WORKING PAPER NO. 20 DECEMBER 2002

THE COMMON LOON IN THE ADIRONDACK PARK

An Overview of Loon Natural History and Current Research

By Nina Schoch, D.V.M., M.S.

WILDLIFE CONSERVATION SOCIETY

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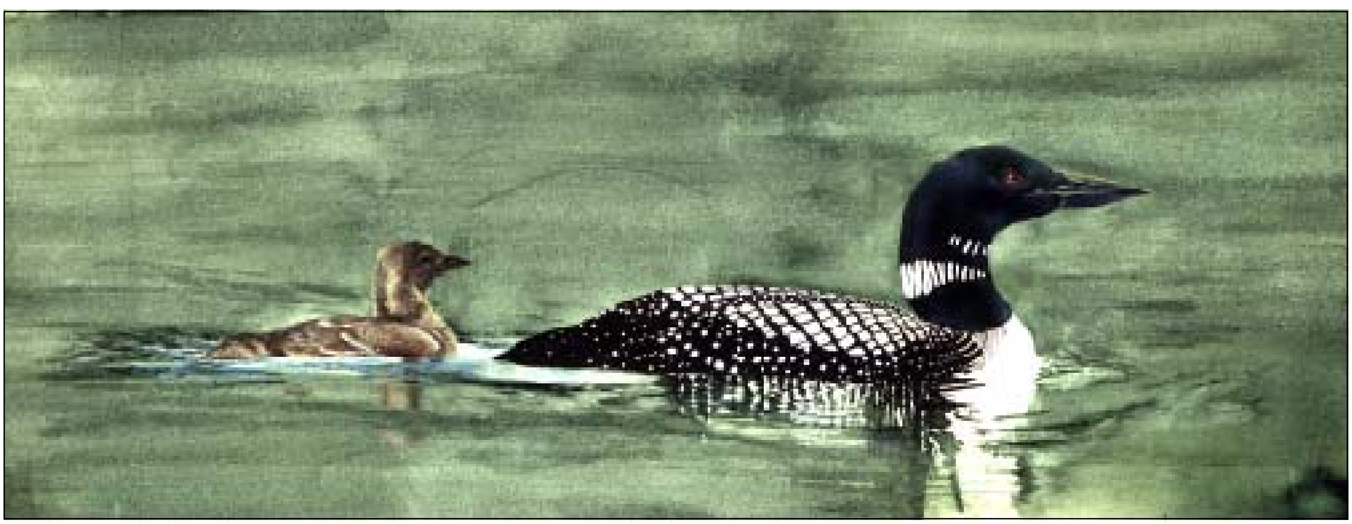

Loon with Young
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DEDICATION

To my husband, Bill, whose patience and assistance has enabled me to bring the idea of the Adirondack Cooperative Loon Program and this working paper to a reality,

To Dr. Judith McIntyre, whose pioneering work in loon natural history and behavior has been the basis of many loon monitoring organizations and research in North America,

and

In Memory of
Anne Lacy-Trevor, who could express in one beautiful painting what I have attempted to put into many words here.

ACKNOWLEDGEMENTS

Many people have substantially contributed to my understanding of conservation on the landscape and ecosystem levels, as well as to my increasing awareness of loons and factors affecting their populations. First and foremost, I would like to thank my husband, Bill Schoch, for his kind patience and encouragement, enabling me to explore and learn about new fields. Dr. John Cogar at High Peaks Animal Hospital has also been tremendously flexible and patient with accommodating my growing interest in wildlife and contaminant research.

I am deeply indebted to Dr. Mark Pokras, Andrew Major, and Dr. David Evers for introducing me to the field of loon contaminant research and for their friendship. Craig Cheeseman, Rick Godin, Bob Inslerman, Jay Mager, Dr. Judith McIntyre, Bob Miller, Karl Parker, Fred Realbuto, Karen Roy, Howard Simonin, Bryan Swift, Kate Taylor, and Harry Vogel have been exceptionally generous with their support and encouragement along the way. The camaraderie of the capture field crews will always be remembered, thanks to all who have participated, especially David Adams, Shearon Clarke, Chris DeSorbo, Kristen Drew, Kim Goodspeed, Michael Hough, Ken Munney, Ken Karwowski, Gary Lee, Rose Miconi, Kathy O'Brien, John Ozard, Pete Reaman, Lucas Savoy, Jesse Schwartz, Laura Sommers, Mary Beth Warburton, and David Yates.

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Finally, I am especially grateful to all the personnel and Adirondack Park residents who have assisted with the many aspects of the Northeast Loon Study Workgroup research in the Adirondack Park, and with the development of the Adirondack Cooperative Loon Program. It is only through the willing cooperation of the public and private landowners and the Park residents that we have been able to accomplish the variety of projects conducted by the ACLP. Unfortunately, there is not enough space to acknowledge each person individually, but I am thankful for the kind assistance of the many people we have approached during this research and education effort.

PROLOGUE

I arrived in the Adirondacks over a decade ago, with a lifelong fascination for the natural world. Loons, the classic "symbol of the wilderness", touch people deep into their souls. My first memorable experience with loons was during a fall camping trip on a remote Adirondack lake. The rain pelted down on our tarp, as we watched the silhouettes of an adult loon and its chick floating on the surface of the water nearby. That night we were awakened by the duetting of barred owls and the howling and yipping of coyotes. Suddenly the haunting tremolos of the loons pierced the chorus, filling the dark night with their calls. I feel incredibly fortunate to live in such close proximity to the Park's natural inhabitants.

Slowly my dream of working in the field of conservation has come to pass. Through this paper I hope to share with the reader some of the knowledge that I have gained while working to increase awareness of and promote solutions for problems affecting the Common Loon in the northeastern United States. Not only is the Common Loon an incredible and fascinating species to observe, but it also is reflective of the landscape in which it exists. A healthy landscape enables its inhabitants to thrive. In the Adirondacks, air and water quality, disturbance, and lead sinker toxicity are a few of the factors affecting the loon population. As awareness of these problems continues to grow among the human residents of the Park, it is my hope that efforts will increase to minimize anthropogenic effects on wildlife populations and that the health of the landscape will continue to improve.

Nina Schoch
Ray Brook, New York
Summer, 2002

INTRODUCTION

Gavia immer
The Common Loon
Song of the Wilderness
The Great Northern Diver
The Spirit of the North Woods

These are but a few of the names we have for this charismatic bird, which inspires great admiration in the people who have the opportunity to see one on an Adirondack lake. The unique characteristics of the Common Loon (*Gavia immer*) cause humans to be intrigued by, and even very possessive about, this species. Perhaps it is the dramatic black and white plumage that we see on the adult birds breeding in the Adirondacks. Or maybe it is their lingering soulful calls that resonate off the nearby hills and carry through the night.

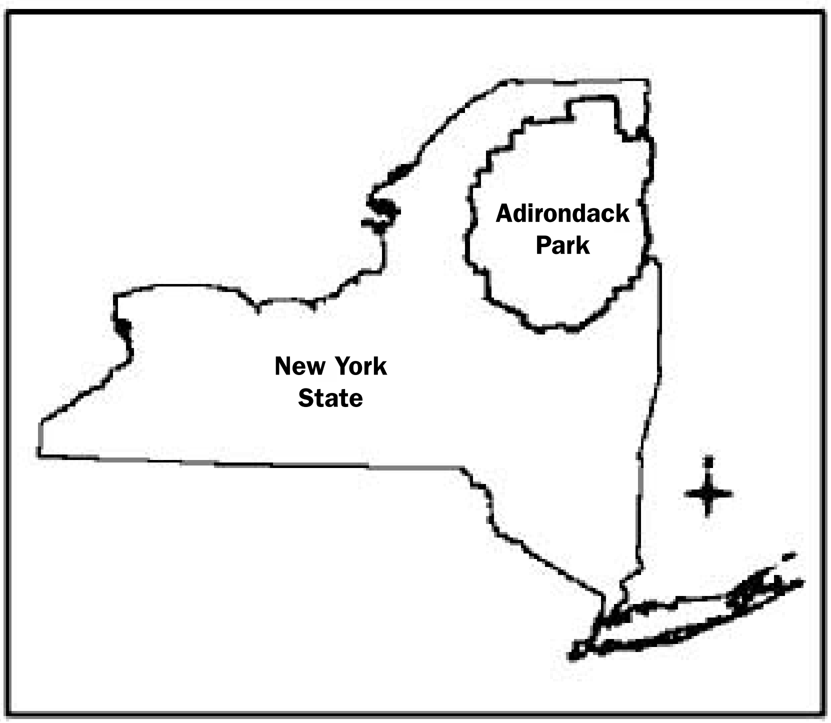
Numerous legends exist in northern cultures about Common Loons, including tales about how the loon received its necklace, lost its voice, and assisted in the creation of the earth (Cameron, 1985; Dwyer, 1988; Cleaver, 1990). Adirondack residents love to talk about and photograph their favorite loon. Why do loons attract this kind of attention and devotion? Why aren't they regarded as ducks and geese? People were irate when a loon was shot on an Adirondack lake a few years ago, although annual hunting seasons on other types of waterbirds are accepted as a matter of course. Some Park residents and visitors disapprove of contaminant sampling and banding of loons. However, songbird and waterfowl banding and sampling are routinely conducted throughout New York, the United States, and the world. This paper explores some of the natural history traits that differentiate loons from other species of waterbirds, and which also make this species an excellent biological indicator of the environmental health of the Adirondack Park.

The Adirondack Park of New York State encompasses almost six million acres and is one of the largest relatively intact forested landscapes in the northeastern United States. The unique blend of public and private lands and waterbodies, a combination of developed and undeveloped lakes, rivers, and forests, exposes wildlife to a wide array of circumstances. Loons adapt to a variety of situations in their breeding and wintering habitats. In the Adirondacks, this species summers on both developed and undeveloped, as well as on motorized and non-motorized, lakes and reservoirs. However, habitat alteration and increased disturbance from human use of waterways within the breeding habitat of the Common Loon has great potential, particularly when combined with other factors, to impact the reproductive success and population of this species.

Wildlife utilization of the diverse habitats within the Park is one factor considered by local and state governments and agencies when evaluating an area for human use and the development of regulations for human activity.

