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Anthropogenic Influences on Avian Life, Past and Present, Within the Adirondack Park

Melodee A. DeCoteau
Skidmore College

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by

Melodee A. DeCoteau

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Advisors: Kenneth Johnson, Sandra Welter

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ABSTRACT

In the northeastern corner of New York over the last 10,000 years, avian life developed a complex network of niches within the varied ecosystems produced by the retreat of the last glacier. When humans began to dominate the area, beginning around two hundred years ago, avian diversity was compromised. The past and present anthropogenic influences have increasingly intensified the stresses on avian life in the park. If avian diversity is to be preserved, human factions must work together to decrease that stress. The establishment of the Adirondack Park and hunting seasons as well as restrictions on pesticide use have directly and indirectly helped curtail complete destruction of Adirondack avian diversity. Future preservation of Adirondack avian life depends on a collaborative effort, locally and nationally, that will increase knowledge and appreciation for the special needs of all avian species and why it is important to retain optimum avian diversity.

INTRODUCTION

A forlorn "meow" emitted from a gray catbird camouflaged in leaves at the top of a tree, a white winged crossbill plucking at ripe red raspberries in an overgrown berry patch and a confused brown pelican blown by high winds out of its normal territory were random occurrences at different times and places that stirred my adolescent curiosity about birds. As I matured, my desire to spend time in diverse natural areas in hopes of seeing a new species grew. A positive identification of each new bird compelled me to read species descriptions. Field guide accounts created an expanding list of avian related questions and eventually an appreciation for the scope of avian research available to those willing to look for it.

I was a fortunate young bird enthusiast with diverse natural wildlife areas close by in which to pursue my early avian exploits; and every hike or picnic included bird watching. The trips were primarily in two areas in northeastern New York State. My first region of exploration was the northeastern fringe of the Adirondack Mountains, the St. Lawrence River Valley, where farmland, secondary woods and deciduous forests with varied streams and rivers host a multitude of birds to identify. The second region was mountain trails within the interior of the Adirondack Park, where peaks and valleys, swamps, ponds and forests host their own array of avian splendor. These diverse ecosystems offered equally diverse avifauna, which was reflected by my growing list of identified avian species. Indications of problems associated with the environments of many of the native birds I had identified could be found in local papers, popular avian literature, and finally research journals. My explorative research developed into genuine concern about the environmental issues that face the birds that live permanently and seasonally in the six-million acre Adirondack Park of New York State.

Anthropogenic influences have shaped many of the past and present problems facing avian species in this park that encompasses most of northern New York State. The logging practices of the late 1800s and early 1900s left mature forests in vast ruins. Pervasive clear cutting removed the delicate, old forest environment that many bird species required for food and habitat. Pristine waterways were diverted or dammed by man to provide water for increasingly large stocks of domestic animals and large mono-crop fields. The major river diversions supplied water routes to move logs from where they were cut to mills and markets. These disruptions drastically altered the environment, and avian habitat became extremely unpredictable. Species depending on aquatic sustenance and nesting areas suffered directly because of the anthropogenic influence on rivers. In the mid-twentieth century, new roadways broke into the remote territorial habitats of ground dwelling bird species, which increased trapping and hunting and decreased game bird populations. The combined problems substantially increased the risks and stresses facing the complete spectrum of bird populations that made up the avifauna within the ecosystems of that time.

By the end of the second world war, concealed threats silently began taking their toll on songbirds and raptors. Populations of both avian families were nearly decimated before the devastating toxins associated with pesticides were known to adversely affect birds. Increased awareness about toxins in the last few decades has resulted in laws regulating pesticide use. Improved local environmental conditions subsequently improved the health of previously compromised bird populations; however, there are still a host of man-made chemical threats facing native and migratory species throughout the park.

The most current researched and documented environmental dilemmas include acid rain and global warming. These problems need to be carefully studied and judiciously managed if the Adirondack Park's future is to again involve the diverse avian populace it once hosted. The inappropriate application of fertilizers is another environmental concern. Residents should be educated about the proper application of fertilizers in order to minimize the harmful affects of aquatic eutrophication and soil degradation. If this is not done, the food webs birds rely on will continue to be compromised.

A range of other concerns compound the negative environmental affects on the avifauna in the Adirondacks. Alien invasions of species covering the complete spectrum of biota play a role in all aspects of avian existence from habitat destruction to disease. There is evidence that nesting and feeding habitat is being disrupted by the irresponsible use of motorized personal vehicles. Finally, land development by humans is always a factor when considering the habitat needs of avian wildlife. The Adirondack Park Agency creates and enforces land use restriction laws designed to decrease natural habitat destruction brought about by human development. Their enforcement indirectly secures avian habitat.

Old and new problems must be merged into a single focus of issues addressed by Park officials, private organizations, and resident citizens. If progress is to be realized, the vast amount of research indicating the validity of the above mentioned problems must be shared and discussed among all of the human factions that affect the Park's health. The future success of Adirondack avifauna will depend heavily on the curtailment of acid rain, monitoring of global warming trends, continued reduction in use of toxic chemicals and eutrophocating fertilizers, creation of a diverse habitat management system understood and approved by Park citizens, and finally the increased public awareness and concern for the welfare of resident and migratory birds.

BACKGROUND

Park History

> ***I felt I was entering a different world. It was a land of very high skies of orange sunsets and menacing thunderstorms. A place that was strange and liberating. Yet, a place where one was perfectly at home. I felt I was visiting a foreign country, but a foreign country to which I belonged.*** **(Edmond Wilson, 1931)**

The Adirondack Mountains are claimed by many to be among the oldest in the world. The highest of the thousand peaks is Mount Marcy at 5344 ft (White, 1954). The elevation of these mountains might not visually suggest "old" but geologically they are, for the present day peaks are actually the eroded tops of what eons ago were much higher summits. The bedrock is composed of igneous (created from molten lava) and metamorphic (altered sedimentary and igneous) rocks. It includes gneiss, marble, quartzite and anorthosite dated as old as 1.1 billion years (Brown, 1985). Today these rock types are evident in the cliffs, outcrops, and peaks of the mountains.

The last ice age, which began approximately one million years ago, shaped most of the mountains and valleys into modern day vistas. The last glacier from that ice age, over ten-thousand years ago scoured the mountains of their soils, leaving bare rock faces and erratic deposits of rocks and soils. Glacial melt water trapped between the ridges and valleys formed the estimated twenty-three hundred lakes and large ponds still present (Brown, 1985). Most of the lentic systems empty into moving waterways, which eventually end up in one of thirty major rivers. The rivers complete their journey in one of five drainage basins, the St.

Lawrence River, Hudson River, Mohawk River, Black River, and Lake Champlain (Brown, 1985).

The incredible forces from the movement of the advancing and retreating ice shaped the North Country's terrestrial environment. Soil was pushed and shoved away from its original location by the ebb and flow of retreating ice. The result was unevenly distributed deposits of rock, clay and sand. For the most part this created soils that were nutrient poor and unstable. Flora and fauna growing on them could easily be disturbed and quickly destroyed by exposure to harsh climatic conditions (Brown, 1985). Nonetheless, once the ice made its final retreat, plants quickly re-occupied the mountains. Forests eventually grew on the delicate soils, and approximately thirty tree species established dominance. Species that could thrive in the northern ecosystem were largest in population and geographic extent. These species included red spruce, yellow birch, beech, hemlock, sugar maple and white pine. The numbers of each of these species may be different in modern Adirondack forests but the same thirty still dominate (Brown, 1985).

The migration of plants from south to north provided new territory, food and shelter for the insects, reptiles, amphibians, mammals and birds of the time. For approximately nine thousand years Adirondack plants and animals lived and died according to the cycles of unpredictable, inherently harsh northern weather conditions.

There is not much evidence of established human colonies within the mountainous area that was to become the Adirondack Park, but some native people of North America did pass through. The Iroquois and their rivals, the Algonquin, were the first recorded human occupants in the history of the Adirondacks. They used the region for seasonal hunting and fishing, but the nearby flatlands surrounding the mountains provided conditions much more suitable for settlements. Historical accounts depict these first groups of people in the Adirondacks as warlike. When different tribes met in the summer hunting grounds, violence often ensued (White, 1954). This pre-civilized, hostile human interaction was the beginning of a trend that, to a certain degree, has constantly plagued human populations in the Adirondacks.

In 1536, Jacques Cartier, on a hilltop in Montreal, was the first European explorer to record a vision of the Adirondacks, which lay south of the shores of his aquatic route, the St. Lawrence River. Seventy-three years later, in 1609, two other explorers came much closer and even ventured into the mountain range. Samuel D. Champlain entered the area from Canada, the same route traversed by Cartier. Henry Hudson entered the interior of New York via what was to be known as the Hudson River (White, 1954).

For the next two centuries, there were various groups of people in the northern part of New York. The French and Indian War in the 1750s, the Revolutionary War, and the War of 1812 began the immigration of settlers that would establish some of today's human populations. The government encouraged soldiers to stay in the northern part of New York by granting them land close to where they had fought in the wars along the Hudson River and Lake Champlain (White, 1954).

In addition to the deactivated soldiers, there were wandering hunters, trappers and prospectors. Prospectors sought riches from the veins of iron, talc, garnet and other minerals discovered in the mountains (Hyde, 1974). Settlers from Vermont and Canada attempted to carve homesteads out of the thick forests growing on rocky sloped landscapes. Others continued the explorations of their predecessors. Ebenezer Emmons, a notable geologist, named the mountain range, "The Adirondack Mountains" in 1837 (White, 1954). Eventually, tourism took hold drawing city dwellers into the untamed forests. Vacationers were shown the best places to hunt, fish and relax by expert Adirondack guides (Brumley, 1994). The expertise provided by these woodsmen and the seasonal flow of people using their services played a very important role in shaping the future of the Adirondacks. Today many local economies rely on the tourist industry that developed from that era.

