only for the Adirondacks and Hudson Valley, but will likely affect all areas

Vision, Goals and Objectives for the Basin

Vision

The Upper Hudson Basin will be part of a connected, healthy and sustainable ecosystem.

Public and private conservation partners will work in a coordinated fashion to gather the most accurate, comprehensive data on Species of Greatest Conservation Need and their habitats 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 work in a coordinated manner to manage populations and habitats over large spatial and temporal scales. This will be done through comprehensive planning, land protection, adaptive management, and rigorous evaluation.

The result of these efforts will be healthier and secure animal populations, habitats, and communities. Loss of Species of Greatest Conservation Need to extinction will be slowed or halted. Species that are currently 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

- Study and evaluate the appropriate balance of habitat types within the Upper Hudson Basin. Once a set of target acreages for each habitat type is agreed upon, set priority actions for SGCN and their habitats based upon these targets.

- Establish a conservation framework within the Upper Hudson Basin through which public and private stakeholder interested in wildlife conservation can work cooperatively towards the management, enhancement, and protection of the Basin's at-risk biodiversity.

- Ensure that no at-risk (threatened/endangered, rare, or declining) species becomes extirpated from the Basin. Furthermore, ensure that common species remain common.

- 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 habitats/natural communities used by SGCN where the habitat vulnerability and factors influencing habitat quality are not fully understood.

- 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/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 (2003 and 2004; Upper Hudson Table 15). 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.

There are several existing management plans that address natural resource conservation issues within the basin (Upper Hudson Table 17). The goals and objectives of the plans catalogued here vary in their focus (e.g., water quality, planning and development, fish and wildlife), spatial and temporal scale, and cooperating partners; however, they all provide valuable information on conservation threats and strategies in this region of New York State and should be consulted before implementing recommended actions.

Data Collection Recommendations

Data collection (research, surveys, and inventories) is a crucial first step for the majority of SGCN in the Upper Hudson Basin (Upper Hudson Table 16). Many of the conservation actions in the following categories (e.g., Planning, Land Protection, etc.) should not or cannot 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.

Most of the species in the taxa listed below are tracked by the New York Natural Heritage Program and recorded in the State's comprehensive database of rare species and significant natural communities. Any new information derived from SWG funded activities involving Heritage-tracked species be submitted to the Heritage Program and integrated into their database.

DATA COLLECTION RECOMMENDATIONS FOR CRITICAL SPECIES

There are a number of priority species and groups that need population, habitat, and life history research to address critical data gaps. This information will help to more clearly identify threats and establish baseline information for these species. This type of data collection will address multiple threats to many species. Detailed recommendations for the following species and species group are listed in Upper Hudson Table 16:

- Barn owl
- Boreal forest birds
- Breeding waterfowl
- Common loon

- Deciduous/mixed forest breeding birds
- Early successional forest/shrubland birds
- Forest breeding raptors
- Freshwater marsh nesting birds
- Grassland birds
- High Altitude Conifer Forest Birds
- Osprey
- Peregrine Falcon
- Amphibians and Reptiles
- Box Turtle
- Freshwater wetland amphibians
- Lake/river reptiles
- Stream salamanders
- Uncommon turtles of wetlands
- Vernal pool salamanders
- Woodland/grassland snakes
- Insects
- Karner blue butterfly
- Other Butterflies
- Other moths
- Odonates
- Riparian tiger beetles
- Stoneflies/Mayflies of lotic waters
- Mammals
- Game species of concern
- Indiana bat
- Tree bats
- Marine Fish
  - Fourspine stickleback
  - Atlantic sturgeon
  - American shad
  - Alewife
- Freshwater Fish
  - Round whitefish
  - Heritage strain brook trout

DATA COLLECTION RECOMMENDATIONS FOR CRITICAL HABITATS

- 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 for the following species and species groups are found in Upper Hudson Table 16:

  - Deciduous/mixed forest breeding birds
  - Early successional forest/shrubland birds
  - Freshwater marsh nesting birds
  - Grassland birds
  - High Altitude Conifer Forest Birds
  - Box Turtle
  - Marine Fish
  - Atlantic sturgeon

- Strongly human-altered landscapes may have disrupted predator-prey cycles. Anthropogenic activities such as development and pesticide application may serve to directly reduce predator or prey populations. Additionally, human-altered habitats may favor generalist predators by creating long, linear edge habitats and small habitat patches (with a high edge to 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 Catskills or Adirondacks, large grassland or wetland complexes) provides insight into how to repair ecological processes in human-altered habitats. Specific data collection recommendations for the following species and species groups can be found in Upper Hudson Table 16.

  - Barn owl
  - Freshwater marsh nesting birds
  - Osprey

- Many of the SGCN in this Basin rely upon aquatic habitats during some stage of their life cycle (e.g., natal sites, foraging sites). Conservation partners have identified the degradation of water quality, habitat quality, and the acute and chronic effects of contaminants in aquatic habitats as a significant threat to wildlife. It is important to quantify the effects of these threats on the survival of SGCN. Specific recommendations for the following species and species groups listed below are found in Upper Hudson Table 16:

  - Common loon
  - Freshwater marsh nesting birds
  - Peregrine Falcon
  - Round whitefish

- American eel
- Riparian tiger beetles
- Marine Fish
- American shad

❖ Invasive exotic plants and animals diminish the quality of upland and aquatic habitats throughout the Basin. It is important to engage in early detection for these exotic species, to quantify their effects on SGCN and critical habitats, and to develop guidance on minimizing the potential detrimental effects of exotic species on species survival and habitat quantity and quality. Specific recommendations for the following species and species groups are included in Upper Hudson Table 16:

- Early successional forest/shrubland bird
- Round whitefish
- Riparian tiger beetles