People use the Adirondacks, and the natural resources within the Park, for a variety of development and recreational activities. Town and county governments, the Department of Environmental Conservation (DEC), the Adirondack Park Agency, and the state legislature all interact to regulate activities in this high profile park. Wildlife utilization of the diverse habitats within the Park is one factor considered by local and state governments and agencies when evaluating an area for human use and the development of regulations for human activity.

The purpose of this working paper is to provide an overview of Common Loon natural history and the factors affecting the population of loons breeding in the Adirondack Park. Increased knowledge and understanding of the habitat and breeding requirements of loons, especially the threats to their populations, will enable sound decisions to be made regarding loon conservation and management within the Adirondack Park, ensuring that the call of the loon will be heard echoing throughout Adirondack lakes and ponds for generations to come.



LOON NATURAL HISTORY

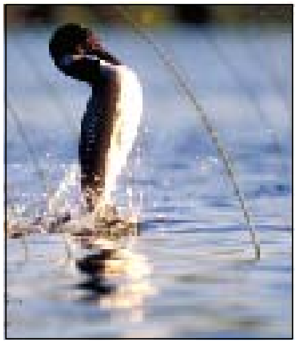
The Family of Loons

Loons are only found in the Northern Hemisphere. Although a waterbird, loons are distinct from waterfowl, which include ducks, geese, and swans. The Common Loon is one of five species of the family of birds known as *Gaviidae*, and the only loon species to breed in New York, primarily in the lakes of the Adirondack Park. The other four loon species, Yellow-Billed (*Gavia adamsii*), Arctic (*Gavia arctica*), Red-Throated (*Gavia stellata*) and Pacific (*Gavia pacifica*), breed on tundra lakes in northern North America, Europe, and Asia.

In the breeding season, the uniqueness of each species is very apparent, and their plumage is striking. There is no difference between the sexes in their appearance, although males are usually larger than females. The black back of the Common Loon is "checker-boarded" with a regular pattern of white spots, contrasting sharply with the pure white underbelly. A "necklace" of white stripes graces the dark black neck, which has a green sheen. The bill is black and the eyes are red.

The breeding plumage of Yellow-Billed Loons is very similar to that of Common Loons. They are distinguished from Common Loons primarily by their pale bill. During the breeding season, Yellow-Billed Loons are found in the far northern arctic habitat of North America, Europe, and Asia. Their winters are spent along the west coast of North America, and the coasts of Europe and Asia.

Breeding Arctic and Pacific Loons are strikingly beautiful birds, with their gray heads, vertical white stripes along the sides of the neck and the chest, black and white checkered backs, and a glossy black throat. They differ slightly in size, vocalizations, and coloration, primarily of their throats, which shimmers green in the Arctic Loon, while that of the Pacific Loon has purple highlights. Pacific Loons summer in Alaska, the Russian Far East, and northern Canada,



and winter primarily along the west coast of North America. Arctic Loons, on the other hand, breed in northern Asia and Europe, and winter along both coastlines.

In their breeding plumage, Red-Throated Loons have vertical white stripes rising up the back of the neck to the top of their gray head. Their red throat contrasts clearly with the gray of the neck and the white chest. The back is darkish gray. The smallest, farthest ranging, and most unique of the loon species, the Red-Throated Loon breeds in northern North America, Europe, Asia, and Greenland, and winters along the coasts of these continents (Dennis, 1993; Strong, 1995; Dregni, 1996).

As fall approaches, the plumage of all loon species takes on subtle changes, slowly becoming grayer and relatively drab. The characteristic black and white feathers dot the surface of the water as the birds preen and the winter plumage grows in. Wintering loons have a dull gray back and a white underbelly. The different loon species can be difficult to distinguish in their winter plumages unless close observations are made.

Loons require a long “runway” of water to gain speed before becoming airborne. Loons are actually incapable of taking off from solid ground.

Common Loons are regularly observed throughout New York during their migration to and from their breeding lakes. In winter, Common Loons can be found in New York near Long Island in the Atlantic Ocean, as well as on Lake Ontario, the Finger Lakes until ice-up, and on the lower Hudson River. Yellow-Billed and Red-Throated Loons are also occasionally observed in New York during their migration to wintering waterbodies along the east coast.

The “Terrestrially Challenged Northern Diver”

Common Loons are extremely well adapted to their aquatic environment. Loons only come to land to breed, incubate their eggs, or when they are gravely ill. Occasionally called a "feathered fish", their elliptical streamlined body shape is designed for swimming and diving. Their bodies have become so specialized that loons are actually compromised in their ability to move about on land and to become airborne.

The bones of loons are very dense and thick, providing them with the ballast to dive through the water at will. However, this specialization results in a very heavy body, so that loons require a long “runway” of water to gain speed before becoming airborne (McIntyre, 1988). Common Loons are actually incapable of taking off from solid ground. If one has the misfortune to become "iced in" during a sudden cold spell, or lands in a field or on a road during bad weather, it is grounded and unable to fly, despite being perfectly healthy. It is literally trapped where it is, and must wait until it is rescued, the ice melts, or it dies.

The legs of a loon are also unique, and designed for their underwater skills. The thighs are enclosed within the body, while the lower legs and feet are placed far back near the base of the tail. The feet are turned to the side, resulting in excellent propulsion through the water. However, this adaptation causes adult loons to be "terrestrially challenged" – they are virtually incapable of walking on land, since their body is balanced so far ahead of their legs. They fall forward when attempting to take a step on solid ground. Loon legs are also flattened, enabling them to cut through the water like a knife, thus reducing drag against the water. As the legs move forward, the foot web closes, minimizing resistance through the water. The foot web opens up when used for propulsion, powerfully forcing the loon ahead or down deep into the water.

The Loon as a Predator – Favorite Foods

Primarily a piscivorous (fish-eating) species, the Common Loon is a visual hunter, preying on a variety of fish species, crustaceans, and aquatic invertebrates. In conditions of dark water or dense vegetation, loons may not be able to fish effectively if their vision is obscured. Adult loons prefer to hunt in shallow water, from three to six feet in depth, which correlates well with the fish species that live in the littoral zone where rooted plants can grow to the water's surface (Strong, 1995).

Loons opportunistically hunt prey species that are easiest to catch and most abundant. Thus, despite the spiny fins, yellow perch (*Perca flavescens*) are often a primary prey species, because perch swim erratically when pursued and live in the shallower levels of the lakes, where visibility is good. Species such as trout and suckers, however, swim in a straight line and aim for deep water when chased, making capture more difficult (Barr, 1973; Barr, 1996). In the winter, fish species such as flounder and herring, as well as crustaceans, are also regular components of their diet (McIntyre, 1988). Fish weighing 10-70 grams are predominantly eaten, but larger fish (up to 250-300 grams) may occasionally be taken. Loons routinely ingest small stones (pea-sized in adults, smaller in chicks), maintaining an average of 10-20 stones in the gizzard. This grit aids in the grinding of hard material, such as fish bones or the shells of crustaceans, before it passes into the lower digestive tract (Barr, 1973; Barr, 1996).

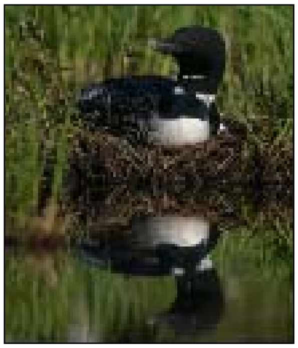
Primarily a piscivorous (fish-eating) species, the Common Loon is a visual hunter, preying on a variety of fish species, crustaceans, and aquatic invertebrates.

Feeding dives average less than a minute, but dive time has been attributed to prey availability, with longer dives recorded on lakes where conditions (e.g.: acidity of water) resulted in greater difficulty in finding or capturing food (Parker, 1985a). Male loons are larger than females, and are capable of capturing larger prey items. This sexual dimorphism enables loons to partition food resources between males and females, thus reducing competition for prey (Barr, 1973).

When feeding young chicks, adult loons catch prey items appropriate to the size of the chicks. Black downy chicks will receive prey that are two to five centimeters in size, such as small crayfish, sunfish, and minnows. Loons have also been observed feeding aquatic plants to their young, although these may have been accidentally fed in conjunction with giving the chicks aquatic animals (Taylor, 1974). Immature loons in juvenile plumage are capable of eating larger items, up to several inches in length. Common Loons primarily feed their chicks prey from the lakes on which the young were hatched (McIntyre,1988). However, under rare circumstances, such as when prey availability is minimal due to acidic conditions, Common Loons have been observed flying to another lake to capture fish and returning to the natal lake with food for their young (Parker, 1985b).

Raising the Loon Family

In late April and early May, even with the lakes still ice-covered, Adirondack residents will hear loons flying overhead. It is often observed that loons return



to their territorial lakes the day the ice lets out and open water is available. Loons migrate northward along several routes. In the Adirondack Park, they initially arrive on larger waterbodies, such as Lake Champlain. Then, as the weather turns warmer and the ice breaks up, they take daily flights away from these large lakes to check on their breeding lakes. Unless they switch mates or territories, approximately 80% of loons will return to the same breeding lake and territory year after year (Evers, 2001). Breeding males and non-breeding adults usually return to the lakes first, followed by breeding females. This consistency enables the loon pair to minimize time spent on courtship rituals and begin the process of building a nest and laying eggs (McIntyre, 1988).

Both parents incubate the eggs, and black, downy chicks hatch after 26-30 days.

Courtship displays are subtle, consisting of bill dipping, circling, and swimming quietly together. Suitable breeding habitat includes an offshore nest site that is minimally disturbed, and is away from terrestrial predators and other pairs of loons. Nests are commonly situated on the edge of an island and adjacent to deep water, enabling a loon to slip into the water virtually unnoticed if danger threatens. If no islands are available, loons will also nest on logs, rocks, and pieces of bog mat (McIntyre, 1988).

One or two (rarely three) large, olive-brown spotted eggs are laid two to three days after mating. Incubation usually begins in late May or early June, although it may occur later, particularly if the first nest fails and the birds renest. Both parents incubate the eggs, and black, downy chicks hatch after 26-30 days. Since incubation is initiated after the first egg is laid, the eggs hatch asynchronously. As a result, the first chick that hatches is larger than the second chick. The older chick establishes dominance over the younger chick, receiving food first and growing more quickly. This sibling rivalry can result in a significant size difference between the two chicks, and can occasionally cause the younger chick's demise, if it is attacked by the older chick or does not receive sufficient food for growth and survival (Barr, 1973; McIntyre, 1988).