Although the land was being "opened" for human use during this time, land ownership was an unreliable investment. Adirondack land often exchanged hands according to those who were giving up on the mountain life and those who were naive about the lonely, poor, hard existence facing them there. The result was a rapid succession of land ownership. Land quickly moved between state and private citizens, and between private citizens and speculators. Many new land owners failed in their attempts to reap profit or even basic necessities from the harsh terrain, and consequently, the land ended up back in the hands of the state (White, 1954). The rapid exchange of ownership, in effect, camouflaged environmentally devastating practices; in only a few decades entire forests disappeared, vital waterways were altered, and once abundant game and fur animals became scarce. The destruction did not go unnoticed. Those who had the privilege of previously visiting the area and who had appreciated its great wildness were beginning to feel despair. The once wild, majestic forests were being depleted at an alarming rate (White, 1954).

By the late 1800s, politicians and conservationists who enjoyed vacationing in the Adirondacks actively campaigned to stop the destruction they were witnessing. In 1883, the state acted to preserve the mountains by no longer selling land to the public (Brown, 1985; Fosburgh, 1959; White, 1954). Two years later, in 1885, the Forest Preserve of New York State was created. The Adirondack region became an established park in 1892, with land use restrictions within the boundaries enclosing all the land owned by the state as well as all of the private land within those borders. This stirred public controversy. Private landowners felt their land rights were violated by the new restrictions on their own land use (Fosburgh,1959). Controversy developed between private citizens and politicians, spurred by the activities of conservationists calling for increased restrictions on all park lands. In addition, the imprecise wording of the 1884 Forest Preserve Act created concern. The original law was not specific enough to stop private timber companies from cutting on the Preserve, so in 1894, two years after the Park's formation, Article XIV of the New York State Constitution was amended.

> ***"The lands of the state, now owned or hereafter acquired, constituting the forest preserve as now fixed by law, shall be forever kept as wild forest lands. They shall not be leased, sold or exchanged, or be taken by any corporation, public or private, nor shall the timber thereon be sold, removed or destroyed."***

The century following the Parks' formation has been tumultuous. Private landowners have struggled to regain unrestricted land use of their properties, but face increasing numbers of conservationists and environmentalists who oppose them (Fosburgh, 1959). It is impossible to speculate what condition the environment would be in if the private owners (who own 60% of the park lands) had exerted enough pressure to win their case against land restrictions. It is reasonable to think that the Forest Preserve Act and the formation of the Adirondack Park helped the Adirondack ecosystem return from the brink of destruction and rebuild viable communities of native plant and animal species. Currently, various educational efforts and a greater attitude of compromise between involved groups have diminished the conflicts regarding what should or should not be allowed within the borders of the park. This has led to an optimistic outlook for an enlightened, evolving form of park management that can accommodate both residents and environmental advocates and permit a sustainable ecosystem for Adirondack wildlife.

CHAPTER 1

PAST AVIAN ISSUES

> ***In my hand I held the most remarkable of all living things, a creature of astounding abilities that elude our understanding, of extraordinary, even bizarre senses, of stamina and endurance far surpassing anything else in the animal world. Yet, my captive measured a mere five inches in length and weighed less than half an ounce, about the weight of a fifty-cent piece. I held that truly awesome enigma, a bird.*** **(Fisher, 1979. See Gill, 1995)**

Theodore Roosevelt was a sickly teenager in the 1870s. Many people believed the Adirondack air had healing qualities, so young Roosevelt spent a few summers wandering the lakesides and mountains near Paul Smiths, a fashionable resort area of that time. He spent part of his time cataloging the birds he identified. In 1877, when Roosevelt was nineteen, his observations were published as a four-page pamphlet, *The Summer Birds of the Adirondacks in Franklin County, NY.* He was among the first to raise public interest about avian life in the northeastern mountains (White, 1954). The pamphlet included birds common throughout the Park (**Table 1**).

Table 1. Roosevelt's List of Summer Birds in Franklin County, New York.

Eastern Bluebird	**Ruby-throated Hummingbird**	**Blue Jay**
Common Loon	**Black-capped Chickadee**	**Barred Owl**
American Crow	**American Robin**	**Wood Duck**
Bald Eagle	**Song Sparrow**	**Downy Woodpecker**
Purple Finch	**Winter Wren**	**Red-tailed Hawk**

(adapted from- http://www.trthegreatnewyorker.com)

This list did not represent the complete diversity of Adirondack avifauna. There are one-hundred and fifty known varieties of breeding birds and two hundred and sixty-one observed species within the boundaries of the park (Beehler, 1978). Some species that need very distinct environments can be found only in isolated areas. Other species, like those Roosevelt recorded, are commonly found because their habitat requirements are less specific. While Roosevelt's list was incomplete, it provided visiting and resident birdwatchers an identification list to match and try to improve upon.

Bird enthusiasts, from the 1870s or today, can appreciate the pamphlet published by Roosevelt. His publication was during an era when North America was witnessing major disruptions in avian populations. One most notable disruption led to the extinction of a species. In 1857, a committee addressed concern over the dwindling number of passenger pigeons. They concluded the bird needed no protection from human influences because nothing could destroy the huge passenger pigeon populations, not even human hunters who were killing them in mass numbers for food markets. Forty-three years later, in 1900, the wild passenger pigeon was extinct, with the last captive pigeon dying fourteen years later (Askins, 2000).

The huge colonies of passenger pigeons that were common before the middle 1800s were not only excessively hunted for their meat, they were, at the same time, losing their habitat as well. The pigeons relied on eastern deciduous forests for acorns and beechnuts. These trees were being harvested as carelessly as were the birds that depended on the nuts. The birds did not adapt quickly enough to compensate for the loss of food, nor the loss of protection that their huge flocks had previously afforded them (Askins, 2000; Ehrlich, 1988). Negative human influence had in half a century directly caused the extinction of what some biologists claim to have been the largest populations of birds anywhere in the world at that time.

As passenger pigeon numbers rapidly declined, hunters and profit mongers were also decimating other avian populations for the adornment of fashionable hats. In 1886, Frank Chapman, a biologist living in New York City, counted seven hundred hats as he walked along the city's streets. Five hundred forty-two of the hats he counted were adorned with feathers and even whole birds (Ehrlich, 1988; Gill, 1995). The feathers he observed on his walk were not taken exclusively from exotic bird species. Chapman identified forty local bird species by their feather coloration or by their stuffed bodies. Inanimate woodpeckers, sparrows and warblers had been lavishly arranged on stylish women's hats (Ehrlich, 1988; Gill, 1995).

The remoteness of the Adirondack lands and their rough terrain probably provided some protection from the cities' destructive fashion whims. If, however, steps had not been taken to curtail the practice of killing birds for their desirable feathers, hunters would have surely ventured into the rough North Country terrain when supplies became short elsewhere. Luckily, some citizens who were sensitive to the situation were beginning to organize into groups. These groups were ready to rally against inhumane practices that jeopardized avian populations[1]. Eventually, laws were established to protect birds in New York and other states. In 1877, Florida passed a plume-bird law prohibiting wanton destruction of eggs and young (Gill, 1995). The wording of the law was less than precise, which could account for feathered creations that Chapman saw nine years later on the streets of Manhattan. Florida's plume-bird law was a starting point for the protection of avifauna against fashion-driven feather harvesting. Even earlier, in 1846, a Rhode Island law prohibited the springtime shooting of wood ducks, black ducks, woodcocks and snipes, all common species within the Park's ecosystems (Gill, 1995). Both of these

[1] The American Ornithological Union, established in 1883, developed a model law that all states would soon adopt.

laws showed concern for the future survival of these bird species that humans had compromised by mismanagement or careless disregard.

Some of the laws enacted were too late to have a positive effect on specific bird populations. In 1869, ten years after it was deemed unnecessary to protect the passenger pigeon, hunting regulations were established. The law stated that no shot was to be fired within a mile of pigeon roosting sites (Gill, 1995). The vague wording of the regulations gave pigeon hunters opportunities to circumvent the intended limitations. The passenger pigeon's extinction is testament to the hunters' determination. One of the oldest avian protection laws in New York's history, enacted in 1706, created a closed hunting season for grouse and turkey (Gill, 1995). Managing viable populations of these valuable food sources by limiting the hunting season only, could not have been effective because other critical environmental upheavals challenged the bird's existence.

Habitat destruction was not addressed in the early avian protection laws. By 1850, the Adirondacks were providing the country with 1.6 billion board feet of pine timber per year, a fifth of this country's entire production (Brown, 1985). So although the game birds of the North Country were now allotted time to breed and raise young without being pursued by hunters, the great white pines, which dominated their breeding grounds, were becoming rare due to systematic over-harvesting. At the same time, the pulp mill industry developed a method for using wood (instead of rags) to produce paper products. The state of New York alone supplied one third of the country's paper pulp. Of the seventy-five mills in the state, sixty-four were supplied entirely with Adirondack timber (Brown, 1985). Unlike previous timber harvesters, pulp mill companies were not as particular about the size or type of tree used in their paper production. Great spans of the northern deciduous forests were extensively harvested until the formation of the Adirondack Park (1892) curtailed the exhaustive timber harvesting.

The once majestic stands of white pines, followed by the more diverse deciduous forests, had been decimated by 1900, and two-thirds of all New York state's forests were gone (Brown, 1985). The century-long process of deforestation without regard for delicate ecosystems had so drastically altered the environment, it was no longer suitable for the birds that once lived there.

Wild turkey populations were common before the 1800s, but after that time they could no longer be found in the areas of the park that had been its domain for centuries before. They fed on the nuts, berries and grains, which were prevalent in the deciduous and coniferous forests of the Adirondack mountains. Once the forest habitat had diminished, their food supply was gone. They also faced introduced diseases. Settlers brought with them exotic fowl that possessed inherited diseases to which endemic fowl species had no resistance at all. The plight of the wild turkey was typical. The loss of habitat drove them to smaller and smaller pockets of suitable forage where the nearby exotic fowl spread exposure of diseases the turkeys could not survive. The result was fewer turkeys in isolated pockets of habitat. Consequently, the last turkey seen in or near the Adirondack Park was recorded in 1844.