❖ Some farming and forestry practices that lack ecologically based objectives can be detrimental to wildlife. Conversely, the existence of agriculture and some agricultural practices can effectively maintain habitat for some species in the Upper Hudson Basin. A needed first step is to determine the relative proportions of farming practices (mowing frequency, timing of mowing, etc.) and forest management practices (partial harvest, clear cut, etc.) in the basin. Then, evaluate the preferences and compatibilities of each SGCN in relation to these existing management practices. Existing management practices can be matched to the vision of the relative proportion of habitat types set forth in the initial stages of this plan. It will then be appropriate to act on the specific recommendations shown on Upper Hudson Table 16 within this vision for habitat types for the following species groups:

- Deciduous/mixed forest breeding birds
- Early successional forest/shrubland birds
- Forest breeding raptors
- Grassland birds

❖ Anecdotal evidence and preliminary survey efforts have suggested that wildlife collisions with human-created structures (e.g., wind towers, cell towers, and power lines) can have significant population-level effects. The U.S. Fish and Wildlife Service (USFWS) is currently investigating the effects of these types of structures on wildlife populations (specifically, migratory birds), but a more targeted effort should be made in the unique landscapes of the Upper Hudson Basin. Species of Greatest Conservation Need that should be included in this action include migratory birds (early successional forest/shrubland birds, deciduous forest birds, forest breeding raptors) and bats (tree bats). The effects of human-created structures on SGCN should be evaluated from a basin- and state-wide perspective. Siting of human-created structures should also be evaluated from a basin- and state-wide perspective.

Planning Recommendations

- 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 at all scales (e.g., local open space plans, Unit Management Plans, New York State Grassland Bird Management Plan, North American Waterbird Conservation Plan, various endangered and threatened species recovery plans) 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).

- Develop and integrate a "coarse-filter" approach to compliment the "fine-filter" approach utilized in this CWCS. The "coarse-filter" approach emphasizes the conservation of ecosystems that adequately support the vast majority of species and the full array of natural communities. It is thought to be an efficient approach, because it protects guilds of species that include many SGCN (e.g., the "fine-filter"). While the goals for SGCN are to provide for their recovery and maintain potential for their survival, goals for ecosystems will be to maintain (or restore) ecological processes to prevent additional species from imperilment.

- 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 156 SGCN occurring in the basin, 26 depend on barrens and woodlands, 55 depend on forested habitat, 44 depend on grasslands, and 29 depend on mineral soil wetlands. Some species depend on all four of these habitat types at some point in their life cycle. 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 the key to the health and abundance of many of the SGCN currently living in this basin.

- Over 70% of the Upper Hudson Basin is forested. There is 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 that may address only one species, habitat type, or geographic area (e.g., Wildlife Management Area, a private forest tract, or municipality). Some specific planning recommendations for species in forested habitats include:

    - Develop a management plan that provides guidance on maintaining and enhancing early successional forest/shrub habitat for the suite of early successional forest/shrubland birds.

    - Public and private partners should coordinate development of local conservation programs that specifically address forested landscapes. These

plans should incorporate the needs of deciduous forest birds, early successional forest/shrubland birds, and forest breeding raptors.

- Investigate the feasibility to manage fields, existing early successional forests, and mature 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, grassland birds, and forest breeding raptors.

- Develop a management plan for high elevation birds, including 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.

- Conservation planners should revise the Federal Karner Blue Butterfly Recovery Plan and complete the New York Karner Blue Butterfly Recovery Plan to identify protection/management strategies for sustaining Karner blue metapopulations over the long term.

❖ Only about 5% of the Upper Hudson Basin is classified as wetland or some other aquatic habitat (scattered throughout the Basin), yet many SGCN within this watershed rely on these critical 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. Some specific planning recommendations for species in stream and wetland habitats include:

- Continue participation in the North American Waterbird Plan, Bird Conservation Regional Plan, and other regional planning efforts. Focus on and refine recommendations for common loon and freshwater marsh nesting birds.

- Public and private conservation partners should coordinate the development of a monitoring and control plan for invasive exotic species in wetlands (i.e., purple loosestrife, *Phragmites australis*) and along streams (i.e., knotweed) 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.

- Watershed management plans should consider the connectivity of aquatic systems, particularly with regard to the needs of migratory fish.

❖ Public and private partners should coordinate development of stream and watershed management plans, and/or local wetland conservation programs that specifically address aquatic biodiversity conservation. Measures to reduce water quality degradation, increase riparian habitat, and connections between aquatic and upland habitats should be included. These plans should incorporate the specific needs of:

- Freshwater Marsh Nesting birds - American bittern, least bittern, pied-billed grebe, king rail
- Freshwater Wetland Amphibians - Northern cricket frog, Fowler's toad
- Lake/River Reptiles - Eastern ribbon snake, wood turtle
- Stream Salamanders - long-tailed salamander
- Uncommon Turtles of Wetlands - Blanding's turtle, spotted turtle, bog turtle
- Vernal Pool Salamanders - blue spotted salamander, Jefferson salamander
- Odonates of Rivers/Streams - Common sanddragon, extra striped snaketail, pygmy snaketail, Septima's clubtail
- Odonates of Bogs/Fens/Ponds
- Odonates of Lakes/Ponds

❖ About 10% of the Upper Hudson Basin is grassland. Planning efforts should focus on both public and private lands and include the benefits of this habitat to grassland birds. Specifically:

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

- 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 is critical.

❖ A statewide strategy on atmospheric deposition is needed, particularly for benefit of the Upper Hudson Basin where the issue originally came to national attention with the acidification of Adirondack lakes. The recently implemented Acid Deposition Reduction Program addresses threats of acidification and nitrogen compound deposition. An emerging and critical threat to much of New York's fish and wildlife, including SGCN, is mercury. While DEC already regulates mercury emissions originating in New York, a plan is needed for sustained and increased efforts in monitoring, and to lead a regional approach that galvanizes other states to address the threat of atmospheric deposition. An atmospheric deposition plan should specifically address monitoring of mercury deposition and presence in water bodies and wildlife (e.g., forest birds, mink, otter, etc.). A multi-state approach, like the existing Regional Greenhouse Gas Initiative should address the ecosystem effects of mercury deposition on SGCN.