The chicks are initially raised in a sheltered, "nursery" area of the lake, where they grow rapidly, almost doubling their weight each week for their first month of life, and changing to a dusky brown down at two to three weeks of age. The chicks gradually expand their use of the rest of the territory over the next two to three months, as the gray juvenile plumage eventually replaces the down. Primary feathers are last to develop, and, although they are the size of adults, juvenile Common Loons are incapable of flying until about eleven weeks of age, when the primaries are fully expanded (Barr, 1973; Strong, 1995).

Heading South

As day length shortens and the air grows chilly in the northern lakes, Common Loons "stage up" for migration, gathering together in large groups. Normally viewed as single or paired, during the staging process loons become much more social and can be observed in groups of 10, 20, or more. Non-breeding adults will begin to cluster together in mid-August, and start to migrate as early as the end of August and beginning of September. They are usually observed flying overhead in small groups migrating to the coast for the winter. Grouping together enables loons to decrease search time and improve foraging efficiency on unfamiliar waterbodies encountered during migration (McIntyre and Barr, 1983).

Adult loons that were successful in raising chicks continue to care for their young until the immature birds fledge at about 11-12 weeks of age. Then the parents will spend more and more time away from the fledglings, and usually migrate to the coast in September or October. Once the primary feathers are fully grown in, juvenile loons begin short practice flights to nearby lakes and gain experience catching prey. Loon chicks usually leave their natal lake after their parents, even into late October and November, depending on when they hatched. They will spend the next three to four years riding the coastal waves before returning to the area of their natal lakes in breeding plumage (Evers et al., 2000; Evers, 2001).

Loon Communication

Loons communicate with a variety of vocalizations, some subtle, some loud and eerie to the uninformed observer. The hoot, wail, tremolo, and yodel are the primary sounds loons use to communicate with each other. Often they will combine two or more sounds, or members of a pair may call at the same time, producing a duet.

The hoot is a soft, short contact call between birds. Adults will hoot to each other, and parents will hoot gently to chicks, enabling them to keep in touch with the other birds. When diving to feed chicks, parent birds hoot each time they surface with fish. The chicks then swim rapidly to the adult birds, begging all the while (pers. obs.).

Wails are longer, mournful calls of one, two, or three notes produced by birds when they are separated and want to move closer to one another. Parents wail to their chicks to encourage them to leave the nest, approach to be fed, or to emerge from a hiding place (McIntyre, 1988).

The tremolo, often called the "laughing call" of the loon, is an alarm call used when birds feel threatened, such as when a boat or a predator is approaching a chick or a nest too closely. A version of the tremolo is also used during flight and during the “nocturnal chorus”. Members of a pair will duet as a distraction display when defending nests or chicks, using tremolo calls, often mixing them with wails and yodels (Barklow, 1979).

Loons communicate with a variety of vocalizations, some subtle, some loud and eerie to the uninformed observer.

The yodel is produced exclusively by males, and is used in territorial situations and aggressive encounters with other loons. Males also yodel if a predator is approaching the chicks or territory, as when an eagle flies overhead. The posture of a male is distinctive when yodeling – it crouches flat to the water, with head and neck extended, and the lower bill just above the water. Each male has a distinctive yodel, enabling individual birds to identify each other. Male loons may change their yodel if their social status changes, such as following a territory switch (Walcott et al., 1999).

Chicks use a begging call when hungry, and simultaneously peck at the parent’s bill, encouraging the parent to hunt for food for the chick. Young loons will continue to beg from their parents even when they are fully capable of hunting for themselves as fledglings. When separated from their parents or when under attack by a predator or a sibling, chicks call almost continuously with a distress call, including peeps, yelps, and wails. The adult birds respond by moving closer to the chicks, and may hoot or wail to contact the chick (McIntyre, 1988).

CONSERVATION ISSUES AND FACTORS AFFECTING THE POPULATION OF BREEDING LOONS IN THE ADIRONDACK PARK

The productivity and survival of loons are affected by a variety of factors, both natural and anthropogenic. Although loons are present on many lakes in the Adirondack Park, not all the birds reproduce, and many eggs and chicks are lost to a variety of circumstances every year. Population models indicate that the rate of population growth may not be accurately reflected in periodic surveys in such a long-lived species. The size of the population of non-breeding loons (called the buffer population) can mask the true effect of threats impacting the breeding population until the buffer loons have been fully incorporated into the breeding population (Evers et al., 2002). Thus, it is important to consider the current status of both breeding and non-breeding loon populations, as well as the impact of different threats on the population growth rate, to fully evaluate the long-term status of the population of Common Loons in the Adirondack Park.

Many factors affecting loons are a direct or indirect result of human activity. Minimization or elimination of these anthropogenic threats will restore a better balance to the Adirondack loon population, and lessen the relative impact of natural threats, such as predation or nest loss due to flooding from excessive rain. The following sections provide an overview of the anthropogenic and natural factors that currently impact, or have potential to impact, the population of loons breeding in the Adirondack Park.

Mercury – The Insidious Toxin

Mercury is released as a gas from a variety of anthropogenic sources (e.g.: coal burning power plants, waste incinerators, mining, and smelting), and is carried suspended in the atmosphere on global currents, such as the jet stream, from the Midwest east to New England. Mercury precipitates to earth attached to rain, snow, or dust particles, and then runoff washes it into lakes and ponds. Contamination is highest in acidic waterbodies where elemental mercury is converted at a faster rate to the more toxic form, called methylmercury, and in waterbodies with high degrees of water level fluctuations, such as reservoirs for hydroelectric dams (Simonin et al., 1994). Water level fluctuations increase the exposure of contaminants in sediments at low water levels and increase mixing of the sediments and water (Evers and Reaman, 1998).

Exposure to contaminants is high in aquatic animals, where contaminants can accumulate at increasing levels in the food chain, a process called biomagnification. Thus, predators at the top of the food chain, such as loons and other fish-eating animals, are exposed to higher concentrations of toxins than animals lower in the food chain, including fish and plankton.

Mercury levels in freshwater and marine fish in North America are at levels that pose significant health risks to humans and wildlife that consume fish.

Mercury levels in freshwater and marine fish in North America are at levels that pose significant health risks to humans and wildlife that consume fish. The Environmental Protection Agency (EPA) has issued a national advisory for women of child-bearing age and young children to limit the consumption of non-commercial freshwater fish to minimize the accumulation of mercury. Many states have also issued advisories listing specific waterbodies where testing has documented high concentrations of mercury in certain species of fish. In New York State, the 2002-2003 Department of Health advisory recommends limiting the consumption of fish due to mercury contamination from eighteen lakes in or near the Adirondack Park (NYS DOH, 2002). The NYS DEC is currently conducting research to determine the mercury levels of fish from additional lakes throughout the Park and New York (H. Simonin, NYS DEC, pers. comm.). In the Adirondacks, mercury is the atmospheric toxin with the greatest impact, other than acid deposition, on the ecosystem (Simonin and Meyer, 1998).

In an effort to decrease the level of mercury contamination in the environment at the largest human-caused source, the EPA announced in December, 2000, that it will regulate mercury emissions from coal-fired power plants. The EPA will propose mercury regulations by 2003, final regulations will be issued in 2004, and power plants are expected to be in compliance by 2007. In addition, as part of the 1990 Clean Air Act, the EPA has initiated regulations to reduce mercury emissions from other major sources, including municipal waste combustors, medical waste incinerators, and hazardous waste incinerators (US EPA, 2000).

Mercury levels in loons generally increase from west to east across North America, with the highest levels occurring in birds breeding in New England and eastern Canada (Evers et al., 1998). High levels of mercury are correlated with behavioral changes that lead to decreased reproductive success, decreased survival of juvenile and adult loons, and increased susceptibility to other diseases (Evers et al., 2002). In Maine, it is estimated that 26% of the breeding loon population has unacceptable levels of risk due to methylmercury accumulation and that at least 19% of loon eggs are potentially impacted. The Adirondack Cooperative Loon Program is currently conducting research in the Adirondack Park to determine the impact of mercury contamination on the

breeding population of loons in the Park. Preliminary results indicate that 17% (16 of 93 loons) of the birds sampled from 1998-2000 have mercury levels high enough to result in behavioral changes or decreased reproductive success (Schoch and Evers, 2002). Reports summarizing results of this mercury research are posted on the ACLP website, www.adkscience.org/loons, as they become available.

Researchers classify loons into four risk categories based on the blood or feather mercury levels of the birds. Loons classified into the low and moderate risk categories indicate that they have been exposed to mercury in the environment accumulating in the food chain, but that the mercury levels are not elevated enough to result in perceptible impacts on behavior or reproductive success. Birds in the high or extra-high mercury risk categories have noticeable changes in behavior and decreased reproductive success due to the increased mercury levels in their bodies (Evers et al., 2002).

Adult loons with elevated mercury levels exhibit neurologic and behavioral changes that result in decreased normal activities, such as feeding and defense from other loons and predators. Reproductive success also decreases, due to reduced egg laying and to decreased time spent incubating eggs and feeding juvenile loons (Barr, 1986; Evers et al., 2002). Loons with extremely elevated levels of mercury in their bodies hatch 37% fewer young when compared to low risk pairs (Evers et al., 2002).

Immature loons are more susceptible to the toxic effect of mercury than are adult birds. Significant behavioral differences occur in immature loons with high methylmercury levels, including increased preening and decreased time spent riding on the parents' backs (Nocera and Taylor, 1998; Counard, 2001). These behavioral changes result in increased exposure to predators and increased energy expenditure, contributing to decreased survival of young loons.

Mercury levels in loon eggs and chicks are especially revealing as they represent recent dietary uptake of mercury from the lakes on which the eggs were laid or the chicks were hatched, since chicks are fed prey primarily from their natal lakes (McIntyre, 1988; Evers et al., 2003; Fevold et al., 2003; Kenow et al., 2003). Adult loon blood mercury levels also represent recent dietary uptake of mercury by the birds. However, feather mercury levels in adults reflect

At some locations in the Northeast, mercury levels in loons increase annually at a rate that is predicted to significantly reduce individual lifetime reproductive success and survival.

mercury that has accumulated over their lifetimes while feeding on a large number of different waters during migration and on the breeding and wintering grounds.