Although wild turkey had been extirpated from the Adirondacks because of careless logging practices, the Park slowly regained forest cover. The improving habitat supported the turkey's gradual migration back into the area from the southeast. New York state conservationists aided the reestablishment of turkeys by reintroducing supplemental populations. Decades after their extirpation, healthy populations of turkeys are again found within the Adirondack mountains (ESF, website).

The spruce grouse shared a similar decrease in numbers during the same period. They did not disappear from the northeastern environment entirely but their numbers are dangerously small today. Currently they are on the New York state endangered species list (DEC, 2002). Habitat loss and increased hunting decreased the spruce grouse populations of the 1800s drastically. These concerns were compounded by interspecific competition with the ruffed grouse (DEC, 2002). The loss of traditional habitats meant having to share pockets of suitable land with other bird species with similar requirements. The spruce grouse is a specialized bird that for sustenance, requires coniferous forests, consisting of spruce, fir and jackpine buds and needles (Ehrlich, 1988). Isolated pockets of suitable forest helped the species survive, barely. The megapopulations of spruce grouse were estimated to have been reduced to approximately two hundred and fifty birds in the mid 1970s. The Department of Conservation (DEC) in New York state formed The Spruce Grouse Recovery Team in 1992 to ensure future success of a viable breeding spruce grouse population (DEC, 2002, website). Today known populations are monitored to ensure the best possible outcome for future populations of this reclusive grouse (Brown, 2002).

The extreme over-harvesting of the northern forests did not affect just game birds. Most indigenous bird species faced similar reductions because of habitat loss.

Migrant and resident songbirds lost their traditional breeding grounds. Birds of prey lost their secluded nesting sites. Ground-dwelling birds lost large areas of old growth canopy trees that had provided them with protection. Migrant water fowl and wading birds slowly lost their traditional nesting sites due to human modification of lakes, ponds, streams and rivers. They also faced a new competitor for food. Humans were over-harvesting fish, just as they over-harvested the forests (Brown, 1985).

Since *every* species of bird has a limit to the sustainable population densities in a given area, the numbers of each species had to change to suit the available habitat (Newton, 1998). Population decline was inevitable. In the 1890s, only eighteen percent of the state's land was considered forested, a drastic reduction from the historical data that described virgin forests covering virtually the whole state (Brown, 1985). Deforestation figures mandate a drastic reduction in the numbers of birds that could be sustained in the compromised Adirondack environment of the late nineteenth and early twentieth centuries.

A disturbing component of the problems native bird species faced in the 1800s was the introduction of exotic species. A most notable example was the house sparrow. In 1850, eight pairs were imported from England to New York City (Laylock, 1966). The sparrow was imported for insect control by European settlers who missed seeing a bird common to their homeland. House sparrows are not very particular about their food source or where their nesting materials come from. They very effectively exploited many aspects of human environments and thrived while native birds were diminishing in numbers, losing their specialized habitats to humans and the now established house sparrow.

The European starling was successfully introduced a few decades after the house sparrow, by Eugene Scheifflin, a drug manufacturer from New York, who was determined to successively introduce these insectivores to North America. Scheifflin had two hobbies, birds and Shakespeare. His supreme goal was to introduce into this country, all of the birds Shakespeare had mentioned in his writings. The starling was one of those bird species. In 1900, his imported starlings began successfully breeding and expanding their territory (Laycock, 1966). The population expansion was dramatically rapid and quickly encompassed more territory than anyone could have imagined. The Adirondack Park became part of their transcontinental migration. Starlings are considered a pest by agriculturists and homeowners alike. They are destructive in their pursuits to feed on insects, reside in groups, which make them noisy in quiet environments, and aggressive in peaceful surroundings. Compromised Adirondack habitat was altered even more by the starling's glaring presence.

There is no doubt that the efforts of individuals like Roosevelt and organizations dedicated to the preservation of native birds did favorably alter the uncertain future facing many species during the environmental upheavals of the 1800s. Their efforts did directly affect avian awareness and preservation, but the largest factor securing the avifauna diversity in the Adirondacks came from the indirect human intervention created by the establishment of the Adirondack Park. The Adirondack Park was originally established primarily for watershed protection, not for the preservation of avifauna. Forest destruction precipitated erosion of soils'; erosion of soils' meant diminished watersheds, and shrinking watersheds produced compromised water supplies for urban areas. People who understood the cause and effect of soil erosion were concerned with securing a healthy water supply for future generations of New Yorkers and urged lawmakers to preserve the mountains that ultimately provided their fresh water supply. Watershed protection came at a crucial time for the beleaguered Adirondack avian life. Without the indirect benefit of the park's formation, avian life would not have fared as well as it has.

CHAPTER 2

RECENT AVIAN ISSUES

Chemical:

Avian life in the Adirondack Park, and throughout the world, faced an ominous future when Paul Mueller, a German chemist, synthesized the new compound dichloro-diphenol-trichloro-ethane, commonly referred to as DDT (Carson, 1962). The compound was developed in 1873, and by 1939, its power as an insecticide was hailed worldwide as a miracle able to destroy insect vectors of such diseases as malaria, yellow fever, and typhus. DDT's insecticide qualities were credited with saving millions of human lives, and Mueller was awarded the Noble Peace prize for his invention (Harte, 1991).

DDT is chemically classified as an organochlorine. This group of chemicals affects the nervous systems of mammals and insects. Organisms that have been exposed to an organochlorine, such as DDT, have a delayed reaction to its toxic effects. Symptoms occur a few hours after exposure. They can include numbness of the face, fatigue, headaches, tremors and convulsions. Victims develop a sense of confusion, excessive irritability and fear with delayed vomiting. Neural disruptions can cause death due to heart and respiratory failure (Harte, 1991).

These obvious and frightening symptoms did not appear in the humans that had early contact with the DDT, so it was presumed harmless to humans while lethal to insects. However, it can be produced in different forms, and the earliest form produced and tested was a powder that did not easily penetrate human skin. Low absorption of the powder form of DDT was the likely reason humans did not seem affected (Carson, 1962). Freely used anywhere parasites, pathogens and pests prevailed, toxic concentrations slowly created sediment layers in the environment.

A truly sinister aspect of DDT slowly worked its way through aquatic and terrestrial food chains[2] wherever application had occurred. Humans were relatively unaffected by the poison directly, but un-refutable evidence was building that suggested DDT was creating havoc, indirectly, in all the living organisms that came in contact with it. Specifically, by the late 1930s, healthy populations of pre-DDT birds were suffering mass die-offs, post-DDT (*see* Carson, Gill, Ehrlich, Harte). One well-documented example involves the devastating outbreak of Dutch Elm Disease (DED) in the United States. DED occurs when a destructive fungus is transported, by elm bark beetles, into the interior sap channels of an Elm tree (Carson, 1962). In the 1930s, the modern solution for saving the stately tree was to spray lethal doses of DDT directly on the affected trees.

Mr. Mehner, a doctoral student at Michigan State University, was studying American robin populations that nested on campus grounds at the time the college was spraying its elm trees. He noticed something was drastically wrong with the robins that had returned to their nesting grounds after winter migration (Carson,

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[2] Food Chain (Definition) a scheme of prey/predator relationships from the lowest to highest organism. Example- microscopic plants→snail→fish→bird

1962). The DDT spraying began in the fall, but the birds escaped this application by flying south as they normally did and then returning with warmer spring weather. Normal springtime robin behaviors stopped there. The robins that settled on the campus grounds began their routine activities, but before they had established nesting territories, they had convulsions and died. Those that survived long enough did attempt building nests but were unsuccessful. Each group of robins that died was replaced with a new group attempting to utilize the vacated territories. They also met their death in the same manner their predecessors had (Carson, 1962).

The unexplained deaths of the robins became Mr. Mehner's doctoral research project. His studies on the campus's bird fatalities established a link between the DDT spraying in the fall and death of the robins in the spring. Earthworms, the robins food source, proved to be that link. DDT was applied in large amounts to all of the affected elm trees, with excess chemicals leaching into the soil to become part of the earthworm diet. Concentrated insecticide formed deposits in the earthworms internal organs. Hungry robins, depleted after a long migration, ingested numerous worms per hour. The DDT became bioconcentrated in their systems, quickly reaching lethal levels. Affected robins soon developed convulsions followed by inevitable death (Carson, 1964).

DDT was used against similar insect infestation in the Adirondack Mountains. The mountains did contain diseased elm trees, but attempts to control other insect pests, like the spruce budworm, the larch sawfly and the gypsy moth, broadened the spectrum of pesticides routinely used against pest populations (Brown, 1985). Black flies and mosquitoes were also targets for the era's prevalent applications of chemicals. In the 1960s, it was common to rid a house of flies by using a hand-pumped spray applicator, leaving a fine residue on everything the misty spray landed on. On a grander scale, low flying planes dispersed oily clouds (the oil allowed easier penetration of an exterior surface) over infested crop fields. Unfortunately, many of the targeted insects soon showed resistance to the toxic sprays continually used on them. That meant a continuation of the diseases the insects carried and a growing supply of remnant chemicals entering food chains (Harte,1991).

It was evident that while populations of targeted insects were quickly rebounding from DDT exposure, the North Country's birds were not. Insect-eating songbirds, grassland-nesting birds and birds of prey were all having serious reproductive problems. By the mid-1960s, they were quickly disappearing from terrestrial and aquatic ecosystems (Carson, 1962; Wiemeyer, 1993; Bartuszevige, 2002). Insectivorous birds had plenty of food available now, but it was laden with toxins. Destructive chemicals slowly concentrated in their body tissues. Those that did not die from direct contact with the poisons were subsequently unsuccessful in their nesting attempts, the outcome of bioconcentrated toxins resulting from their dietary intake.