❖ Develop land use planning guidelines for all SGCN species to encourage the incorporation of appropriate conservation measures by all land use planners.

Land Protection Recommendations

This category of actions encompasses a variety of acquisition mechanisms such as easements, cooperative agreements, fee title acquisition, donations, development rights acquisition, and others. The type of acquisition 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.

Acquisition should address reduction or protection from threats to the targeted species and their habitats. A common threat to many SGCN in this basin is the loss of habitat due to anthropogenic changes like development (residential and commercial, roads, power lines), dredging, wetland draining, and the suppression of natural disturbance regimes such as fire and flood.

FORESTED HABITATS

Since much of the forested habitat in the Adirondack Mountains is protected by the rules governing development in the Adirondack Park and by large tracts of public land administered by DEC and others, public and private entities interested in acquiring habitat for SGCN should direct their limited resources to the southern portion of the Upper Hudson Basin (from the Mohawk Valley south) where development pressures pose a relatively greater threat to species of concern and their habitats than in other parts of the Basin. This includes the Helderbergs, the eastern portion of the Catskill Mountains, the Shawangunk Ridge, Hudson River Valley, and the Taconics. Acquisition should focus on unprotected forest buffers around streams and wetlands supporting SGCN and large, intact forests that provide benefits to multiple SGCN. Specific species and groups are described below:

- Deciduous/Mixed Forest Breeding Birds - Secure habitats critical to species survival by acquisition of easements, or by other land protection mechanisms. Target species include:

  - Cerulean Warbler - large, unfragmented forest tracts where available. Breeding Bird Atlas (BBA; 2000-04) data indicate concentrations in Orange, Putnam, Dutchess, and Ulster Counties, central Schoharie County, and southeast Albany County.
  - Red-headed Woodpecker - open deciduous woodlands where available. BBA (2000-04) data indicate concentrations in southern Ulster, northern Orange, and southwest Dutchess Counties. The previous BBA effort (1908-85) indicates several confirmed and probable breeding sites throughout the Mohawk Valley. Further investigations should occur to determine the value of acquiring habitat here.
  - Worm-eating Warbler - large, unfragmented forest tracts containing ravines and hillsides in thick deciduous woods where available. BBA (2000-04) data indicate that the range for this species in New York State is concentrated in the southern part of the Upper Hudson Basin - most of Orange and Ulster Counties east to the Hudson River, and Putnam, Dutchess, and Columbia Counties from the Hudson River east to the Taconic Highlands.

- Early Successional Forest/Shrubland Birds - Implement a Landowner Incentive Project for early successional birds for 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). The results of the 2003 and 2004 State Wildlife Grant studies investigating this issue should guide where and when habitat acquisition and/or restoration activities occur for this species. BBA data (2000-04) indicate confirmed and probable breeding sites for golden-wings throughout the Basin, with concentrations in northwest Schoharie County/southern Montgomery County, southwest Ulster County/southeast Sullivan County, and Orange County.
  - Canada Warbler - deciduous woodlands and riparian thickets. BBA (2000-04) data indicate that this species is found from the Adirondack Park south through the Hudson River corridor, with many observations in the hills to the west (Helderbergs, Shawangunks) and east (Taconics) of the Hudson River.
  - Whip-poor-will - open woodlands, from moist lowland deciduous forests to montane forests and pine-oak woodlands. BBA data (200-04) indicate that the largest concentrations of this species are in Ulster County in the southern portion of the Basin, and Warren and Essex Counties in the northern portion of the Basin.

- Forest Breeding Raptors - Secure habitats critical to species survival by acquisition of easements, or by other land protection mechanisms. Target species include:
  - Long-Eared Owl - coniferous and mixed coniferous-deciduous forests, especially near water. BBA (2000-04) data show breeding records for this species in Dutchess County in the southern part of the Basin, Schoharie, Albany, and Rensselaer Counties in the central part of the Basin, and Essex County in the northern part of the Basin.

- High-Altitude Conifer Forest Birds - the sole SGCN in this group is Bicknell's thrush. This relatively rare, forest interior species is found in high elevation habitats of the Adirondack and Catskill Mountains. Since most or all of the required spruce-fir stands on peaks of the Adirondacks and Catskills are in public ownership, acquisition should focus on the surrounding mosaic of northern hardwood forest types.

- Karner Blue Butterfly - this species is in the "forested habitat" category here, but it is reliant upon open habitats (containing its host plant, blue lupine) within a forested landscape, like that seen in the Glacial Lake Albany Recovery Unit. Those interesting in securing habitat for this species should acquire easements, where appropriate, to create habitat and to establish a buffer from human development in all Karner blue recovery units as described in the draft New York State Karner Blue Butterfly Recovery Plan. Along with the Recovery Plan, the results of the work funded under the 2003 and 2004 State Wildlife Grants should also be used to help guide where habitat protection efforts should take place within the Recovery Unit.

- Woodland/Grassland Snakes - many of the den sites for snakes of conservation concern are on private lands. Secure habitats critical to species survival by acquisition or 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:

  - Timber rattlesnake - relatively undisturbed forested habitats (mixed coniferous/deciduous), and open woodlands with talus/rocky outcrops. New York State Herpetile Atlas (1990-99) data report the occurrence of this species in several blocks in Orange and Ulster Counties, as well as Schoharie, Montgomery, Columbia and Dutchess Counties.
  - Eastern hognose snake - barrens/woodlands with coniferous components, open uplands with sandy soils and/or dunes. New York State Herpetile Atlas (1990-99) data report the occurrence of this species in several blocks in Orange, Ulster, and Putnam Counties in the southern portion of the Basin, and Albany, Schenectady, and Saratoga Counties in the north-central portion of the Basin.