Loons can rid their bodies of mercury through deposition of mercury in feathers and eggs. Thus, with every molt, and for females, with every egg laid, mercury is depleted. However, ingestion of fish with a high mercury content causes loons to accumulate mercury faster than they can rid their bodies of it through depuration in feathers and sequestration in eggs. This is particularly true for male loons, since they lay no eggs. At some locations in the Northeast, mercury levels in loons increase annually at a rate that is predicted to significantly reduce individual lifetime reproductive success and survival (Evers et al., 2002).

Acid deposition changes soil chemistry ... reducing the ability of soils to buffer acid inputs, and acidifies lakes and streams, detrimentally affecting aquatic life.

Acid Rain

Acid deposition, more commonly known as "acid rain", results from the emission of sulfur dioxide and nitrogen oxide compounds by a variety of sources, primarily from power plants in the midwestern United States and Ontario, and from vehicles. These acidic compounds are blown across eastern North America by westerly winds and fall back to earth as dry deposition in the form of particles and gases, cloud and fog deposition, or as wet deposition in the form of rain or snow. Acid deposition changes soil chemistry, impacting forest vegetation and reducing the ability of soils to buffer acidic inputs, and acidifies lakes and streams, detrimentally affecting aquatic life (Driscoll et al., 2001a; Driscoll et al., 2001b).

The poor buffering capability of the thin, acidic soils and nutrient-poor waterbodies in the Adirondack Park make lakes and ponds within the Park particularly susceptible to acidification. Acid deposition leads to decreased prey (fish and insect) diversity and abundance. Loons adapt to decreased prey availability by feeding prey items to chicks that are smaller or larger than normally preferred (Parker, 1985a). Adult loons on acidic lakes spend more time feeding their chicks and have longer dive times. Chicks beg more frequently than those on less acidic waterbodies, and aquatic insects are the primary prey items rather than fish species (Parker, 1988). On rare occasions, adult loons raising chicks on acidic waterbodies have been observed flying to nearby lakes to capture fish and returning to the natal lake with prey for the young, a very unusual behavior for Common Loons (Parker, 1988).

Acid deposition also contributes to increased availability of methylmercury in affected waterbodies, leading to greater bioaccumulation of methylmercury in the food chain. In Wisconsin, loon egg mercury levels are higher on more acidic lakes (Fevold et al., 2003; Kenow et al., 2003). In the Adirondacks, mercury levels in yellow perch and loons correspond to the acidity of the waterbody on which they were captured; animals with the highest tissue mercury levels were from acidic waterbodies (Simonin et al., 1994; Driscoll et al., 1995; and Schoch and Evers, 2002).

The Clean Air Act Amendments of 1970 and 1990 have resulted in lowered deposition of sulfur dioxide, but have had negligible effect on the deposition of nitrogen oxide compounds (Driscoll et al., 2003). The Adirondacks and other affected areas are now more sensitive to acid deposition due to the accumulation of acids and loss of buffering capacity in the soil. Recent analysis of lakes in the Adirondack Park that are monitored long-term indicate positive changes in several water chemistry parameters, including improvement in pH and sulfuric acid (Driscoll et al., 2003). However, computer models indicate that current emission regulations are not sufficient to achieve full recovery of sensitive ecosystems for many decades, and that further reductions in emissions of acidic compounds are needed to realize and accelerate effective chemical and biotic recovery of the environment (General Accounting Office, 2000; Driscoll et al., 2001a; Driscoll et al., 2001b).

The need to decrease emissions causing acid deposition has resulted in legislative and legal action at both the federal and state levels, including in New York. Legal action against power companies failing to meet the requirements of the Clean Air Act has resulted in settlements reducing acidic emissions and providing funding for environmental projects (Dybas, 2001). At the time of this writing, several legislative efforts are under consideration in the United States to limit emissions beyond the levels currently permitted under the Clean Air Act. For example, the Clean Power Act of 2001, sponsored by Senator Jeffords, would set strict limits on airborne emissions of sulfur dioxide, nitrous oxides, mercury, and carbon dioxide.

New York State recently set stricter emission standards for vehicles sold in the state, and passed the Acid Rain Pollution Credits Trading Bill, which prohibits New York utilities from selling pollution credits to fourteen states upwind from New York (Residents Committee to Protect the Adirondacks, 2000). In the spring of 2003, New York State's Environmental Board passed the most stringent acid rain controls of any state in the nation. These regulations will reduce sulfur dioxide emissions from New York power plants by 50% and nitrous oxide emissions by 70% below the levels allowed by the 1990 Clean Air Act Amendment. Nitrogen oxide emissions will also be regulated year-round instead of just seasonally (NYS Governor Press Release, 2002).

Human Disturbance

Loons are capable of adapting to a variety of conditions. However, particularly during the breeding season, a threshold of tolerance may be reached that will cause a nest to fail or result in the death of chicks or adults. Paddlers, campers, motorboaters, and "jet-skiers" all can contribute to disturbance of loons and other wildlife sharing the waterways. Disturbance of a loon on a nest interrupts incubation, and can lead to nest failure or abandonment. The increased level of disturbance of incubating loons associated with the Memorial Day and Fourth of July holidays is of particular significance, since failure of an original nest may occur on Memorial Day, followed by failure of a renesting attempt on July Fourth. A third nesting attempt is extremely rare, and would result in chicks hatching so late in the season that they would be unlikely to fledge prior to the lakes freezing over for the winter. Disturbance of wildlife is easily preventable by observing normal behavior and habits from a distance. In some areas, loon nesting sites are actively managed to minimize human disturbance, resulting in increased nest success (Kelly, 1993; Loon Preservation Committee, 2001).

Loons are capable of adapting to a variety of conditions. However ... a threshold of tolerance may be reached that will cause a nest to fail or result in the death of chicks or adults.

Adult loons will vigorously "dance" on the water or call loudly to distract predators and people away from chicks or a nest. Although an upset loon is an amazing sight to watch as it performs its "penguin dance" and calls with tremolos or yodels, recreationists should recognize that they are too close, and withdraw so as to minimize interference with the raising of the young. Repeated displays by adult loons require the expenditure of high amounts of energy on territorial defense, resulting in less time devoted to the care of chicks, feeding, and resting. Recreationists on the water can help significantly by staying away from the shoreline, keeping a sharp eye out for loons (and other wildlife), and giving them a wide distance to feed and care for their young.

Personal Watercraft ("Jet Skis")

Personal watercraft (PWC), often known as "Jet Skis", are designed to ride high on the water, and do not have a propeller. Thus, they are capable of entering shallow waterways or closely approaching shorelines where loons nest. They can be driven at high speeds, are loud, and their two-stroke engines are polluting. The use of personal watercraft in the Adirondack Park and throughout North America has increased dramatically in the last decade, along with the growing human population. In New York State, Department of Transportation registrations of PWCs increased from ~51,000 in 1997 to ~58,000 in 2000 (M. Barnes, pers. comm.).

Loon nests and young chicks are easily swamped by the wake of a PWC or a motorboat, resulting in chilling of the eggs or chicks, and possible abandonment by the parents. Loons regularly exposed to interruptions from PWC or motorboat traffic are less likely to successfully raise their chicks. Documented and anecdotal reports of loons and other waterbirds being chased, injured, or killed by PWCs have risen correspondingly throughout the northeast (Miconi et al., 2000; M. Godin pers. comm.). In New Hampshire, the reproductive success of loons living on Lake Winnepesaukee, where PWCs are permitted, is lower than on Squam Lake, where they are banned (Vogel, 1999).

Many states have passed regulations restricting the use of personal watercraft to reach a compromise between the different constituents using the waterbodies within the state, and to preserve the environment and its wild inhabitants. In New York, the Jet Ski Home Rule bill was passed in the fall of 2000. The Home Rule Bill enables local governments to create Personal Watercraft Regulation Zones on lakes within their townships. The use, hours or days of operation, horsepower, and speed limits of PWCs is regulated within these zones (Residents Committee to Protect the Adirondacks, 2000). To date, the Towns of Johnsburg, Brighton, Webb, and the Villages of Lake Placid and Lake George have implemented the Home Rule Bill, regulating or banning the use of PWCs on lakes within their townships, and several other towns are considering similar regulation.

In addition, the Jet Ski Emissions Control Bill also passed in 2000, and subsequently, in 2003 NYS's Environmental Board announced regulations to reduce emissions from personal watercraft sold in New York State beginning in 2006 (Residents Committee to Protect the Adirondacks, 2000; NYCRR Part 210, 2003). Implementation of the Jet Ski Home Rule and the Emissions Control Bills will create a better balance between human motorized use of Adirondack waterways and maintaining environmental quality for humans and wildlife.

People visiting an island or paddlers moving along a shoreline too closely can inadvertently cause adult loons to leave their nests.

Paddlers and Campers

People visiting an island or paddlers moving closely along a shoreline can inadvertently cause adult loons to leave their nests. In most cases, humans are unaware that they are disturbing the birds, as loons frequently slide unnoticed off a nest – people may not even realize that a nest is present. If eggs are exposed for long periods of time, or repeatedly uncovered, they become chilled and fail to hatch. Campers should avoid choosing sites near a nesting loon, as the resulting disturbance may cause the loons to leave the nest repeatedly, exposing the eggs to predation or chilling, and may even lead adult loons to completely abandon the nest.

Recreationists often misinterpret a distressed loon's behavior or vocalizations (e.g.: tremolos or yodels), and, instead of moving away, actually move closer to watch a bird or its chicks, which further upsets the bird. When raising chicks, loons are easily agitated by people and boats approaching them, and devote time and energy to defensive behaviors that are needed to successfully raise the chicks. Thus, it is important for people to understand what a loon's vocalizations and behaviors mean, enabling them to minimize disturbing the birds during the breeding season.

Shoreline Development

Researchers have observed reduced hatching success of loon eggs in nests near developed shorelines and increased human disturbance, compared to nests on less developed lakes. For chicks that hatched, survival to fledging age was no different between nests exposed to intense development and those that were in less developed areas, presumably because the parents moved the chicks to a less disturbed area of the lake after hatching (Heimberger et al., 1983).