Birds of prey, in particular, were significantly affected by the use of pesticides in the first half of the twentieth century. Eagles, ospreys, and others require larger food sources like fish and small mammals, and these food sources already had accumulated deposits of toxins in their tissues. Bioconconcentrated levels of pesticides were inevitable in birds higher on the food chain, and it quickly affected their fecundity. Reproduction efforts failed because this unnatural chemical buildup inhibited the birds' ability to absorb calcium, so their eggs lacked thick enough shells to survive the incubation period (Gill, 1990).

Bald eagles and ospreys, which have traditionally had healthy populations in the Adirondack Mountains, suffered huge losses during the era of rampant DDT use. Their rapid decline is explained by examining the time required for offspring to reach adult breeding status. Raptors rear very few offspring per year: eagles, one or two, and ospreys, three to four. Those that successfully fledge require years (eagles-five, ospreys-three) to mature. The slow turnover of breeding adults meant a rapid decrease in population sizes because fewer and fewer breeding pairs were successful in rearing offspring (DEC, 2000).

The research on the campus of Michigan State University, and other similar studies, launched two new extremely important areas of scientific research: ***bioconcentration,*** as explained above, and ***indicator species***. An indicator species is a living organism that acts as a predictor of an environment's health. Indicator species demonstrate just how important it is to understand the interconnectedness of all living organisms in an ecosystem. The Adirondack bird-of-prey populations are a note-worthy example. DDT was initially deemed harmless to organisms other than the targeted victims, but problems facing untargeted organisms, such as the birds of prey, indicated a more complicated scenario.

New York State Department of Conservation (DEC) records, prior to1900, state there were nearly eighty active eagle nests in northern and western New York. By the 1950s and 60s, because of DDT, the bald eagle was extirpated from its New York habitat (DEC, 2002). Likewise, osprey nests numbered around one thousand in the 1940s, diminishing to approximately one hundred and fifty nests in 1969 (DEC, 2002). Seven hundred and fifty once-active osprey nest sites were gone in just two decades. The lost populations of both majestic species indicated a dire link between repeated applications of pesticides and lethal concentrated levels of the same toxins in untargeted organisms which occupy a higher niche in the same food chain.

The decline of Adirondack eagles and ospreys indicated an unhealthy environment. The bioconcentrated toxins were killing birds (along with other untargeted animals) and the noticeable decline in their numbers alarmed ornithologists, conservationists, policy makers, and residents of New York. Their concern, supported by scientific evidence, confirmed DDT was killing organisms far beyond the scope of targeted insects (MacLellan, 1962; Bartuszevige, 2001; Custer, 2002). Throughout the mid-1900s, negative public opinion and scientific research against the pesticide usage mounted. Eventually, the opposition to continued use of pesticides that had been solidly linked to the decline of wildlife prompted New York state to ban the use of DDT in 1971, a year before the rest of the country (DEC, 2002).

In 1976, New York state initiated a Bald Eagle Restoration Project in an attempt to reestablish northeastern populations. Eaglets collected in Alaska were "hacked" (hand reared until independent) and released on traditional eagle territories in northern New York. By 1989, there were ten pairs of eagles with nests. So the project objectives changed from transplanting alien eagles to monitoring the productivity of the newly established breeders (DEC, 2002). The osprey populations have likewise increased since the banning of DDT (**Table 2**). Both species were considered threatened by the federal government in the aftermath of DDT. They have now rebounded to healthy numbers within the Adirondack Park. The eagle has moved from being considered "endangered" to "threatened", a status mandating continued legal protection under provisions of Environmental Conservation Law (Brown, 1985). Osprey, now successful enough in reestablishing their north country populations, have moved from "endangered" (1976) to "of special concern" (1999)(Brown, 1985; DEC, 2002).

Table 2 – Eagle and Osprey Nest Numbers Pre, During and Post DDT in NYS

	Pre-DDT	During DDT	Post- DDT
American Bald Eagle	**80 plus nests**	**Extirpated**	**47 successful nests (2001)**
Osprey	No numbers available	**Eight birds/year**	**13 successful nests (1977)**

Adapted from DEC's Eagle Fact Sheet, 2002 and the Annual Report to Federation of NYS Bird Clubs & Facts about the Adirondack's, VIC website

Other issues facing the birds of the Adirondack Park during the early part of the 1900s were less directly associated with the resident humans. Severe drought throughout the winter and spring of 1903 created abnormally dry conditions in the Adirondack mountains. In April a fire erupted, burning six hundred thousand acres before it expired in June. Accounts of the fire speak tragically of the great camps burnt in the great wilderness, but wild animals seemed not to merit more than a brief mention (Duquette, 1989). However little attention they received, the fact remains that six hundred thousand charred acres meant extreme habitat loss for animals, including the birds.

In November of 1950, the northern woods were hit by another form of natural disaster, a major wind storm. As Pieter Fosburgh so aptly wrote in his book *The Natural Thing, the Land and It's Citizens*,

> ***"…'every now and then the weather winds up and lets go with a round house swing that makes all man's efforts to wreck his domain look very puny indeed, the trouble being that the resulting mess is in proportion to the power of the weather, and way out of proportion to man's power to clean it up." (Fosburgh,1959)***

The nearly one hundred-mile-per-hour winds came from the east and devastated pockets of forest that had grown strong root systems to withstand westerly winds. In one day, seventy percent of preserved forest and forty percent of less restricted areas of the park suffered deforestation. The storm left a vast tract of debris, a fire hazard that caused political debate about the forest management practices within the forest preserve. The outcome of those debates permitted the removal of fallen timber on "forever wild" land which went against Article XIV of the New York State Constitution. Regardless of the legality regarding tree removal in that situation, Adirondack bird populations, once again, lost 423,735 acres of prime habitat (Fosburgh, 1959).

Natural and unnatural upheavals have negatively affected bird life within the Adirondack Park throughout the last two hundred years. Windstorms and fires altered fragile ecosystems. Logging practices, chemical usage, hunting, trapping and habitat destruction have further compromised an environment that had taken since the last ice age to develop. Concerned citizens have done their part in trying to curb the disasters brought about by human influence. Yet, those concerned with preserving the environment and its native inhabitants have not been able to change the fact that avian life, upon entering the twenty-second century, still struggles to sustain populations with minimal habitat and compromised food sources.

CHAPTER 3
CURRENT AVIAN ISSUES

Man, the supreme meddler, has never been quite satisfied with the world as he found it, and as he has dabbled in rearranging it to his own design, he has frequently created surprising and frightening situations for himself. (George Laycock, The Alien Animals, 1966)

The heated debate over restrictions within the Adirondack Park's blue line between private citizens, conservationists, and environmentalists has resulted in the establishment of the Adirondack Park Agency(APA)[3]. This state organization is responsible for administrating the State of New York Adirondack Park State Land Master Plan (State of NY, 1972). The plan sets very specific guidelines for the use of state lands that are classified into nine basic categories (**Table 3**). These lands constitute forty percent of total land in the park. The remaining sixty percent is held by private citizens and companies. The APA also oversees land use and development on those private land holdings. Private land is classified according to land use patterns (**Table 4**). All development on state and private land must meet the requirements laid out for each classification. The system was created to specifically address land usage that in the past had been mismanaged. But there are still many private land owners that dispute the conditions forced on them by state government (Terrie, 1997; State of NY, 1972; Brown, 1985).

The conflicts that originate from contrasting opinions regarding the use of public and private lands in the park place avian life in a precarious position. Park residents that oppose the state's environmental efforts inadvertently curtail the success of current projects designed to reestablish natural habitats. To help balance the inequity caused by these human influences, organizations that value the contributions of local avifauna in the Park's natural habitats have worked to preserve and reestablish jeopardized species. Their efforts must continue with diligence to ensure a safe future for all avian species. As human society expands, avian issues become more deeply enmeshed in human dilemmas.

Table 3 - Nine Categories of State Land Within the Adirondack Park

Wilderness	1, 016,979 acres , 11,147 acres of water
Primitive	61,400 acres, 2,214 acres of water
Canoe	18,231 acres, 1,452 acres of water (in St. Regis , town of Santa Clara)
Wildforest	Areas are scattered no statistics given
Intensive Use	No Statistics. Includes campgrounds, Day Use areas, Boat Launches
Historic	Crown Point – 385 acres, John Brown's Farm – 65 acres
State Administrative	Properties held in 7 counties within park boundaries
Wild, Scenic and Recreational Rivers	Wild – 155.1 acres, Scenic – 511.3 acres, Recreational – 539.5 acres
Travel Corridors	Include Railroad Lines and Highways

Adapted from Adirondack Park State Land Master Plan – Adirondack Park Agency 1997

Table 4 – Private Land Use Classifications

Hamlet
Moderate Intensity
Low Intensity
Rural Use
Resource Management

Adapted from Adirondack Park Agency Act – Adirondack Park Agency 1991

Chemical:

Use of chemical insect controls did not stop when DDT was banned in 1972. A host of pesticides and other persistent chemicals were never banned. Pesticide use within the Adirondacks, for the control of mosquito and black fly populations, demonstrate the spectrum and toxicity of chemicals used today. It is important to

[3] The Adirondack Park Agency was established in 1971.

understand the potential harm to wildlife these individual and combined pesticides hold in our local ecosystems.

There are currently thirteen active ingredients in the pesticides registered for use on black flies and mosquitoes in New York State (Paul, 2000) (**Table 5**). The chemicals are used as either larvicides (used in water) or adulticides (used on land). Two bacteria, Bti (*Bacillus thuringiensis israelensis*) and *Bacillus sphaericus,* are biological controls and are classified among the thirteen active agents. Both bacteria produce spores containing crystals that mosquito and black fly larva can ingest but cannot digest, which effectively reduces their populations with little evidence of other living organisms being harmed. Three currently used chemicals are derived from chrysanthemums or synthetically produced to mimic them. Pyrethrins, Resmethrin (trade name Scrouge), Sumithrin and Permethrin are broad-spectrum adulticides that kill beyond their terrestrial targets and can be lethal to aquatic life, including fish. Evidence suggests that while they are toxic to fish, there is minimal threat to other animals, such as birds, because they break down into harmless components when metabolized (Paul, 2000; Harte, 1991).