- Box Turtle - As one of the biggest threats to this species in this Basin is habitat loss and fragmentation of habitat by roads (resulting in a significant road mortality), it is important to secure large tracts of intact habitat relatively free from development. This can be done through the acquisition of easements or by other land protection mechanisms. New York State Herpetile Atlas (1990-99) data show records for this species throughout the Hudson River corridor from Saratoga County southwards, with the largest concentration of observations in Ulster, Dutchess, Putnam, and Orange Counties.

- Vernal Pool Salamanders - vernal pools, dotted across the forested landscape, form an extensive system of small, unregulated wetlands that provide critical wildlife habitat. Vernal pool salamanders use both forested and wetland habitat types –(i.e., 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 & Jefferson Salamander - New York State Herpetile Atlas (1990-99) data show records for these species primarily south of the Mohawk Valley, with concentrations in Schoharie and Albany Counties in the north, and Ulster, Dutchess, Orange, and Putnam Counties to the south.

FRESHWATER WETLANDS AND OTHER AQUATIC HABITATS

Aquatic habitats are scattered throughout the Upper Hudson Basin. Conservation partners interested in acquiring aquatic habitats should focus their resources on areas 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. An example of a rare ecotype within

this Basin that faces multiple threats is the calcareous seepage wetland mosaic in the Taconics (southeastern portion of the watershed), which includes a variety of fens and seepage swamp communities. In addition, areas of existing or restorable emergent marsh habitat adjacent to state-owned emergent marshes should be acquired to create larger marsh complexes under state protection.

- Freshwater Marsh Nesting Birds - Secure habitats critical to species survival by acquisition of easements, or by other land protection mechanisms. The results of the 2004 State Wildlife Grant work on marsh birds should help to 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 the Adirondacks with focus on Warren, Hamilton, and Essex Counties.
  - Least Bittern - freshwater wetlands with emergent vegetation. BBA (2000-04) data show concentrations of observations of this species closely tied to wetland habitats along the Hudson River, with additional observations in Albany and Warren Counties.
  - Pied-Billed Grebe - well vegetated lakes, ponds, and marshes. BBA (2000-04) observations for this species are spread throughout the Basin.

- 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 to guide acquisition projects. Target species include:
  - Northern Cricket Frog - sunny, shallow ponds with abundant vegetation and/or slow-moving algae-filled water courses with sunny banks. The Hudson Highlands-Shawangunk region of New York State is the northern limit of this species range. During the New York State Herpetile Atlas (1990-99), this rare species was observed in only eight survey blocks statewide, almost all of which are within this Basin (Dutchess, Ulster, and Orange Counties).
  - Fowler's Toad - wetlands in both wooded and grassland landscapes. New York State Herpetile Atlas (1990-99) data show records for this species closely tied to wetland habitats along the Hudson River from Warren County southward.

- 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 to guide acquisition projects. Target species include:
  - Blanding's Turtle - shallow marshy waters and ponds. New York State Herpetile Atlas (1990-99) effort observed this species in only 24 survey blocks statewide, six of which are within this Basin - one in southwest Hamilton County and five in Dutchess County.
  - Bog Turtle - early successional wetlands such as wet meadows, calcareous fens dominated by sedges or sphagnum moss, and other tussock-forming herbaceous vegetation. In New York State, bog turtle populations are found primarily in a few key sites in Columbia, Dutchess, and Putnam Counties.

- Spotted Turtle - marshy meadows, small bogs and swamps. New York State Herpetile Atlas (1990-99) data show records for this species from Schenectady County southwards, with the concentration of the population in the Hudson River valley in Greene, Ulster, and Orange counties west of the Hudson River, and Columbia, Dutchess and Putnam counties east of the Hudson River.

RIVERS AND STREAMS

Secure habitats critical to species survival by fee acquisition or conservation easements for streams and adjacent uplands. SGCN that depend upon healthy riparian and floodplain habitats to maintain necessary channel condition include mollusks and brook trout. The wood turtle and eastern ribbonsnake require the availability of adjacent upland habitats for completion of their life cycle. Stream segments that contain large cobble bar habitat in the Esopus Creek and Hudson River are critical for riparian tiger beetles. Stream salamanders would benefit from acquisition of riparian buffers that stabilize banks and filter sediment from runoff, thus preventing sedimentation of breeding habitat. Acquisition should focus on riparian and floodplain forest, wetland, and meadow complexes that support the life cycle needs of SGCN and contribute to in-stream habitat quality (e.g., undercut banks, supply of coarse particulate organic matter, geomorphic structure, shading). Acquisition targets might include entire segments of stream, floodplain or shoreline that support high biodiversity, including rare or declining species or other important ecological characteristics.

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 will enable better management and protection of these habitats for grassland birds and barn owls. Acquisitions should reflect the recommendations of priority grassland focus areas being developed by the New York State Grassland Bird Management Plan (State Wildlife Grant, 2003). Acquisition of grasslands should focus on the needs of these critical species:

- Grassland Birds - Acquisitions focusing on grassland bird habitat should be directed toward protecting existing grasslands or acquiring and restoring grassland habitats within relatively 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. (Figure 1).
- Barn Owl - Acquisitions for barn owls should concentrate on areas where they are already known to breed. BBA (2000-04) data indicate that this is in areas of south central Sullivan and northern Orange Counties and central Washington County. As more barn owl breeding sites are observed, this effort should be expanded.

Management and Restoration Recommendations

Successful management and restoration efforts will require large-scale cooperation among public and private stakeholders, where each organization contributes its strength to the management system. These contributions must range from coordination to data collection, implementation, and monitoring/evaluation so that habitat and species management goals can be achieved at the Basin level. DEC, the government entity tasked with conservation of the State's fish and wildlife resources, should take the lead in coordinating such an endeavor.