In the Adirondack Park, over 8000 new houses were built in the last decade, primarily along lakeshores and roadsides (Bauer, 2001). The number of territorial loon pairs decreases as lake development increases (Stockwell and Jacobs, 1993; H. Vogel, pers. comm.). On a motorized lake in the Adirondack Park, higher numbers of loons were observed in areas of the lake that had less development and human activity (Eschbacher and Schwartzberg, 2000). The above studies indicate that shoreline development and human disturbance can lead to decreased reproduction in Common Loons through reduction of the number of territorial pairs on a lake and decreased hatching success.

Some individual loons are capable of habituating and adapting to human activity, whereas other loons react extremely defensively to even minor incursions into their territory. Such differences have been observed regardless of whether the waterbody is developed or not, or whether motorized boats or non-motorized boats are permitted (pers. obs.). Additional research will help determine the degree that shoreline development, and the increased disturbance and pollution associated with development, impact loon reproductive success in the Adirondack Park and throughout the Northeast.

Shooting

In the past, prior to the establishment of state and federal protection in the early 1900's, people commonly shot loons in the Adirondack Park and elsewhere throughout North America (Crowley and Link, 1987). They were considered a challenge to sportsman, as they were difficult to hit when they dove under water, and one was never sure where they were going to pop up next (McIntyre, 1979).

Times and attitudes have changed considerably. In the United States, it is now illegal to kill or possess any bird protected by the Migratory Bird Treaty Act (it is also illegal to possess the feathers, nests, and eggs of migratory birds). However, incidents of shooting loons do still occur, and death due to shooting is still a mortality factor affecting Common Loon populations (Franson and Cliplef, 1993). For example, in 2000, a loon was found shot to death on an Adirondack lake, and loons were observed being shot on a regular basis on their wintering grounds along North Carolina beaches during the spring of 2003 (K. Karwowski, USFWS, pers. comm.).

Fishing

Lead Poisoning

Anglers occasionally lose fishing tackle – either through snagging a line or when a fish breaks the line. Unfortunately, fishing tackle containing lead has toxic consequences for loons and other waterbirds who inadvertently eat such items. Ingestion of lead fishing tackle causes lead poisoning, and eventually death, when the acidic environment of the bird's stomach breaks down the metal weights. In the United States and Canada, it is estimated that hundreds of tons of lead fishing tackle are deposited in marine and fresh waters annually, primarily through loss of sinkers and jigs while fishing (Scheuhammer and Norris, 1995). In New York, Englebright (1994) estimated that millions of lead fishing sinkers are deposited in New York's freshwater lakes, ponds, and rivers each year. More than 20 species of waterbirds, including loons, are affected by lead toxicity due to ingestion of lead fishing tackle.

Lead toxicity due to ingestion of lead fishing tackle has been determined to be a significant factor in the mortality of Common Loons throughout the northeastern United States and New York.

Loons accidentally ingest lead fishing sinkers or jigs while they are feeding,

if fishing tackle is still attached to a fish, or when they pick up small stones, which aid in grinding up food in the gizzard. Lead toxicity due to ingestion of lead fishing tackle has been determined to be a significant factor in the mortality of Common Loons throughout the northeastern United States and New York. Excluding catastrophic events, such as the botulism outbreak on Lake Erie, lead toxicity has accounted for approximately 20-49% of the deaths in breeding adult loons brought in for necropsy over the last decade to the NYS Wildlife Pathology Laboratory and the Wildlife Clinic at the Tufts University School of Veterinary Medicine (Stone and Okoniewski, 2001; Sidor et al., 2003).

Lead poisoning is one anthropogenic cause of mortality in Common Loons that can easily be prevented through the use of non-lead fishing tackle and public education programs. A simple change in fishing hardware can have tremendous benefits for loons and other aquatic birds that fish or feed in affected waters. Efforts to reduce mortality in waterbirds due to lead poisoning have been made in Great Britain and Canada through regulation banning the use of lead fishing sinkers and jigs. In the United States, lead sinker use has been banned on some national wildlife refuges and national parks, and the U.S. Fish and Wildlife Service is currently considering banning the use of lead fishing tackle on all national wildlife refuges. New Hampshire and Maine have recently passed legislation regulating the use and sale of lead fishing tackle and promoting education of anglers about non-toxic alternatives. Vermont has implemented a public education program, including brochures and a lead sinker exchange program, to encourage anglers to voluntarily use non-lead fishing tackle alternatives.

In New York, legislation banning the sale of lead fishing sinkers weighing 1/2 ounce or less was passed in the spring of 2002, and will take effect in 2004. Implementation of this bill will eventually reduce the quantity of lead sinkers deposited in New York waterbodies, thus decreasing the chances of waterbirds ingesting lead fishing tackle and developing lead toxicity.

Common Loons occasionally die or suffer permanent injury when they accidentally ingest fishing hooks or become entangled in fishing line.

Education programs, such as the Lead Sinker Exchange Project initiated in 2002 by the Adirondack Cooperative Loon Program and the National Wildlife Federation, will result in increased awareness among anglers about the problems associated with lead fishing tackle use, and the availability of alternative types of fishing tackle. Through the Lead Sinker Exchange Project, Adirondack anglers have the opportunity to exchange their lead fishing tackle for a free sample of non-toxic sinkers at fishing tackle supply stores and boat launches throughout the Park. Anglers also can learn more about the toxic effects of lead on loons and other wildlife, and the availability of alternative fishing tackle by reading the free brochures available at the exchange sites.

Entanglement in Fishing Line/Ingestion of Hooks
Common Loons occasionally die or suffer permanent injury when they accidentally ingest fishing hooks or become entangled in fishing line. In some cases, a loon can live with a fish hook in its digestive tract without apparent problems until the hook deteriorates in the acidic environment of its stomach. However, in other instances, hooks pierce the digestive tract, leading to peritonitis (systemic infection) and death (W. Stone and M. Pokras, pers. comm.). Fishing line entanglement or ingestion of fishing hooks has accounted for up to 8% of the deaths of breeding adult loons brought in for necropsy to the NYS Wildlife Pathology Laboratory and the Wildlife Clinic at the Tufts University School of Veterinary Medicine (Stone and Okoniewski, 2001; Sidor et. al., 2003).

Many other species of wildlife, including waterfowl, songbirds, and mammals, are also affected by fishing line entanglement, which can result in infection, permanent injury, crippling defects, or death. On the ocean and large waterbodies outside the Adirondack Park, loons and other waterbirds commonly become entangled in commercial fishing nets (McIntyre, 1989; Forsell, 1999).

Water Level Fluctuation
Loon nests located along the shoreline of islands or on small hummocks of vegetation in the water may be affected by fluctuating water levels. If the water level drops during a dry period or due to lowering of a reservoir, the adults may abandon a nest, because it may become too high above the water for them to reach. Increased exposure of shoreline may also make a nest more susceptible to predation (Fair, 1979). On the other hand, if the water level rises either due to excessive rain or reservoir manipulation, the nest may become flooded, resulting in chilling or submersion of the eggs and failure to survive to hatching.

Water level fluctuation also causes stirring of the sediments at the bottom of a waterbody, releasing mercury trapped in the sediments and enhancing its conversion to methylmercury, a form toxic to wildlife. Thus, water level fluctuation impacts loon populations through direct effects on the nests, and through indirect effects by increasing the bioaccumulation of methylmercury in the waterbody's inhabitants.

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Nest Rafts
Artificial nesting platforms, also known as "nesting rafts", are occasionally placed by humans in an attempt to encourage a pair of loons to breed (McIntyre and Mathisen, 1977). Such platforms have proven to be an effective management tool in the right circumstances, such as when water levels flucuate during the nesting season or suitable nest sites are not readily available. Loon productivity has increased significantly in many places as a result of successful raft placement (Sutcliffe, 1979; DeSorbo and Evers, 2002; Piper et al., 2002).

However, rafts generally will not attract loons to a new lake or to an abandoned territory, nor will they inspire non-breeding pairs to nest. In addition, several potential problems must be considered before placing a nest raft. Using rafts may result in saturation and overpopulation of available territories, causing increased aggression between breeding pairs of loons, and leading to decreased survival of chicks to fledging, despite good hatching success. Improperly placed nest rafts can result in greater exposure to predators and disturbance from humans. If a raft is not securely anchored, it may break free, potentially resulting in loss of the nest and eggs, and possibly becoming a navigational hazard. Most successful rafts are placed in existing territories where a resident pair of breeding loons has repeatedly nested and failed due to changing water levels or predation. If used, rafts require annual maintenance and should be placed in an appropriate location (Loon Preservation Committee, 2001; S. Gallo, Maine Audubon Society, pers. comm.).

The use of nest rafts in the Adirondack Park is warranted only under conditions of fluctuating water levels and repeated failure of nesting attempts. On public waterbodies within the Park, placement of a nest raft may require a permit from the NYS Department of Environmental Conservation and/or the Adirondack Park Agency (B. Swift, NYS DEC, pers. comm.). The use of nest rafts currently placed in the Park is under study by the Adirondack Cooperative Loon Program to determine if loons have higher reproductive success on natural or artificial nests and to better understand the circumstances which are appropriate for nest raft placement.

Catastrophic Events

Oil Spills

Vessels transporting oil occasionally suffer an accident, resulting in oil spills along the coastline. Ocean-going wildlife, including Common Loons, are exposed to the toxic oil, which contaminates and reduces the water repellency of their fur or feathers. Oil is also ingested by the affected animal during grooming or preening. Hundreds to thousands of animals can be affected by a single spill. Although oil spill response teams work tirelessly to rehabilitate the animals, the success/survival rate is low, particularly for Common Loons (Tri-State Bird Rescue & Research, Inc., 1990).

Common Loons are primarily exposed to this hazard on their wintering grounds or during migration. Until recently, it was unknown exactly where loons migrated, and what problems, such as oil spills, affected them on their wintering areas. However, new monitoring techniques, including genetics research, banding, and satellite telemetry, now make it possible to determine which population(s) of breeding loons has been affected by an oil spill. Thus, mitigation funds can be delegated to the state(s) whose breeding population of loons is impacted, providing funding for habitat restoration and management of loon populations (A. Major, USFWS, pers. comm.).