A less common way to deal with insect pests in the North Country is to use a product that creates a thin film on the surface of a standing body of water. Monomolecular Surface Film (MSF) uses isostearyl alcohol to coat the surface of a body of water, making it impossible for developing mosquito larvae to breathe (Paul, 2000). Methoprene, a method of control used in New York state against biting insects disrupts the development of mosquito larva by causing hormonal imbalances, effectively diminishing the population because many do not develop into breeding adults (Paul, 2000).

Table 5 – 13 Pesticides Approved For Use in New York State

Active Ingredient	Target Insect/Stage	Chemical
Bti(*Bacillus thuringiensis israelensis*)	Mosquito & Black Fly/Larvae	Bacterium
Bacillus sphaericus	Mosquito/Larvae	Bacterium
Pyrethrin	Mosquito & Black Fly/Adult	Chrysanthemums
Resmethrin	Mosquito & Black Fly/Adult	Synthetic Pyrethrin
Sumithrin	Mosquito & Black Fly/Adult	Synthetic Pyrethrin
Permethrin	Mosquito & Black Fly/Adult	Synthetic Pyrethrin
Chlorpyrifos	Mosquito/Adult	Organophosphate
Temphos	Mosquito/Larvae	Organophosphate
Naled	Mosquito & Black Fly/Adult	Organophosphate
Malathion	Mosquito &Black Fly/Adult	Organophosphate
Methoxychlor	Mosquito/Adult	Organochlorine
Methoprene	Mosquito/Larvae	Hormone disrupter
MSF	Mosquito/Larvae	Isostearyl Alcohol

Adapted from Paul & Sinnott, 2000

Chlorpyrifos, Temphos, Naled and Malathion are organophosphates structurally similar to chlorinated hydrocarbons (DDT) and are very toxic to wildlife. Organophosphates are popular because, unlike the DDT class of chemicals, they degrade quickly after application. Organophosphates, when combined with other similar chemicals, metabolize into poisons potentially a hundred times more powerful than their original form (Carson, 1962; Beehler, 1978; Harte, 1991). To ensure the safety of resident wildlife, all pesticides require applications separated from any similar pesticide application. But how can it possibly be monitored? Insect and fish-eating birds generally have large forage ranges, and it is reasonable to conclude that exposure to multiple areas of pesticide use is inevitable.

Highly toxic organophosphates cause death to birds that have ingested the chemical or absorbed it through direct contact. A series of startling statistics indicates their use is too hazardous in any situation. In 1981, fifteen hundred geese and one hundred ducks were found dead at a lake in Etter, Texas where nearby wheat fields had been pesticide treated (ABC, 2002). In 1990, twenty purple martins died from organophosphate poisoning. In northern New York, in 1982, thirty-two hundred birds (including red-winged blackbird, common grackle, mourning dove, Cooper's hawk, red-tailed hawk, blue jay, eastern meadowlark and song sparrow) were found dead close to a field that had been planted with treated rye seeds (ABC, 2002). American robins and Canada geese have also been victims of lethal exposure by feeding on golf courses (ABC, 2002). This class of pesticides is too hazardous to use considering the numerous deaths attributed directly to application.

Methoxychlor, an organochlorine, is a broad-spectrum poison that kills more organisms than just mosquitoes and black flies. Like its relative chemicals, methoxychlor becomes part of the food chain insectivorous birds rely on. As with the organophosphates, metabolic processes alter the poison into something harmless, unless other similar chemicals are present. If that occurs, the resulting concentrated toxin becomes lethal (Carson, 1962; Beehler, 1978; Harte, 1991). This pesticide presents a greater risk because its ingredients remain active for approximately three weeks after application (Paul, 2000). While it does degrade after that time, those three weeks pose a potential threat to any bird feeding in the immediate area.

The spectrum of pesticides currently used in the Adirondacks indicate a conscious effort to preserve the integrity of existing wildlife, including birds. Many of the approved compounds have not shown any serious environmental implications, but some have. Scientific review has shown a direct correlation between application of organophosphates and organochlorines and the death of birds. These deaths indicate environmental hazards too great to ignore. This family of chemicals is directly responsible for killing untargeted animals and is unnecessary. Alternative pesticides are available. The conservation of Adirondack avifauna would have one less environmental stress if humans would opt for the less toxic pesticides available.

The remnants of polychlorinated biphenyls (PCBs), a group of chemicals used over the same period of time as DDT, must be considered as an avian issue today. In 1970, at its height in productivity, eighty-five million pounds were being produced annually (Harte,1991). This organochlorine compound, manufactured in forty to seventy different forms, was a useful product because of its low flammability. Its diverse compounds were used for insulating transformers and capacitors as well as in hydraulic fluids and lubricants used in heavy equipment. Some products intended for direct consumer sales, like plasticizers, inks and dyes, adhesives, pesticide preparations and protective wood coverings contained PCBs and were distributed world wide (Harte, 1991). Like the other organochlorines mentioned in this paper, PCB sediments eventually infiltrated food chains which bioconcentrated in top consumers.

PCBs were restricted in the 1970s, because they are persistent compounds with long-term potential for contamination anywhere deposits in sediments may be found. The Hudson River, Lake Champlain, and the St. Lawrence River systems border the Adirondack Park. All are contaminated with PCBs (Alcoa, 2001; Simonin, 1998). A dam removal in Fort Edwards demonstrated the serious problem that remains in the sediment layers of affected Adirondack aquatic systems. In 1971, the

Fort Edward Dam on the Hudson River was demolished because it was in structurally poor condition. The result was several tons of PCB-laden sediments being released to wash downstream (Cantwell, 2002). This northern section of the Hudson River is now considered the largest PCB contamination site in the United States, with over three hundred thousand pounds of PCB laden sediment, most of it concentrated in a forty mile stretch within Adirondack boundaries (Scenic Hudson, 2002). Concern over this contamination was a catalyst for research into the human health and economic implications of PCB exposure. The published data resulting from those concerns primarily center on human health hazards and contamination of the native fish and game (i.e. deer). Fish and game are economically important in the Adirondacks, as a food source and as a tourist draw. Understanding the level of their contamination was the priority that set into motion the massive cleanup efforts along three of the major watersheds in the Adirondacks (Cantwell, 2002). But what about the implications of PCB bioconcentration in less economically important creatures?

Resident and migrating local raptors, waterfowl, and wading birds rely on the above mentioned waters for sustenance. The mounting evidence indicating the toxicity of PCB accumulation led lawmakers to restrict human consumption of fish and game associated with the contaminated waters (Harte, 1991). Those same dangers exist for the avian communities in the Adirondacks. All piscorvores, including bald eagles, ospreys, great blue herons and common mergansers, are negatively impacted (sometimes devastated) by PCB contaminated waters (Barnett, 2000; Butler, 1992; DEC, 2000; Mallory, 1999). Avian insectivores are as well. Tree swallows (insectivores) nesting along contaminated areas of the Hudson River have shown abnormal nesting behavior that ultimately affects their reproductive success (McCarty,1999; Custer,TW, 2001). The abnormal nesting behaviors have been linked to disrupted endocrine systems as a direct effect of accumulated organochlorides (Harte, 1991). PCB-laden sediments must be considered a detriment to all birds that feed on contaminated organisms in these areas.

A heated debate exists over whether or not the PCB sediments should be dredged, covered by naturally accumulating sediments, or contained within manmade structures (Alcoa, 2001). If left in place, there is potential for a future contamination release similar to the Fort Edward Dam disaster. Complete sedimentation removal and processing is the only way the waters can be made safe from organochlorines. Until then, birds, like swallows and waterfowl, will suffer declining numbers in an already compromised habitat.

The seriousness of allowing contaminated sediments to remain unchecked is demonstrated in an occurrence at Lake Apopka, Florida (Youth, 2002). The area had been diked for agricultural purposes in the early 1900s. The land was farmed once it was dry enough, and the pests associated with the agricultural industry were controlled with DDT. After the ban on DDT, the pesticide was no longer used on the fields, but it was still present in the sediment layers because it did not biodegrade. Over eighty years later, a restoration project began that allowed water to reform the pre-1900 marshland. The crop fields reverted back to shallow wetlands designed to encourage the return of local and migratory water birds. The DDT that had been dormant in the terrestrial sediments became free-flowing particles in the newly reestablished aquatic system. The project designed to benefit dwindling numbers of marshland birds resulted in the mass death of approximately one hundred and seventy species of birds with an estimate of forty thousand bird deaths in a single day (Youth, 2002). DDT is a still a threat. Fourth Lake is the only lake within the Adirondacks known to contain DDT- laden sediments and a threat to its resident birds (Simonin, 1998). Direct threat of DDT contamination appears to be minimal, but so many summer species winter in contaminated areas, such as Florida or in locations where it is still legally used, it is necessarily still a serious ornithological issue.

DDT created problems that weren't identified until the 1970s. In the Adirondacks, its influences must be considered a current avian problem. Some migratory birds winter in foreign countries that still allow the use of the lethal compound to control insect pests. American kestrels from New York state migrate to various locations in southern United States, Central America and Mexico for the winter months (Rappole, 1995). Eggs collected from the nests of these migratory kestrels were tested for PCB levels. They had thin shells and high levels of pesticides. Organochlorine residues from contaminated prey they had consumed during the winter months proved to be the cause (Rappole, 1995).