Vehicle Collisions

- Box Turtle - one of the biggest threats to this species in this Basin is habitat fragmentation by roads resulting in significant road mortality. Develop and implement mitigation strategies to manage adverse effects of habitat fragmentation including the establishment of safe travel corridors under roadways. The results of the 2003 State Wildlife Grant study on reducing turtle mortality during migration should be consulted when implementing this recommendation.

- Lake/river reptiles - manage the variety of adverse influences that might reduce lake/river habitat suitability for the eastern ribbonsnake and wood turtle, 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 Blanding's spotted, and bog turtles. Also, similar to box turtles, these 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 road kill.

- 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.

- Riparian tiger beetles - suitable, large river cobble bar habitat in the Upper Hudson Basin may be of particular importance for the riparian tiger beetle, *Cicindela ancocisconensis* (Hudson River, Esopus Creek). Reduce or eliminate detrimental ATV use on cobble bars where this species occurs or could occur if such activity was lacking or reduced.

Forested Habitats

- Boreal forest birds - work with private landowners to implement land management strategies that favor spruce grouse, olive sided flycatcher, and other species dependent on early successional boreal forests. Within this basin this action should focus on high elevation areas of the Adirondack Mountains (portions of Essex and Hamilton counties). Explore creation of wildfire management guidelines for Forest Preserve Lands. Determine if these guidelines can be applied to other lands. If they can, work with public

and private land managers to execute fire management for boreal forest bird species such as spruce grouse, olive sided flycatcher, and other species dependent on early successional boreal forests.

- Deciduous/mixed forest breeding birds - implement population control of whitetail deer in areas where deer populations are affecting forest regeneration and species composition, and where traditional hunting programs are unable to reduce the deer population to levels compatible with breeding bird population objectives. High priority species include cerulean warbler, worm-eating warbler, and red-headed woodpecker.

- 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 planned timber and abandoned agricultural field management. High priority species include golden-winged and blue-winged warblers, Canada warbler, whip-poor-will, and American woodcock. Maintain, restore, and enhance fire-adapted early successional ecosystems through the use of prescribed fire.

- Forest breeding raptors - maintain appropriate breeding habitat for long-eared owls around occupied nest sites.

- Box Turtle - manage vegetative succession by means of prescribed burns, herbicide applications, and/or by timber harvest, and evaluate the effectiveness of such measures in enhancing habitat suitability for the species.

- Karner blue butterfly - this species is in the “forested habitat” category here, but it is reliant upon open habitats (containing its host plant, blue lupine) within a forested landscape, like that seen in the Glacial Lake Albany Recovery Unit. To combat conversion of land for human uses and loss of habitat to succession, create new Karner blue habitat adjacent to existing habitat patches where possible. In addition, create dispersal corridors between population sites and to buffer areas against human encroachment. The results of the 2003 and 2004 State Wildlife grants studies should be applied to these management efforts (lupine restoration study, adaptive habitat management study).

Freshwater Wetlands

- Breeding waterfowl - install nest boxes to increase populations or productivity of common goldeneye in appropriate locations in the Adirondacks. Also, maintain or increase abundance and suitability of emergent marsh habitats for breeding American black ducks in the Adirondack region.

- Common loon - use artificial nesting platforms, where feasible and appropriate, to improve nesting success 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.

- Freshwater marsh nesting birds - use incentive and cost-share programs 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 (blue-winged teal, American black duck), marsh birds (American and least bitterns, pied-billed grebe, king rail), and other water birds. Also, 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.

- Osprey - nest platforms should be maintained and new ones placed on nesting locations in the Adirondack Park.

- Freshwater wetland amphibians - manage the variety of factors that might be limiting wetland habitat suitability for high priority amphibian species (Northern cricket frog, Fowler's toad). As with marsh birds, use cost-share and incentive programs to manage and restore marsh habitats on private lands in the southern part of the Basin with the highest amphibian diversity and the direst threats (Ulster, Dutchess, Putnam, and Orange Counties).

- Lake/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 turtle.

- 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 Blanding's, bog, and spotted turtles. Management actions should focus on occupied (and adjacent) habitats in the southern portion of the Basin (wetlands and fens in the Hudson Highlands and Taconics in Columbia, Dutchess, Putnam, and Ulster counties).

- Identify suitable waters for management of Heritage brook trout strains such as Little Tupper, Windfall, and Horn Lake strains. If there are insufficient ponds in watersheds of origin for these Heritage strain fish, then expand populations into suitable waters within the same watershed to continue protection of the strain.

- Examine the use of and need for protective barriers on outlets of Heritage brook trout waters to prevent invasive species such as sea lamprey and other predatory fish.

- Reclaim degraded waters in the watersheds of origin of Heritage brook trout in order to restore populations of these fish to their historic range.

- Restore round whitefish to additional waters on public lands in the basin.

- Management activities should consider natural form and function as much as possible in order to maintain natural ranges of habitat disturbance. The Coastal Nonpoint Pollution Control Program (CZARA section 6217) provides a process for improving in-stream and riparian habitat, and water quality associated with maintenance and operation of existing modified channels. The management measures offered by this program and others can be used to maintain and improve in-stream habitat structure for SGCN.

Grasslands

- Grassland birds - restore habitat function and manipulate habitat structure and composition through mowing and prescribed fire. Most of the grasslands in the Upper Hudson Basin are in private ownership. Incentive and cost sharing programs are required if management of this habitat type is to be successful. Public and private agencies are going to have to 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 to 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).

Invasive Species

- 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 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). The Nature Conservancy's Adirondack Park Invasive Plant Program is currently working to control the spread of invasive plants in the Adirondacks.