Botulism

Avian botulism, a disease caused by the bacterium *Clostridium botulinum*, produces toxins under anaerobic conditions in the presence of a protein source and at optimum temperatures. Periodic outbreaks result in large die-offs of affected birds, primarily migratory waterfowl and fish-eating birds. Ingestion of the toxin causes paralysis – birds are unable to fly, walk, or hold their heads up (a classic sign called “limber neck”). The toxin acts rapidly, and birds can show clinical signs and die within hours after ingestion, despite being in good body condition (Franson and Cliplef, 1999; Friend and Franson, 1999). Outbreaks of botulism have potential to significantly alter the structure and existence of affected waterbird sub-populations.

Since 1999, an outbreak of Type E botulism has occurred annually on Lake Erie, causing several die-offs of bottom-feeding fish species and the death of thousands of migratory fish-eating birds, including Common Loons, Red-breasted Mergansers (*Mergus serrator*), cormorants, and a variety of gull and duck species. Based on transects conducted along the New York portion of the Lake Erie shoreline by the NYS Department of Environmental Conservation, it was estimated that over 6000 birds were killed in New York by the toxin in 2000, including approximately 600 Common Loons and 2500 Red-breasted Mergansers (Kandel et al., 2001; Sea Grant, 2001). The total number of birds of all species (~3000 in New York) that were affected by botulism was lower in 2001, although it was estimated that approximately 1000 loons died along the New York portion of the shoreline that year. The total loon mortality for all of eastern Lake Erie, a much larger area that includes the Ontario, Ohio, and Pennsylvania shorelines, is estimated between 3000-4000 loons annually from 2000 and 2002. The Common Loons affected were assumed to have been migratory birds from the midwestern states and Canada, rather than birds breeding in the Adirondack Park, since Lake Erie is west of the migratory path for the Adirondack breeding birds (K. Roblee, NYS DEC, pers. comm.).

The exact mechanism of the botulism outbreak on Lake Erie has yet to be fully determined. The bird species affected depend upon what species are migrating through Lake Erie when the temperature drop occurs. Researchers are currently examining the role that round gobies (*Neobogius melanostomus*) and quagga mussels (*Dreissena bugensis*), both invasive exotic species, may play in the transmission of the Type E toxin. High numbers of gobies have been found in the digestive systems of the affected birds, and the gobies contained quagga mussels and Type E botulinum toxin (K. Roblee and W. Stone, NYS DEC, pers. comm.). Research planned by the NYS DEC will assess the impact of Type E botulism on Great Lakes waterbirds. In particular, this study will help determine if specific sub-populations of Common Loons use Lakes Erie and Ontario, and identify the breeding and wintering grounds for those sub-populations (B. Swift, NYS DEC, pers. comm.).

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Loon eggs are susceptible to predation by raccoons, otters and gulls. Loon chicks often fall prey to eagles, snapping turtles, large fish, and other loons.

Diseases

In addition to botulism, Common Loons are susceptible to a variety of diseases and parasites. Aspergillosis, air sacculitis, peritonitis, umbilical infections in chicks, and cancer have all been determined to be causes of mortality in loons. Diseases or parasites may not directly cause the death of a loon, but can weaken a bird's immune system, making it susceptible to other factors, such as attacks by other loons, leading to its death. On the other hand, another condition can result in the exacerbation of an underlying low-grade infection or parasite. For example, the stress of a trauma may lead to an overgrowth of Aspergillosis, a fungal infection of the respiratory tract, which can weaken the bird enough to ultimately result in its death. Thus, in many cases, factors contributing to mortality will act synergistically, and more than one problem will be detected on necropsy (Franson and Cliplef, 1993; Stone and Okoniewski, 2001; Sidor et al., 2003).

Predation/Interspecific Competition

Loon eggs are susceptible to loss by both mammalian and avian predators, including ravens (*Corvus corax*), raccoons (*Procyon lotor*), otters (*Lutra canadensis*) and gulls (*Larus spp.*). High populations of opportunistic predators, such as raccoons and gulls, are associated with human populations. Thus, loon egg loss and nest failure tend to be higher near areas of human development (Titus and VanDruff, 1981).

Loon chicks often fall prey to eagles, snapping turtles (*Chelydra serpentina*), large fish (e.g.: northern pike (*Esox lucinus*)), and other loons. The successful reintroduction of the NYS endangered Bald Eagle (*Haliaeetus leucocephalus*) into the Adirondacks in the 1980's has resulted in a growing population of eagles throughout the Park (P. Nye, NYS DEC, pers. comm.). Correspondingly, the number of observations of Bald Eagles harassing and killing loon chicks and adults has also increased, and has resulted in fewer loon chicks surviving to fledging on affected lakes within the Park (D. Andrews and J. McIntyre, pers. comm.).

Adult loons are also susceptible to harassment or predation by species such as otters and eagles, particularly if the loon is already compromised by another problem, such as an injury or lead toxicity. In addition, intraspecific competition can lead to nest failure or abandonment, chick mortality, and trauma or death of adult birds. Adult loons can be extremely territorial, aggressively attacking each other. These attacks result in injuries, such as sternal puncture wounds, which can be severe enough to contribute to the death of the injured loon (Franson and Cliplef, 1993; Stone and Okeniewski, 2001; Sidor et al., 2003).

LOON RESEARCH AND MONITORING IN NEW YORK STATE

Why Study Loons?

Common Loons are listed as a Species of Special Concern by the New York State Department of Environmental Conservation. This designation reflects the fact that, although loons are not endangered or threatened, there is concern for the continued welfare of the loon population summering in New York. Common Loons, their feathers, eggs, and nests are also protected by federal law under the Migratory Bird Treaty Act.

Loons have a long life span, often living 25-30 years, and produce only one or two (rarely three) young each year. This strategy of reproductive success requires considerable parental investment, but helps ensure the survival of the young to fledging, and potentially adulthood, in an environment that is stable or predictably seasonal in time. On the other hand, many species of waterfowl live for shorter periods of time and produce numerous young each year with less parental investment per chick, but lose the majority of young to predation and other factors (Dasmann, 1981; Begon and Mortimer, 1981). The slow reproductive response of loons can make loon populations particularly susceptible to impacts, compared to waterfowl species, which have a relatively rapid reproductive response.

Common Loons are also highly territorial, returning to the same area each spring, and usually to the same territory on the same lake. The development of a technique to uniquely identify loons through color banding has enabled much groundbreaking research to be conducted on the behavior and reproductive success of this species (Evers, 1993a; Evers, 1993b). For example, banding studies have shown that loons do not necessarily mate for life as had been previously believed, and that if a mate switch or a territory switch does occur, the displaced bird moves to another lake usually less than a mile or two away

(Piper et al., 1997; Piper et al., 2000; Evers, 2001).

Loons are predators at the top of the food chain, feeding primarily on their territorial lakes during the breeding season. Thus, changes in their tissues are reflective of the water quality of the lake on which they reside (McIntyre, 1988; Evers et al., 1998). Other species of fish-eating animals, such as eagles and otters, have larger feeding territories, are more difficult to catch for sampling and banding, and their diets are not as consistent. Bands are also difficult to detect in such species. In loons, band colors can be reliably determined year after year.

These characteristics combine to make Common Loons an ideal indicator of long-term environmental quality trends. Individually marked birds (using colored plastic bands) can be monitored over time to determine such factors as reproductive success, mate and territory bonding, and accumulation of environmental contaminants.

Loons are predators at the top of the food chain, feeding primarily on their territorial lakes during the breeding season.

Population Surveys

A survey of the breeding population of loons in the Adirondack Park was conducted during the summers of 1977 and 1978. Observations on 301 lakes throughout the Park indicated that the population was low in density, but high in productivity (estimated at 0.83 chicks fledged/pair of breeding adults; Trivelpiece et al., 1979). In the summers of 1984 and 1985, NYS DEC conducted a second survey of breeding loons in the Adirondack Park, finding 157 breeding pairs and 196 chicks on 500 lakes and ponds. Two hundred and forty-seven non-breeding adult loons were also counted. It was estimated that 200-250 breeding pairs, and a total of 800-1000 adult loons inhabited the waterbodies of the Adirondacks. Compared to the earlier survey, the 1984-85 survey indicated that the population of breeding loons in the Park appeared stable or possibly increasing (Parker et al., 1986).

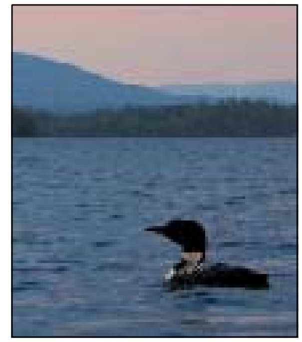
Audubon Society of New York's Loon Conservation Project

The New York Loon Conservation Project (NYLCP) is a program of the Audubon Society of New York State, Inc. (ASNY), which has been observing Common Loon populations and promoting education about loons and efforts to protect their populations since 1987. NYLCP volunteers, known as "Loon Rangers", participate in breeding loon surveys and an annual breeding loon census. Results of annual monitoring by ASNY volunteers on selected lakes within the Adirondack Park indicate that the breeding population of Common Loons in the Park has continued to increase since the population survey conducted by the NYS DEC in the 1980's (F. Realbuto, ASNY, pers. comm.).

Audubon Society of New York State's staff educate the public about loons and environmental quality through literature, workshops, and presentations. In addition, ASNY staff participate in cooperative efforts with other conservation organizations and state and federal agencies to better understand loons and important issues affecting their populations.

Dr. McIntyre's Research on Stillwater Reservoir

Dr. Judy McIntyre has conducted a long-term (~25 year) study of the loons and their territories on Stillwater Reservoir in Herkimer County. This study also evaluated the effects of the dam on the reservoir's loon population. Preliminary results show that annual population surveys provide more accurate information than those made periodically (e.g.: every 5-10 years) or by using only parts of a total study area. Dr. McIntyre has observed that the loon population on Stillwater Reservoir has increased over the period of the surveys, following an initial count of 10 pairs, stabilizing at 14-17 pairs for most years of the research project. Rapidly rising water levels have accounted for the highest degree of nest failure, and when they occur late in the season with no possibility of renesting, have accounted for the lowest productivity (J. McIntyre, pers. comm.).