Metals:

There are unnaturally high amounts of certain metals in Adirondack ecosystems, accumulating in aquatic systems primarily from atmospheric particulates emitted from various remote industrial sources (**Table 6**). These can negatively affect avian health. Heavy metal particles are carried to the mountains by primarily west to east winds. Many of these waste particles precipitate, contaminating the soil and water in the Adirondack mountains. Other sources of the unnaturally high levels of metals come from waste products seeping into the ground water or lead bullets and sinkers, all contributing to an unnatural aspect of any given food chain. Metals, like pesticides, can become concentrated in certain avian tissues. Accumulation of trace amounts of these metals is often a normal occurrence because they are part of the natural environment. When metal levels exceed tolerable concentration levels, symptoms become apparent depending on the kind of metal and the bird species. Signs of diminished health, physical abnormalities, and reproductive stress all indicate exposure to potential toxic levels of heavy metals (Simonin, 1998).

Table 6 – Important Metal Contaminants in Adirondack Lakes

	Source
Aluminum	Acid rain induced erosion, metal smelters, coal combustion (Harte, 1991)
Arsenic (nonmetal)	Coal combustion, pesticides
Cadmium	Coal combustion, waste combustion
Copper	Mining; smelters
Lead	Plumbing products; lead shot; fish-line sinkers; lead based paints; waste combustion
Selenium (nonmetal)	Coal burning
Mercury	Pulp & paper mills; smelters; chlor-alkali plants, coal burning; waste combustion
Nickel	Mining; smelters; coal burning
Zinc	Metal smelting operations

Adapted from Simonin, 1998 & Scheuhammer, 1987

Mercury (Hg), a toxic metal, is considered a threat to the health of Adirondack avian species. Mercury comes from industrial waste that has settled in the sediment layers of aquatic systems. Although the production and use of mercury is in decline, its environmental effects have long term implications when found in sedimentary deposits (CEQG, 2000). Hg, carried primarily as an inorganic molecule through the air, eventually settles in aquatic ecosystems where aquatic bacteria convert it to a more hazardous organic molecule, methymercury (MeHg). The MeHg enters the food chain and bioaccumulates in the tissues of fish. There is little evidence that the methylmercury disrupts the life patterns of fish, but the toxicity levels in the wildlife preying on them indicate severe health problems (Schoch, 2002; Simonin, 1998; Harte, 1991).

Loons and other birds compromised by methylmercury display neurological problems, kidney lesions, spinal cord lesions and reproductive abnormalities (Simonin, 1998; Sheuhammer, 1987). Current research being conducted by Nina Schoch on common loons in the Adirondacks show mercury levels in tissues high enough to cause behavioral changes, such as a decrease in normal activities and lowered reproductive success (Schoch, 2002). Blood and feather samples were taken from ninety-three loons from 1998-2000, which were then analyzed for Hg. The birds were classified into four groups: low, medium, high and extra high, according to the degree of tissue contamination. Seventeen percent (16/93) of the birds had levels of mercury high enough to be classified in the two high-risk classifications (Schoch, 2002). The loons in the highest risk classification were from lakes that had low pH and alkalinity which correlates with other research connecting a high mercury exposure with acidic lakes (McIntyre, 1988; Simonin, 1998; CEQG, 2000).

The New York State Department of Health (NYSDOH) has put limitations on the human consumption of fish from fourteen Adirondack lakes (Simonin, 1998). Some of the loons in Schoch's study resided in those lakes listed by the NYSDOH. However, there were other loons in the high risk categories that were from bodies of water not on the list of contaminated lakes (Schoch, 2002). The contaminated loons residing on lakes not currently on the list provided by NYSDOH indicate there are additional mercury sediments that need investigating. The newly established Adirondack Cooperative Loon Program (ACLP) will continue efforts to monitor and sample loons for mercury contamination, and ACLP findings may prompt the NYSDOH to add other contaminated water sources to its list.

The ACLP is a worthwhile effort towards the protection of one of the North Country's primary avian attractions, the loon. It is my hope that other Adirondack species of birds, those that are less apt to draw tourists, will be helped also. Research done in other parts of the country show that mallard ducks (Heinz, 1976), common mergansers (Mallory, 1999), and great blue herons (Butler, 1992), all three typical Adirondack species, have elevated levels of mercury in their tissues. Acidic lake conditions exacerbate mercury's environmental effects, so all birds, not just loons, face the bioconcentration problems associated with any form of metal contaminate.

Lead (Pb) is another metal that was once heavily distributed in the atmosphere through the burning of petroleum products, prior to 1975 (Simonin, 1998; Hart, 1991). The atmospheric Pb particulates have been greatly reduced since the advent of unleaded gasoline but exposure to concentrated levels of lead is still a problem for local avian species. Lead sinkers and lead shot use have distributed the metal throughout Adirondack waterways and firearm ranges, and ultimately, food chains. Lead toxicology studies on ducks, doves, kestrels, and starlings correlated low levels of calcium and vitamin D with an increased risk of lead poisoning (Scheuhammer, 1987). Female mallard ducks show a higher rate of lead uptake than male counterparts. Females require excess calcium for eggs, and during the laying season when calcium requirements are highest, they are more susceptible to Pb accumulations (Scheuhammer, 1987).

The ingestion of spent lead shot was identified as a major hazard to North American waterfowl, but there are also exposure possibilities in upland species (Kendall, 1996). Mourning doves are considered game birds, and therefore, may carry within their bodies tiny lead pellets from non-lethal gun shot wounds. They can also ingest the spent shot that rests on their feeding grounds. Both methods of lead interaction produce abnormally high Pb levels in birds near hunting ranges and on hunting lands (Kendall, 1996). Raptors must be considered in conjunction with their terrestrial prey because of the affects of bioconcentration. Studies prove that when American kestrels are exposed to high levels of dietary lead, they suffer decreased growth rates and increased mortality rates compared to kestrels with a normal diet (Scheuhammer, 1987). If there is enough concentrated lead, in the form of spent shot, existing in an upland bird's feeding range, there is a risk of exposure for birds of prey also. That risk increases as it moves through the food web.

The summer of 2002 saw a landmark effort that encouraged fishermen and fisherwomen to use non-toxic alternatives to traditional lead sinkers (ACLP, 2002). Throughout the Adirondack Park, anglers had access to information about the poisoning affects of lead in waterbirds who inadvertently ingest lost sinkers. Fish and game clubs, hosts of Adirondack fishing events and other establishments, offered to exchange lead sinkers for a sample of an environmentally friendly alternative. It was a good opportunity for anglers to try the new products because in 2004 the sale of small lead sinkers in New York State will be banned (ACLP, 2002). It is unfortunate that all lead shot used in shotgun shells will not be part of this ban. Ammunition still available for non-waterfowl hunting leaves many ground feeders, like mourning doves, in continued danger of accidental ingestion. Upland game birds surviving gunshot wounds may suffer from the toxic effects of the lead embedded in their tissues and leave a poison legacy wherever they die.

Aluminum (Al) is the most abundant metal in the earth's crust. Rarely found in its pure form, it requires a refining process to remove the aluminum from bauxite and cryolite ores in vast quantities to satisfy ever expanding aluminum product markets. The refining process is one source of excess aluminum in aquatic systems Erosion, caused by acidic conditions, is the most environmentally significant source of aluminum in the Adirondacks. When the metal is exposed to acidic conditions, it dissolves and enters the food chain (Harte, 1991). There is little evidence suggesting this is a significant problem at this time, but the acidity of Adirondack lakes is on the rise. (A complete explanation of acid rain in the Adirondacks follows this section of the paper). Evidence from Sweden revealed severely deformed eggs, reduced clutch sizes, and high mortality rates in wild passerines nesting along an acidic lake which correlated to the high accumulations of Al in their tissues (Scheuhammer, 1987). This correlation should indicate the importance of understanding how acidity levels in current Adirondack waters may create additional stress in compromised ecosystems.

Elevated levels of other metals (copper, nickel, cadmium and zinc) (Scheuhammer, 1987; Simonin, 1998) and non-metals (arsenic {Scheuhammer, 1987} and selenium {Spallholz, 2002; Hoffman, 2000}), also contribute to avian stress in the North Country. Each one has inspired cautionary messages for those concerned with the ecosystem's health and preservation of avian diversity. But the warnings primarily reach the people already interested in improving the health of the environment. Metal toxicity concerns must be understood by a broader spectrum of people which should include industrial companies, private landowners, and hunting clubs, along with health and environmental organizations, before positive changes can be effectively adopted to decrease metal contaminate levels in the Adirondacks.

Acid Rain:

Coal and oil burning, metal smelting and other industries along the Ohio Valley emit sulfur (S) and nitrogen (N) particles that react with water and oxygen to form sulfuric and nitric acid (Harte, 1991). The formed acids travel with the wind's northeast currents to where the lowland valleys meet the slopes of the Adirondack mountain range. The acids become part of the North Country's frequent rainfall. Acidic dew, rain, fog, sleet, hail, and snow is strong enough to leach minerals (i.e. Ca, K, and Mg) from rock. Normal nutrient flow between soils and plants stops. Soils and waters are altered from normal pH levels of 5.6 to acidic levels below 5.0, too acidic to sustain diverse communities of organisms. Insidious precipitation quietly fell onto the Adirondack Mountains for decades before evidence of its ability to alter the levels of mineral erosion and disturb pH balances caused concern.

The Clean Air Act (CAA) of 1970 addressed unregulated emission levels released from industrial sources and automobile exhaust (Harte, 1991). The act required the Environmental Protection Agency (EPA) to establish standards for acceptable levels of atmospheric emissions, ideally meant to reduce harmful particulates. The EPA initiated penalties on communities that failed to meet standards, limiting emission levels on stationary sources of air pollutants, requiring motorized vehicle inspections and implementing new emission standards (Harte, 1991). The efforts proved to be beneficial, with a twenty-percent overall reduction in atmospheric emissions of sulfur dioxide and carbon monoxide in the 1980s (Harte, 1991). Sulfur dioxide emissions were reduced from twenty-six million tons per year to twenty million tons per year. An amendment to the CAA (CAAA) in 1990 further reduced the acceptable release of air pollutants. It mandated reduced sulfur dioxide emission by another forty percent (Harte, 1991).