Interspecific Interactions

- Common loon - reduce predator-caused breeding failure, where problematic, by increasing hunting or trapping opportunities. 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.

- Deciduous/Mixed Forest Breeding Birds – manipulate habitat structure and composition through restoration and/or management (e.g., forest patch size,

shape) to reduce nest losses to predators. Evaluate the extent to which management actions can reduce nest and chick losses.

- Grassland Birds – manipulate habitat structure and composition through restoration and/or management (e.g., grassland patch size, shape) to reduce nest losses to predators. Evaluate the extent to which management actions can reduce nest and chick losses.

- 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 publicly owned wetlands, but if successful, should be expanded to private lands throughout the Basin.

- 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.

- 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.

Water Quality Degradation

- 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.

- Freshwater wetland amphibians – Manage the variety of factors that might be limiting wetland habitat suitability for resident amphibian species including management of toxicants, adverse hydrological alterations, and anthropogenic inputs of sediments.

- Lake/river reptiles - Manage the variety of adverse influences that might reduce lake/river habitat suitability for reptiles of concern including management of toxicants and adverse hydrological alterations.

- Stream salamanders - undertake remedial actions as needed to restore habitat quality in degraded streams. During the New York State Herpetile Atlas Project (1990-99), the high priority species in this group, long-tailed salamander, was observed in only eight survey blocks statewide. Two of these were in this Basin in southern Sullivan and northern Orange counties. Stream restoration techniques for this species within this Basin should focus on these areas.

- 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.

Population Restoration

- Freshwater wetland amphibians – employ restoration techniques for the Northern cricket frog at selected sites as needed, including captive breeding and repatriation/relocation strategies.

- Game species of concern – Recent records of the New England cottontail are from only a small portion of its historic range. If significant areas of suitable or potentially suitable habitat are identified, reintroduction of the species may be possible to larger portions of its historic range.

- Karner blue butterfly - Where natural colonization will not suffice, reintroduce Karner blue to new habitat areas made in the Glacial Lake Albany Recovery Units.

- 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 to be sure that there is at least one water in the Mohawk sub-drainage with this species.

- Uncommon turtles of wetlands – employ restoration techniques for bog turtle and Blanding's turtle at selected sites as needed, including captive breeding, head starting, nest protection, and repatriation/relocation strategies.

- Woodland/grassland snakes - Employ restoration techniques for timber rattlesnakes at selected sites as needed including head starting and repatriation/relocation strategies.

Adaptive Management

The ability to measure the success or failure of conservation actions requires information feedback loops that allow managers to know if actions received the desired results and to adapt under changing circumstances. Adaptive management requires an effective evaluation program that will over time help to inform us if our collective conservation efforts are succeeding. Any evaluation strategy should be founded in the principles of conservation biology and include direct assessment of the species of interest and their habitats. We should also know if management actions have successfully addressed threats to SGCN and their habitats. A monitoring plan should be developed for the Upper Hudson Basin that utilizes measures calibrated to the region and that incorporates data collected under the SWG program and other programs within DEC and by conservation partners, where possible.

Regulatory and Legislative Recommendations

Most of the regulatory and legislative proposals below are suggested at the statewide level, however New York's home rule law gives local governments the opportunity 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, an issue of particular importance in large portions of this basin (e.g., Putnam, Orange, and Dutchess Counties in the south and Saratoga County in the north).

REGULATORY PROPOSALS RELATED TO THE PREVENTION OF HABITAT LOSS AND DEGRADATION INCLUDE:

- 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. 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 that will benefit from this action include freshwater wetland amphibians (i.e., northern cricket frog, Fowler's toad), uncommon turtles of wetlands (i.e., Blanding's, spotted, and bog turtles), vernal pool salamanders (i.e., Jefferson and blue-spotted salamanders), and pied-billed grebe, king rail, least bittern, and American bittern.

- Identify and protect known common loon nesting areas with focus on the Adirondacks. On most public lands, however, directing human traffic and use away from sensitive loon habitats by redirecting trails may be more effective than "advertising" the location of these areas with prohibitive signs.

- Provide regulatory review and comment on commercial, residential, and other development plans to ensure that any proposed actions would not be detrimental to occupied peregrine falcon habitat. Breeding bird atlas data indicate that the majority of peregrine falcon nesting activity occurs along the Hudson River corridor from Westchester County north through the Adirondack Park. Local and State agencies concerned with planning and development should be aware of this when considering development plans in this basin.

- Protect existing Karner blue butterfly sites and potential habitat areas through regulatory review of development projects in the Glacial Lake Albany Recovery Unit (Albany, Schenectady, Saratoga, and Warren counties).

- Implement the regulatory recommendations of the Regional Greenhouse Gas Initiative and Acid Deposition Reduction Program.

REGULATORY PROPOSALS RELATED TO HUMAN-WILDLIFE INTERACTIONS INCLUDE:

- Establish 150-meter buffer zones on either side of mainland common loon nests. Shoreline areas adjacent to known nursery sites should be protected, and 150-meter buffers established in order to reduce human disturbance near nest sites and nursery areas during the nesting and chick rearing period. Through State regulation or local ordinance, limit boat engine horsepower and establish speed limits on smaller breeding lakes or in designated areas of larger lakes.

- The best strategy for minimizing illegal collection of herpetofauna of conservation concern may be to designate them as protected species. Adopt into New York's Environmental Conservation Law provisions that designate the following as protected game species:

    - Freshwater Wetland Amphibians - four toed salamander, Fowler's toad
    - Lake/River Reptiles - Eastern ribbonsnake, Northern map turtle, spiny softshell
    - Stream Salamanders - long-tailed salamander, Northern red salamander
    - Uncommon Turtles of Wetlands - Blanding's turtle, Spotted turtle, Stinkpot
    - Vernal Pool Salamanders - blue spotted salamander, Jefferson salamander, marbled salamander
    - Woodland/Grassland Snakes - Black ratsnake, Eastern hognose snake, Northern black racer, Northern copperhead, Smooth greensnake, Timber rattlesnake, Worm snake

- Through State regulation or local ordinance protect riparian tiger beetles (*Cicindela ancocisconensis*) and their habitat by reducing or eliminating detrimental all-terrain vehicle (ATV) use on cobble bars where these species occur or could occur if such activity was prohibited (suitable, large river cobble bar habitat like that found in portions of the Hudson River and Esopus Creek).