Dr. McIntyre has also conducted a variety of other research projects, such as evaluating the acoustic effects of the environment on loon vocalizations, and determining the potential disturbance and reproductive impacts of blasting on loons. Dr. McIntyre has been instrumental to the field of loon research, pioneering studies of migratory and wintering birds, and developing techniques to band and color-mark loons. She initiated the first public surveys of loon populations (Project Loon Watch), greatly stimulating public involvement and concern for this charismatic species. Dr. McIntyre has written numerous articles and books about loon natural history, behavior, and the effects of human activity on loon populations. Two of her best known works are: *The Common Loon: Spirit of Northern Lakes*, published by the University of Minnesota Press, and the Birds of North America account #313, *The Common Loon*, which she co-authored with Jack Barr.

Dr. McIntyre has been instrumental to the field of loon research ... writing numerous articles and books about loon natural history, behavior, and the effects of human activity on loon populations.

The Northeast Loon Study Workgroup's Contaminant Research

The Northeast Loon Study Workgroup (NELSWG) and BioDiversity Research Institute of Maine conducted contaminant and genetics research on the breeding loons in the Adirondack Park from 1998-2000. Ninety-six loons, consisting of 57 adults and 39 juveniles, were captured and sampled on 43 lakes in the Adirondack Park during the three summers. Of the adults, 29 were female and 28 were male. Sex was unknown in the juvenile loons. All fifty-seven adults and 26 of the juvenile loons were banded, for a total of 83 banded loons (13 juveniles were not banded because their legs were too small for the bands).

Samples were analyzed to determine the blood and feather mercury levels, blood lead levels, and genetic population characteristics of the breeding loons in the Adirondacks. Seventeen percent of the loons sampled in this research project had mercury levels high enough to cause behavioral changes leading to reduced reproductive success (Schoch and Evers, 2002). The Environmental Protection Agency has used the results of mercury research in loons in the Northeast as one line of evidence in determining the risk that atmospheric mercury poses to the environment. When combined with other ecological and human health studies, the data supported limiting airborne mercury emissions from coal-fired power plants.

Research by BioDiversity Research Institute is expanding to look at mercury levels in loons on their wintering waterbodies, and to determine mercury and other contaminant levels in other fish-eating animals, including mergansers, kingfishers, cormorants, mink, and otters. The results of these research efforts will provide for more defined management of aquatic habitats and populations of fish-eating animals, as well as to further promote more stringent regulation of airborne contaminants.

The Adirondack Cooperative Loon Program is a collaborative research and education project studying the natural history of the Common Loon and the effects of contaminants and human interactions on the Adirondack loon population.

Adirondack Cooperative Loon Program

The Adirondack Cooperative Loon Program (ACLP) is a collaborative research and education project studying the natural history of the Common Loon and the effects of contaminants and human interactions on loon populations in the Adirondack Park. The ACLP has evolved from the contaminant research conducted by the Northeast Loon Study Workgroup in the Park from 1998-2000. The Adirondack Cooperative Loon Program was initiated in the spring of 2001 to continue and further expand upon this work. The ACLP is a partnership of the Wildlife Conservation Society, the Natural History Museum of the Adirondacks, the New York State Department of Environmental Conservation, BioDiversity Research Institute, and the Audubon Society of New York, Inc.

By monitoring loons in their breeding range, the Adirondack Cooperative Loon Program seeks to better understand how factors such as contaminants and human interactions affect loon populations in the Adirondack Park. Contaminant sampling and banding of loons has continued in coordination with BioDiversity Research Institute. The annual return rate and reproductive success of loons color-banded as part of the contaminant research is determined through regular monitoring of each marked bird during the breeding season. The results of ACLP's loon population monitoring program and contaminant research are coordinated with other research projects studying loons and water quality throughout the Adirondacks and the Northeast. Such broad collaboration will enable a better assessment of the effects of mercury and other factors on northeastern loon populations.

An index of the summer loon population in the Adirondack Park is obtained through an annual loon census, conducted on the third Saturday in July. Hundreds of Adirondack residents and visitors volunteer each year to provide information on the presence or absence of loons on lakes throughout the Park. ACLP will be able to determine trends in the Adirondack breeding loon population over time through repeated observations on the same lakes in the Park. Census results are coordinated with similar loon censuses in other states in the Northeast to provide an indication of changes and trends in the regional loon population.

The Adirondack Cooperative Loon Program is also working to minimize anthropogenic impacts on the Adirondack loon population and other wildlife through a variety of public education programs. Presentations about loon natural history, factors affecting loon populations, and ACLP's efforts are provided to the general public throughout the year, reaching over 2000 Park residents and visitors annually.

A newsletter, *The Adirondack Tremolo* is distributed twice yearly and discusses the results of each summer's field work, as well as upcoming ACLP projects. The week-long "Loon Scientists" Program is provided to seventh-grade classes in the Park during the school year. This program teaches students about environmental concerns in the Park as well as about Common Loons. In the 2001-2002 school year, the "Loon Scientists" Program was given to 10 classes (a total of ~200 students) in the Park. (See Appendix 1 to contact ACLP directly to be placed on the mailing list for the newsletter or to receive information about the "Loon Scientists" Program).

In 2002, the ACLP also initiated a Lead Sinker Exchange Project at fishing tackle supply stores and boat launches throughout the Adirondack Park to increase angler awareness about the toxic effects of lead fishing tackle on loons and the availability of alternative types of fishing tackle. Adirondack anglers have responded very positively to the Lead Sinker Exchange Project: ~10,000 brochures and non-toxic sinker samples were distributed during the summer of 2002 at over 60 exchange sites in the Park.

ACLP's website, www.adkscience.org/loons, provides an overview of loon natural history, problems impacting loon populations, and updates on ACLP's research and education projects. Website visitors can hear a loon call, find out where to exchange lead sinkers in the Adirondack Park, or select a lake for the Annual Loon Census. Visitors can also link to other sites to learn more about acid rain, mercury pollution, or other loon organizations. Through the website, ACLP is able to directly involve the public with learning about loon natural history and conservation efforts in North America.

THE FUTURE OF COMMON LOONS IN THE ADIRONDACK PARK

Monitoring, Research, and Management Efforts

Historic information on the status of the Common Loon population in the Adirondack Park is incomplete. However, prior to settlement and development of the Park in the 1800's, the population was known to be more abundant. Human exploration and settlement certainly contributed to its decline, particularly through shooting of adult birds and harassment of breeding pairs (McIntyre, 1979).

Numerous researchers have recommended a variety of monitoring and management techniques to provide additional information about the natural history of the Common Loon and the effects of contaminants on loons, as well as to lead to stable or increasing populations in the Northeast and New York State (Plunkett, 1979; Parker et.al., 1986; Rimmer, 1993; Simonin and Meyer, 1998; Evers et al., 1998; Evers et al., 2003). On a larger scale, the *"Status Assessment and Conservation Plan for the Common Loon (Gavia immer) in North America"* provides a conservation plan for Common Loon populations throughout North America (Evers, in press). This plan is part of the North American Bird Conservation Initiative's (NABCI) efforts to develop landscape-oriented conservation plans that establish population goals and habitat objectives for North American bird species. NABCI is an integrated approach to bird conservation based on regional, biologically driven, landscape-oriented partnerships. NABCI works to strengthen and facilitate coordination among existing partnerships and initiatives to conserve bird populations and the landscapes on which they depend throughout the United States, Canada, and Mexico (NABCI, 2003).

Conservation efforts in New York State for the Common Loon incorporate a combination of population monitoring, research, and education efforts adapted from these recommendations and plans. Results of these studies will help guide management efforts by state and federal agencies.

<u>Population Monitoring Efforts Include:</u>

- An annual census of the population of loons in New York during the breeding season to enable population trends to be determined over time.
- Regular annual monitoring of a study population of individually identifiable (color-banded) loons to determine return rates and reproductive success of these birds and to monitor changes in these parameters over time. Monitoring of color-marked birds will also enable territory and nest site quality and availability to be evaluated in depth.
- ASNY's "Loon Ranger" volunteer monitoring program to evaluate trends in loon reproductive success and human-related impacts to be evaluated for the population of unbanded loons in New York.
- Monitoring of migrating and wintering loons to obtain information about staging areas, migration stopovers, and wintering areas of Adirondack loons. The information collected will be based on band recoveries, migration and

wintering loon surveys (including Christmas Bird Counts, Waterfowl Surveys, and migration stations), and satellite telemetry. This project will also help identify timing and numbers of birds migrating along a specific route, as well as major wintering concentrations of loons. In addition, the quality of habitats utilized by wintering loons can be evaluated.

Research on Loon Natural History Includes:

- An annual assessment of the population of color-marked loons in the Adirondack Park to obtain comprehensive information on loon behavior, foraging, territoriality, inter-lake movements, site fidelity, mate fidelity, reproductive success, territory and nest site characteristics, juvenile survival, and genetic identification of loon subpopulations (providing science-based mitigation options following marine oil spills).

Assessment of Impacts on the Adirondack Loon Population Includes:

- Continued research on the color-marked loon population to assess the level of mercury contamination in aquatic ecosystems in the Adirondack Park, the risk environmental mercury contamination poses to the Adirondack loon population, the number of birds directly impacted by contaminants (e.g.: mercury) within the population, local and population level impacts of acid rain on Adirondack loons, and the impact of different causes of nest failure on loon reproductive success.
- Necropsy analysis of dead loons by NYS DEC's Wildlife Pathology Unit and analysis of non-viable eggs, particularly for the impacts of contaminants, to determine causes of mortality in loons and provide insight into causes of egg failure.
- Determination of the localized impact of human disturbance and activity on Adirondack loon populations due to fishing (e.g.: lead sinker associated toxicity and fishing line entanglement), human activity (e.g.: motorboats, personal watercraft, canoes/kayaks), and shoreline development (e.g.: decreased nest site availability and increased disturbance).
- Implemention of U.S. Fish and Wildlife Service protocols to evaluate potential impacts of hydrological management regimes on loon nesting success on hydroelectric reservoirs in New York and to mitigate impacts of fluctuating water levels on breeding loon pairs as indicated.
- An evaluation of the effects of catastrophic events (e.g.: oil spills) and disease (e.g.: botulism) on loons breeding in, migrating through, or wintering along the coast of New York State.
- Determination of the cause of adult loon, chick, and egg predation and its impact on the reproductive success of the Adirondack loon population.
- Determination of the impact of intraspecific competition on the reproductive success of the Adirondack loon population.
- Evaluation of habitat availability and protection at the landscape level on loon breeding, migration, and wintering areas, and at the local level to minimize or prevent further habitat degradation or fragmentation

Public Education and Information Efforts Include:

- Dissemination of information about loon natural history and conservation needs to increase public awareness of this species and the need to protect its habitat. This will promote responsible public attitudes and help minimize human-related impacts on wildlife populations – particularly with respect to fishing practices, boating activities, and habitat alteration due to development.