The only way to evaluate the effectiveness of these efforts on the local environment is to monitor levels of acidity and levels of metals associated with acidic erosion in our terrestrial and aquatic ecosystems. The DEC has collected data on specific aspects of local aquatic ecosystems since 1977, but their information did not accurately represent the acidic conditions of the state's aquatic systems collectively. The formation of The Adirondack Lakes Survey Corporation (ALSC) in 1983 augmented the previous efforts by DEC. ALSC initiated research surveying waters previously designated as acid sensitive, broadening our understanding of the cause and effect associated with acid rain on different types of aquatic ecosystems (Carroll, 1999). ALSC has compiled information gathered in the Adirondack mountains that has expanded world knowledge, explaining how and why acidic depositions destroy an ecosystem's health (Carroll, 1999).

Current monitoring and research indicates twenty-four percent of the one thousand, four-hundred and sixty-nine lakes in the Adirondacks are too acidic to support fish. Some of the acidification can be attributed to natural occurrences. Most is attributed to industry and vehicle emissions (EC, 2001). The resulting scenario for avian life in the park is similar to other food chain disruptions. Toxic food sources kill birds by accumulation, but with acid deposition, it is starvation. No fish, no piscovorous birds. The eagles, ospreys, kingfishers and other colorful species dependant on fish or other aquatic animals relocate to locations outside the park where waters are stable enough to support their food source.

One half of all the red spruce trees in the Adirondacks have withered and died since 1960; the die-off is attributed to acid rain. Other trees, like sugar maples, white ash and basswood, are weakened from a constant atmospheric deposition of sulfuric and nitric acids (EC, 2001). Though protected land within the Blue Line provides valuable undisturbed habitat for birds, damage from acid rain is destroying the trees necessary for nesting and foraging. If acid precipitation levels cannot be managed or buffered by the delicate Adirondack soils, only the most generalist of avian species will find suitable nesting sites. Warblers, native finches, and sparrows that require very specific nesting sites will no longer find suitable habitat among the protected forests. Non-native species like the house sparrow and European starling will dominate the compromised surroundings because they can survive well in less distinctive conditions.

The wood thrush is a migratory species that is more difficult to see than to hear. Its enchanting morning and evening songs represent peaceful solitude in deep woods. These deep forests are gradually losing their melodious summer visitors. Wood thrush populations decline according to increased levels of acid rain (Hames, 2002). The abnormal level of acid in Adirondack soils has leached minerals, like calcium, from the higher altitudes. Calcium is part of the thrush's diet in the form of snails and slugs, and it is essential for successful egg production (Hames, 2002; EC, 2001). Once again, a species that has in the past nested within the protection of the park must leave for areas that meet its dietary requirements.

It is clear that acid rain has the potential to drastically alter the diversity of avian life in the Adirondack Park. Aluminum, mercury and other metals erode faster in acidic conditions than they would in areas with normal pH levels. The toxic levels of these metals that accumulate in terrestrial and aquatic systems are linked directly to acidic depositions (Scheuhammer, 1987; Simonin, 1998). The toxic metal deposits, combined with the loss of food, the destruction of habitat, and the loss of essential nutrients, are affecting the health and diversity of avian life in the Adirondack Park now and will escalate in the future.

Global Warming:

Earth's atmosphere contains compounds, along with those associated with acid rain, that concentrate to form layers of suspended particles. They include gases like sulfur hexafluoride (SF6), nitrous oxide (N2O), carbon dioxide (CO2), methane (CH4), and hydrofluorocarbons (CFCs, HCFCs, and HFCs). This blanket of emissions cause the sun's heat, which is normally deflected out of the atmosphere, to instead, stay close to the earth's surface, effectively warming the planet unnaturally (Greenpeace, 1998). Warming trends affect all ecosystems on earth, with the delicate boreal forests at greater risk than southern, or lower altitude, temperate forests. Boreal forests encircle the globe in the northern hemisphere, making up a third of the world's forests (Greenpeace, 1998; Niemi, 2000). All plants and animals adapted to the characteristically harsh conditions of the northern, upland forests face the challenge of adapting new strategies to counterbalance the inevitable environmental changes initiated by atmospheric contamination.

Unpredictable air temperatures will alter rainfall and humidity in the boreal forests (Greenpeace, 1998; Niemi, 2000). Some tree species, like the sugar maple, requiring specific amounts of water and cyclic temperatures that facilitate undisturbed dormancy and subsequent growth periods, will suffer in a new, quickly changing environment. Establishment of new populations of these trees in more northern locations will be impeded by climate outpacing any new tree growth. Those most vulnerable, dominant boreal species, will lose their specialized habitat and will be diminished or completely eliminated from boreal ecosystems (EC, 2001; Niemi, 2000; Greenpeace, 1998).

Boreal tree species like red spruce will also experience stress, rendering them more vulnerable to destructive parasitic infestations and acid rain (EC, 2001; Niemi, 2000; Greenpeace, 1998). Spruce bud worms are already a problem facing these northern trees today, and the warming climate will promote increased frequency and lethality of outbreaks (Niemi, 2000). Currently, winter conditions curtail the breeding and feeding seasons of many insects that can spread disease. If warming trends continue, that barrier will be removed, and more dense populations can be expected to cause damage for longer periods of time in forests of already weakened trees. Acid rain contributes to the declining health of the trees in boreal forests by washing away the nutrients and minerals needed to sustain healthy trees (Niemi, 2000, Simonin, 1998). The domino effect of unnaturally warm climates, acid deposition, weakened trees, and prolific populations of forest-devouring insects does not fit well with the model of preservation the Park's founders established in 1892.

The temperature fluctuations associated with global warming will also disturb the food requirements and the reproductive success of the diverse avifauna found in boreal forests (Greenpeace, 1998; Niemi, 2000). Global warming will cause earlier insect hatches and flower blooms because warmer temperatures will be reached sooner in the seasons. Migrant birds that nest in Adirondack boreal forests, dependent on insect protein and flower nectar, will arrive only to find their traditional meals are past their prime. Magnolia warblers, black-throated green warblers, yellow-rumped warblers, olive-sided flycatchers, and yellow-bellied flycatchers (Beehler, 1978) will be forced to find nutrition other than their high quality protein insects and highly concentrated nectars after their long journeys from distant southern locations. Quality and quantity of available food will affect the number of successful nests per season (Youth, 2002; Thomas, 2001; Niemi, 2000; Robinson, 1997). Habitat, disrupted enough by global warming, could eventually be no longer suitable for many current avian species. A question remains about adaptability in these circumstances; will they continue trying to nest in such a depleted area until their numbers can no longer represent a viable breeding population or will there be suitable habitats elsewhere that they will simply move to?

Birds higher on the food chain will also have trouble finding food sources because of the diminishing habitat. Raptors will have to cover more territory to find meals for nestlings. Less available prey translates to fewer breeding birds. Those that do successfully breed in the depleted habitat will have smaller and fewer nestlings (Lacombe, 1994). Specialized raptors, like the northern goshawk, the sharp-shinned hawk and the saw-whet owl (Beehler, 1978) will find nesting on traditional boreal forest grounds increasingly difficult if the forests do not sustain the diverse communities of flora and fauna they once had.

The boreal forests of the Adirondack Park were carelessly and severely lumbered from the 1870s to 1910. In 1950, a November storm ripped through many of the few remaining boreal forest stands (Beehler, 1978). The health of the remaining and recuperating stands, after a century of destructive events, leaves little doubt about the forests' vulnerability entering this century. Health of the resident bird communities is directly affected by the health of the forest. The Breeding Bird Survey (BBS) has been recording data on songbird populations for the last three decades, and their recordings demonstrate this decline. The BBS statistics indicate that in the Adirondacks, many or even most forest songbirds, like those found in the boreal areas, are now declining in populations (Robinson, 1997). Global warming has frightening implications worldwide and locally, with declining avian populations and boreal forests indicating the environmental degradation in progress. The Adirondacks face the risk of becoming a bland environment of only the most tolerant of tree species providing meager habitat for remnants of the avian splendor now frequenting the mountainous landscape.

Local Issues:

> ***I invite you now to try and visualize the loss in biological diversity due to the reduction of natural habitats.....Consider the loss, mostly invisible to us today but destined to be painfully obvious to our descendents, that occurs when an entire wildness area is degraded or destroyed. Edward Wilson.1984. (Nash, 1990)***

Local issues such as shoreline development affect the health and diversity of Adirondack avian life. A shoreline free from human influences offers diversity to a host of birds. Dwellings, artificial lights, septic effluent, and packed or paved roadways are all unnatural things occupying former nesting grounds. In a model avian environment, wading birds nest along the shoreline trees and capture their food in the shallows. Waterfowl nest in grasses and reeds or hollows of nearby trees and dive for aquatic plants. Insectivores take full advantage of insect hatching cycles. Birds of prey optimize their hunting success when soaring along an undisturbed lakeshore. Ground birds have unrestricted movement around the lake for foraging.

In the real world, humans, some of whom place great importance on the natural environment and some of whom place great importance on the recreation offered by the Parks waters, have developed shore lands wherever possible. As humans alter the environment, an inconspicuous change occurs. Birds that eat insects tend to be replaced by seed eating birds, and ground-dwelling birds tend to be replaced by other deciduous nesting birds (Lindsay, 2001). At first thought, a change in species might appear trivial; after all there are still birds flourishing, but it is not this simple. Insectivores do help control mosquitoes, black flies, and defoliating insects. Their help limits the damage insects can cause to the lakeshore forests (Lindsay, 2001). With the insect eating birds gone, lakeshore owners are compelled to rid their often infested trees, bushes and lawns of the pests by applying insecticide, which in turn damages the environment even more. A cycle of shortsighted fixes slowly and silently degrades the delicate balance of birds, insects, and shoreline habitat.