REGULATORY PROPOSALS RELATED TO PROTECTION OF WATER QUALITY INCLUDE:

- Maintain water quality in marshes by minimizing the use of pesticides on public lands. This would prevent the reduction of insect populations and the contamination of wetlands. Species that would benefit from this action include freshwater wetland amphibians (i.e., northern cricket frog, Fowler's toad), freshwater marsh nesting birds (i.e., pied-billed grebe, king rail, least bittern, and American bittern), and odonates of bogs, fens, and ponds.

- Establish water use standards, applicable to both significant water withdrawals and reservoir operations, that explicitly protect in stream flows and thus benefit both water quality and SGCN, particularly mollusk (i.e., alewife floater, eastern pondmussel, elktoe, yellow lamp mussel), odonates of rivers/streams, and marine and freshwater fish (i.e., American eel). In stream flow protections should be designed to maintain the natural variability of stream flows to the greatest extent possible. A statewide commitment to

natural flow regimes will particularly benefit the Upper Hudson Basin, where rapid development is changing watershed hydrology and altering habitat quality for all of the SGCN that utilize aquatic habitats.

- 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 if 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:

    - Common sanddragon
    - Extra striped snaketail
    - Pygmy snaketail
    - Septima's clubtail

- The 2004 State Wildlife Grant will provide for status assessments for nine species of tiger beetles in New York State that will clarify the need for conservation actions in order to maintain these species. Nearly all of the species of concern are found in habitats that have been heavily affected by development or other deleterious factors. Recommendations for official state endangered, threatened, or special concern listing are an anticipated result of the statewide inventory.

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 and maps, web site design and delivery, development and dissemination of best management practices, and technical guidance for land managers.

Human Behavior That Directly Affects Wildlife

- To reduce the detrimental effects of human disturbance on SGCN, 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 SGCN conservation issues, including the effect of human disturbance. Post interpretive signs at public access points,. Produce and distribute informational brochures, posters, press releases and other educational materials. Provide educational programs to schools, lake associations and other groups.

- Provide technical guidance to state and private entities planning the siting and installation of tall structures (e.g., wind turbines, communications towers, and power lines) that are likely to adversely effect populations of migrating birds and bats. USFWS and others are currently investigating the effects of these types of structures on wildlife. Final guidelines developed by USFWS should be consulted when considering the placement and installation of wind towers, 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. This study currently focuses on western and central New York State, but when completed, could be expanded throughout the State. 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. Species of Greatest Conservation need that will benefit from this action include various migratory birds (early successional forest/shrubland birds, deciduous forest birds) and bats (tree bats, Indiana bat).

- Enhance public education to limit killing, collection/translocation, and the (illegal) sale of herpetofauna in the pet trade. High priority species include:
  - Box Turtle
  - Uncommon Turtles of Wetlands – Bog turtle, Blanding's turtle, Spotted turtle, Stinkpot

- Woodland/Grassland Snakes - black ratsnake, Eastern hognose snake, Northern black racer, Northern copperhead, smooth greensnake, timber rattlesnake, worm snake

❖ Public misconceptions about reptiles, particularly snakes, may drive the killing and/or collection of these animals. Develop an educational campaign about the ecological benefits of snakes in an effort to encourage the public to abandon misconceptions about the menace/threat of woodland/grassland snakes. This could take the form of fact sheets, web-based educational modules geared to both adults and children, and popular magazine articles (e.g., DEC's *Conservationist* magazine). High priority species include black ratsnake, Eastern hognose snake, Northern black racer, Northern copperhead, smooth greensnake, timber rattlesnake, and worm snake.

HABITAT LOSS AND FRAGMENTATION

❖ In an effort to reduce habitat loss, develop a series of geographic information system (GIS) based maps and guides that will help to provide the public with the knowledge to appreciate and understand species of greatest conservation need and their habitats. The 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 Upper Hudson Basin and the opportunities to observe and learn about them at 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.

❖ Municipalities of the Upper Hudson Basin require technical assistance and outreach if they are to successfully interpret and use state wildlife information. This assistance may come in the form of training programs, fact sheets, maps, workshops, field identification experience, short-courses, and access to information on model standards, ordinances, curricula, and other types of local programs. Public-private partnerships have been highly successful in implementing outreach and technical assistance to Hudson Valley municipalities. The first ever inter-municipal agreement focused on biodiversity conservation in New York State was recently approved by local governments in Westchester County. The DEC Hudson River Estuary Program's biodiversity outreach and technical assistance program should serve as a model for other regions of the state and be expanded and applied to the entire Upper Hudson Basin.

❖ A key component to conserving biodiversity in the Upper Hudson Basin is the sound management of natural resources on state-owned public lands. New York State owns a significant amount of land in the basin and has the authority to make land-use decisions that could potentially influence populations of SGCN present on these lands. These lands are especially important because they represent areas where management activities can be planned and implemented to meet regional conservation objectives. Maps, reports, and guides should be prepared to transfer information and guide

public land managers in preparing broad-based management plans that will consider all the biological resources of a land unit and its regional contribution to biodiversity conservation.

- Public misconceptions about agricultural practices may result in a homogenous agricultural landscape with relatively little structural and vegetative species diversity. It is important to educate the public about the benefits and need for early successional old field and forest management and restoration, including the development of multiple seral stages across an agricultural landscape. This educational program should focus on both public and private lands and include the benefits of these habitats to early successional forest/shrubland birds such as golden-winged warbler, blue-winged warbler, Canada warbler, whip-poor-will, and American woodcock.