A local issue that directly affects birds is the use of personal watercraft (PWCs), a rapidly growing past time. Most citizens of the Adirondacks have extreme opinions about their use on various types of waters. Many would like them banned entirely, which is vehemently opposed by those who own and enjoy them. While not part of the human centered debate, aquatic habitat required by birds for foraging and nesting is being drastically affected (Burger, 2000). PWCs move faster and closer to nests than traditional motorboats, disturbing nesting patterns. One study on common terns (New Jersey) documented nearly total reproductive failure, due to the inability of the terns to adjust to the constant, close and fast disturbance of PWCs (Burger, 2000). Terns, loons, and other aquatic nesters are unaccustomed to the unpredictable movements of these small crafts, so they are distracted or even killed by this new habitat challenge.

Many other common issues in the Adirondacks indirectly affect the health of resident and migrant avifauna. Eutrophication diminishes avian food supplies by decreasing food web diversity (De Valk, 1998). Invasive plant species replace the native plant species that native birds require for food or nesting. Communication towers in the United States are reported to kill as many as forty million birds every year. Tower lights disorient them, causing them to collide into support wires, the ground, or even one another. Neotropical songbirds (i.e. warblers, tanagers, thrushes, orioles, vireos, flycatchers) that migrate to this area, are most susceptible to these confusing, deadly lights (Seabrook, 2001). West Nile Virus (WNV) has been linked to the death of a blue jay within the Park's boundaries. Crows, members of the same family as blue jays, are also susceptible to WNV and are likely to die if infected. Presently, six counties (Essex, Clinton, Franklin, Hamilton, Warren, Washington) in northeastern New York state have found bird carcasses that tested positive for the virus (McKinstry, 2000). Every one of these environmental issues directly or indirectly affects some aspect of the local avifauna. Such issues as habitat destruction, acid rain, chemicals, and global warming, compounded further by current localized issues, create an environment changing too quickly for normal avian adaptation to overcome.

CONCLUSION

The founders of the Adirondack Park meant to preserve state owned lands. This established parkland has endured more than a century of change. Some changes, brought about by expanding scientific knowledge, have shaped the current methods used to classify the private and public lands within the boundaries of the Park. Cultural attitudes continually challenge the direction, focus, validity and need for any change. It is extremely important to deal with the cultural contentions that have plagued the progress of the park since its conception. Today, when there are so many worldwide environmental contributors affecting the health of Adirondack birds, a pragmatic approach to the local issues could mean sustaining avian life amid the pressures inflicted on its health from beyond the Park's borders.

Past preservation efforts have improved Adirondack environments. Forests that were once excessively logged are now protected by the "forever wild" amendment to the state constitution. Game protection laws are designed to reduce the practice of over harvesting fowl and other game birds. Use of the pesticides that once jeopardized the existence of raptors and decreased populations of songbirds have been replaced with less toxic alternatives. The public's knowledge about the dangers associated with pesticides and their proper applications help prevent the unnecessary use and misuse of new pesticides. The local issues are being more and more effectively dealt with by concerned, knowledgeable groups organized within Park boundaries and organizations dedicated specifically to the health of birds.

Acid rain and global warming issues are not so easily dealt with. If Adirondack citizens, organizations, and politicians hope to effect change in this global problem, there must be continued funding for new and ongoing research in the Adirondacks. Industrial polluters responsible for the current levels of acidity and warming trends do not have the same desire to preserve the Adirondacks as do the Park's residents. The only way to try to protect the Park from these hazards is to prove there is damage, increase local knowledge about the damage, and raise a unified voice for demanding changes in emission standards.

The health and diversity of bird species are dependent on the ability of humans to curtail the increasingly complex problems forced on the birds by anthropogenic inattention. The vision and sound of birds in Adirondack forests, wetlands, rivers, lakes and plains will not likely be the priority of future lawmakers, but like the inadvertent protection given to the birds by the formation of the park, I hope that increased education on awareness of environmental issues will inadvertently help sustain future Adirondack avian communities.

Appendix 1
Scientific Names of Listed Avian Species

Common Name	**Scientific Name**	**Page #**
Eastern Bluebird	*Sialia sialis*	11
Black-capped Chickadee	*Parus articapillus*	11
American Crow	*Corvus brachyrhynchos*	11
Wood Duck	*Aix sponsa*	11
Bald Eagle	*Haliaeetus leucocephalus*	11
Purple Finch	*Carpodacus purpureus*	11
Ruffed Grouse	*Bonasa umbellus*	16
Spruce Grouse	*Dendragapus canadensis*	16
Red-tailed Hawk	*Buteo jamaicensis*	11
Ruby-throated Hummingbird	*Archilochus colubris*	11
Blue Jay	*Cyanocitta cristata*	31
Barred Owl	*Strix varia*	11
Passenger Pigeon	*Ectopistes migratorius*	12
American Robin	*Turdus migratorius*	31
House Sparrow	*Passer domesticus*	17
Song Sparrow	*Melospiza melodia*	31
European Starling	*Sturnus vulgarus*	17
Turkey	*Meleagris gallopavo*	15
American Woodcock	*Scolopax minor*	13
Downy Woodpecker	*Picoides pubescens*	11
Winter Wren	*Troglodytes troglodytes*	11
Bald Eagle	*Haliaeetus leucocephalus*	22
Osprey	*Pandion haliaetus*	22
Purple Martin	*Progne subis*	31
Red-winged Blackbird	*Agelaius phoeniceus*	31
Common Grackle	*Quiscalus quiscula*	31
Mourning Dove	*Zenaida macroura*	31
Cooper's Hawk	*Accipiter cooperii*	31
Red-tailed Hawk	*Buteo jamaicensis*	31
Canada Goose	*Branta canadensis*	31
Tree Swallow	*Tachycineta bicolor*	33
Great Blue Heron	*Ardea herodias*	33
Common Merganser	*Mergus merganser*	33
American Kestrel	*Falco sparverius*	34
Common Loon	*Gavia immer*	39
Mallard Duck	*Anas platyrhynchos*	37
Wood Thrush	*Hylocichla mustelina*	43
Magnolia Warbler	*Dendroica magnolia*	46
Black-throated Green Warbler	*Dendroica virens*	46
Yellow-rumped Warbler	*Dendroica coronata*	46
Yellow-bellied Flycatcher	*Empidonax flaviventris*	46
Olive-sided Flycatcher	*Contopus borealis*	46
Northern Goshawk	*Accipiter gentilis*	47
Sharp-shinned Hawk	*Accipiter striatus*	47
Saw-whet Owl	*Aegolius acadicus*	47

Appendix 2 – Adapted from NYSDEC's endangered species list
Endangered, Threatened, and of Special Concern List of NYS Birds * Adirondack Species

Common Name	Scientific Name	New York Status
Golden Eagle*	*Aquila chrysaetos*	Endangered
Perigrine Falcon*	*Falco peregrinus*	Endangered
Spruce Grouse*	*Falcipennis canadensis*	Endangered
Black Rail	*Laterallus jamaicensis*	Endangered
Piping Plover	*Charadrius melodus*	Endangered
Eskimo Curlew	*Numenius borealis*	Endangered
Roseate Tern	*Sterna dougallii dougalli*	Endangered
Black Tern	*Chlidonias niger*	Endangered
Short-eared Owl*	*Asio flammeus*	Endangered
Loggerhead Shrike*	*Lanius ludovicianus*	Endangered
Pie-billed Grebe	*Podilymbus podiceps*	Threatened
Least Bittern*	*Ixobrychus exilis*	Threatened
Bald Eagle*	*Haliaeetus leucocephalus*	Threatened
Northern Harrier*	*Circus cyaneus*	Threatened
King Rail*	*Rallus elegans*	Threatened
Upland Sandpiper*	*Bartramia longicauda*	Threatened
Common Tern*	*Sterno hirundo*	Threatened
Least Tern	*Sterno antillarum*	Threatened
Sedge Wren	*Cistothorus platensis*	Threatened
Henslow's Sparrow*	*Ammodramus henslowii*	Threatened
Common Loon*	*Gavia immer*	Special Concern
American Bittern*	*Botaurus lentiginosus*	Special Concern
Osprey*	*Pandion haliaetus*	Special Concern
Sharp-shinned Hawk*	*Accipiter striatus*	Special Concern
Cooper's Hawk*	*Accipiter cooperii*	Special Concern
Northern Goshawk*	*Accipiter gentilis*	Special Concern
Red-shouldered Hawk*	*Buteo lineatus*	Special Concern
Black Skimmer	*Rynchops niger*	Special Concern
Common Nighthawk*	*Chordeiles minor*	Special Concern
Whip-poor-will*	*Caprimulgus vociferus*	Special Concern
Red-headed Woodpecker*	*Melanerpes erthrocephalus*	Special Concern
Horned Lark*	*Eremophila Alpestris*	Special Concern
Bicknell's Thrush*	*Catharus bicknelli*	Special Concern
Golden-winged Warbler*	*Vermivora Chrysoptera*	Special Concern
Cerulean Warbler	*Dendroica cerulea*	Special Concern
Yellow-breasted Chat*	*Icteria virens*	Special Concern
Vesper Sparrow*	*Pooecetes gramineus*	Special Concern
Grasshopper Sparrow*	*Ammodramus savannarum*	Special Concern
Seaside Sparrow	*Ammodramus maritimus*	Special Concern

Appendix 3
Scientific Names of Listed Tree Species

Common Name	**Scientific Name**	**Page #**
Red Spruce	*Picea rubens*	7
Yellow Birch	*Betula alleghaniensis*	7
American Beech	*Fagus grandifolia*	7
Eastern Hemlock	*Tsuga canadensis*	7
Sugar Maple	*Acer saccharum*	7
Eastern White Pine	*Pinus strobus*	7

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