- Forests in New York are now predominantly even-aged northern hardwoods. Public reluctance to practice forestry, coupled with the absence of natural disturbances, may result in a homogenous forested landscape with relatively little structural and vegetative species diversity. It is important to educate the public about the benefits and need for early and late successional forest management and restoration including the development of coarse woody debris, standing dead wood, structural variability, and multiple seral stages across the forested landscape. This educational program would focus on both public and private lands and include the benefits of this habitat to deciduous/mixed forest breeding birds, forest breeding raptors, vernal pool salamanders, odonates of rivers/streams, tree bats, Indiana bats, and odonates of small forest streams.

- 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.

- Rivers, streams, and associated wetland habitats can suffer significant modification and degradation due to altered watershed hydrology. Water use decision makers and managers should receive information and education regarding surface and ground water interactions and effects caused by hydrologic modification. Training that addresses the effects of altered hydrology on the structure, dynamics, connectivity, and quality of aquatic habitats will benefit lake/river reptiles, stream salamanders, odonates of rivers/streams, uncommon turtles of wetlands, riparian tiger beetles, and freshwater bivalves .

- Public agencies should make an effort to contact all landowners with threatened and endangered species on their property to alert them to the presence and legal protection of the site and how to co-exist with the species. Parties interested in the conservation of SGCN should help to develop a network of volunteers to "adopt" sites for management and/or assist in monitoring activities. Finally, State agencies and their private conservation partners should develop an outreach effort to municipalities to increase the effectiveness of project review in terms of protection and enhancement of sites and to further the overall recovery strategies for the species.

AGRICULTURAL AND SILVICULTURAL PRACTICES

- 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 (i.e., northern cricket frog, Fowler's toad), freshwater marsh nesting birds (i.e., pied-billed grebe, king rail, least bittern, and American bittern), and odonates of bogs, fens, and ponds.

- There are several SGCN that 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 traditional forestry practices on wildlife. This should be accomplished for the following high-priority species:

  - Deciduous/Mixed Forest Breeding Birds - cerulean warbler, red-headed woodpecker, worm-eating warbler
  - Forest Breeding Raptors - long-eared owl
  - Stream Salamanders - long-tailed salamander
  - Vernal Pool Salamanders - blue-spotted salamander, Jefferson=s salamander
  - Woodland Snakes - Eastern hognose snake, timber rattlesnake
  - Tree Bats - Eastern red bat, hoary bat, silver-haired 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.

Incentives-Disincentives Recommendations

An incentive program geared towards 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 USDA and NRCS, USFWS, DEC, and various conservation programs administered by non-governmental organizations (e.g., local land trusts, The Nature Conservancy, Ducks Unlimited, Inc.).

- Cooperate with NYS farmers and grassland owners to establish the best possible nesting and foraging opportunities for grassland birds (i.e., northern harrier, sedge wren, upland sandpiper) and barn owls. Incentives focusing on grassland bird habitat should be directed toward protecting existing grasslands or restoring grassland habitats within relatively close proximity to existing grasslands to avoid creating sink habitats.

- Enroll partners in Karner blue butterfly management within the Glacial Lake Albany Recovery Unit via the Landowner Incentive Program.

- Where appropriate, assist private entities to protect and manage land for moth protection and conservation, particularly coastal barrens buckmoth.

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.

Baker, J.E., W.F. Bohlen, R. Bopp, B. Brownawell, T.K. Collier, K.J. Farley, W.R. Geyer, and R. Nairn. 2001. PCBs in the upper Hudson River: the science behind the dredging controversy. Hudson River Foundation. New York. 45 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.

Hudson River Estuary Program. 2002. Hudson River Estuary Action Plan 2001. Hudson River Estuary Program. New Paltz, NY. 194 pp.

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

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

National Research Council. 2001. A risk-management strategy for PCB-contaminated sediments. National Academy Press. Washington, D.C. 432 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/

Penhollow, M.E., P. G. Jensen, and L.A. Zucker. 2002. Wildlife and habitat conservation framework: An approach for conserving biodiversity in the Hudson River Estuary corridor. New York Cooperative Fish and Wildlife Research Unit, Cornell University and New York State Department of Environmental Conservation, Hudson River Estuary Program, Ithaca, NY.

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 DEC. BioDiversity Research Institute, Falmouth, ME. 13 pp.

Smith, C.R., S.D. DeGloria, M.E. Richmond, S.K. Gregory, M. Laba, S.D. Smith, J.L. Braden, W.P. Brown, E.A. Hill. 2001. An Application of Gap Analysis Procedures to Facilitate Planning for Biodiversity Conservation in the Hudson River Valley, Final Report, Part 1: Gap Analysis of the Hudson River Valley and Part 2: Atlas of Predicted Ranges for Terrestrial Vertebrates in the Hudson River Valley. New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

Smith, S.D., W.A. Brown, C.R. Smith, and M.E. Richmond. 2004. Habitat Vulnerability Assessment for the Hudson River Valley. New York Cooperative Fish and Wildlife Research Unit, Department of Natural Resources, Cornell University, Ithaca, NY.

Stager, J.C. and M.R. Martin. 2002. Global climate change and the Adirondacks. Adirondack Journal of Environmental Studies. 9 (1): 6-13.

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.

Strayer, D.L., J. Powell, P. Ambrose, L.C. Smith, M.L. Pace, and D.T. Fischer. 1996. Arrival, spread, and early dynamics of a zebra mussel (Dreissena polymorpha) population in the Hudson River estuary. Canadian Journal of isheries and Aquatic Sciences 53: 1143-1149.

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. USEPA. Washington, DC. 17 pp.

Tables and Figures

Tables

Figures