- Promotion of public involvement in research and monitoring of loon populations. This will enhance public knowledge and concern for this species and the aquatic ecosystem upon which it depends.

The current banding program for the breeding loons in the Park conducted by the Adirondack Cooperative Loon Program will enable many of the above conservation objectives to be achieved and provide much information about loon natural history. For example, it is currently unknown where Adirondack loons migrate each winter, and what hazards they are exposed to on their wintering areas. However, winter band returns and new monitoring techniques, such as satellite telemetry, will document inter-seasonal movements. ACLP's research on loons is performed on lakes where other research on water chemistry and fish populations is also being conducted, thus providing a better understanding of the overall aquatic ecosystem in the Adirondacks, and of the full environmental impact of such problems as acid rain and mercury contamination. Monitoring mercury levels in the banded population of loons over time will potentially help researchers link the ecological effects of environmental mercury contamination to emission regulations.

Additional management techniques, such as restricting access to nest sites or the utilization of nest rafts can also be employed in situations where they are indicated. Public education programs about Common Loon natural history and factors impacting loon populations will increase awareness and public concern for this unique species inhabiting our northern waterbodies, and hopefully lead to lessening of anthropogenic impacts on Common Loon populations.

Guidelines for Assisting in Loon Conservation Efforts

Adirondack Park residents and visitors can aid conservation efforts to maintain a healthy population of breeding Common Loons in the Park in many ways. Conservation begins at the local level, and efforts by individual people do make a difference. Educating and encouraging the participation of friends and associates can greatly expand one's influence. Several park-wide conservation efforts have been initiated by the efforts of a few residents (e.g.: the Wildlife Conservation Society's Adirondack Communities and Conservation Program, and the Residents Committee to Protect the Adirondacks).

Increased awareness of water recreationists, including motorboaters, "jet-skiers", paddlers, and campers, will minimize disturbance of breeding loons and lead to increased nest success and chick fledging success. Loons should be observed from a distance, and their defensive territorial displays respected by moving farther away from an upset bird.

The monitoring, public education, and management efforts of these organizations will help ensure that the haunting call of this magnificent species continues to echo off Adirondack waterways for years to come.

Anglers can minimize direct impacts on loons by using non-lead fishing tackle (and non-zinc, which is also very toxic) and disposing of fishing line properly, especially on waterbodies utilized by loons during breeding or migration. Tackle made from such materials as tin, bismuth, steel, ceramic, or glass is non-toxic. Several inexpensive and ecologically safe alternatives to lead fishing sinkers and jigs are currently manufactured.

The familiar saying of "reduce, reuse, and recycle" holds very true when attempting to lower emissions of mercury and acid rain components that greatly affect environmental quality for wildlife and humans. Minimize trash by recycling as much as possible, buying in bulk, and declining unnecessary items (e.g.: junk mail). Reduce emissions by decreasing vehicle use (through car-pooling, grouping errands, and alternative means of transportation), using gas efficient vehicles, and vehicles that meet or exceed current emissions standards (e.g.: hybrid vehicles). State and federal legislative efforts to decrease contaminant emissions, including sulfur dioxide, nitrous oxides, mercury, and carbon dioxide, from power plants, incinerators, and vehicles should be supported which will lead to better water and environmental quality throughout northeastern North America.

Public participation is welcomed by many environmental organizations within the Park. The Adirondack Cooperative Loon Program and ASNY's Loon Conservation Project provide the opportunity for interested residents and visitors to participate in monitoring the population of Common Loons breeding within the Adirondack Park. The monitoring, public education, and management efforts of these organizations will help ensure that the haunting call of this magnificent species continues to echo off Adirondack waterways for years to come.

REFERENCES CITED AND SUGGESTED LITERATURE ABOUT LOONS

Loon Legends and Children's Books on Loons

Cameron, A. 1985. How the Loon Lost Her Voice. Harbour Publishing Co., Ltd. Madeira Park, B.C., Canada. 31pp.

Cleaver, E. 1990. The Loon's Necklace. Oxford University Press. Toronto, Canada. 24pp.

Cohlene, T. 1990. Ka-ha-si and the Loon: an Eskimo Legend. Watermill Press. Mahwah, NJ. 47pp.

Dolan, E. 1987. Why the Loon Calls. Milliken Press. St. Louis, MO. 30pp.

Dwyer, Corinne A. 1988. Loon Legends: A Collection of Tales Based on Legends. North Star Press. St. Cloud, MN. 86pp.

Hirschi, R. 1991. Loon Lake. Coblehill Books. New York, NY.

Klein, T. 1989. Loon Magic for Kids. NorthWord Press, Inc. Micoqua, WI. 48pp.

Krupinsky, J. 1983. Look Out for Loons. The Woodbury Press. Litchfield, ME. 24pp.

Martinson, T. 1990. The Christmas Loon. NorthWord Press, Inc. Minocqua, WI. 54pp.

Loon Natural History

Alvo, R. 1981. The breeding success of Common Loons (*Gavia Immer*) in relation to lake acidity. M.S. Thesis. Trent University. Peterborough, Ontario.

Barklow. W. E. 1979. Tremolo variations and their use in duetting and distraction displays of the Common Loon. Pp. 23- 44 *in* S. Sutcliffe (ed.). Proceedings of the North American Conf. Common Loon Res. Mgmt. Vol. 2.

Barklow, W.E. 1980. Voices of the Loon (record). North American Loon Fund. Meredith, NH.

Barr, J. F. 1973. Feeding biology of the Common Loon (*Gavia immer*) in oligotrophic lakes of the precambrian shield. PhD. Diss. University of Guelph. Ontario.

Barr, J. F. 1996. Aspects of Common Loon (*Gavia immer*) feeding biology on its breeding ground. Hydrobiologia. Vol. 321: 119-144.

Beebe, W. 1907. Notes on the early life of loon chicks. The Auk. Vol. 24: 34-41.

Bent, A. 1919. Life Histories of North American Diving Birds. Reprint. Dover Publications, Inc. New York, NY.

Crowley, K. and M. Link. 1987. Love of Loons. Voyageur Press, Inc. Stillwater, MN. 96pp.

Dennis, R. 1993. Loons. Voyageur Press, Inc. Stillwater, MN. 72 pp.

Dregni, M. ed. 1996. Loons: Song of the Wild. Voyageur Press, Inc. Stillwater, MN. 108pp.

Dulin, G.S. 1988. Pre-fledgling feeding behavior and sibling rivalry in Common Loons. M.S. Thesis. Central Michigan University. Mt. Pleasant, MI.

Dunning, J. 1985. The Loon: Voice of the Wilderness. Yankee Publishing Inc. Dublin, NH. 143 pp.

Enright, J.C. 1999. Hand-rearing Common Loons (*Gavia immer*). Wildlife Rehabilitation. Vol. 17: 65-79.

Evers, D.C. 1993a. Population ecology of the Common Loon at the Seney National Wildlife Refuge, Michigan: Results from the first color-marked breeding population. Pp. 202-212 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish and Wildlife Service. Concord, NH.

Evers, D.C. 1993b. Replicable capture method for adult and juvenile Common Loons on their nesting grounds. Pp. 214-216 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish and Wildlife Service. Concord, NH.

Evers, D.C., J. D. Kaplan, P.S. Reaman, J.D. Paruk, and P. Phifer. 2000. Demographic characteristics of the Common Loon in the Upper Great Lakes. Pp. 78-90 *in* J. W. McIntyre and D.C. Evers (eds.). Loons: Old History and New Findings. Proc. of a Symposium from the 1997 meeting, American Ornithologists' Union. North America Loon Fund. Holderness, NH.

Evers, D.C. 2001. Habitat-specific between year territory fidelity by breeding adult Common Loons. Pp. 57-101 *in* D.C. Evers. Common Loon Population Studies: Continental Mercury Patterns and Breeding Territory Philopatry. Ph.D. Thesis. University of Minnesota. St. Paul, MN.

Evers, D.C. In Press. Status Assessment and Conservation Plan for the Common Loon (*Gavia immer*) in North America. U.S. Fish and Wildlife Service. Hadley, MA.

Hutchinson, A. 1998. Just Loons: A Wildlife Watcher's Guide. Willow Creek Press. Minocqua, WI. 127pp.

Kirkpatrick, S. 1995. In Wilderness Song: Litany of the Common Loon. The Marvelous Works. Jackson, MS. 144pp.

Klein, T. 1985. Loon Magic. Paper Birch Press, Inc. Ashland, WI. 146pp.

Lang, A. and W. Lynch. 2000. Loons. Thunder Bay Press. San Diego, CA. 144pp.

Loon Preservation Committee. 2001. Reflections and Aspirations: Twenty-five Years of Preserving Loons and Their Habitats in New Hampshire. Moultonborough, NH. 17pp.

McEneaney, T. 1991. The Uncommon Loon. Northland Publishing. Flagstaff, AZ. 112pp.

McIntyre, A. E. and J.W. McIntyre. 1974. Spots before your eyes, an aid to identifying wintering loons. Auk. Vol. 91: 413-415.

McIntyre, J. W. 1975. Biology and Behavior of the Common Loon "*Gavia immer*" with Reference to its Adaptability in a Man-Altered Environment. Ph.D. Thesis. University of Minnesota. Minneapolis, MN.

McIntyre, J. W. 1977. The Common Loon. Part II. Identification of potential predators on Common Loon nests. The Loon. Vol. 49: 96-99.

McIntyre, J. W. 1978. Wintering behavior of Common Loons. Auk. Vol. 95: 396-403.

McIntyre, J. W. 1979. Status of Common Loons in New York from a historical perspective. Pp. 117-122 *in* S. Sutcliffe (ed.). Proceedings of the North American Conf. Common Loon Res. Mgmt. Vol 2.

McIntyre, J. W. 1983. Nurseries: a consideration of habitat requirements during the early chick-rearing period in Common Loons. J. Field Ornithology. Vol. 54: 247-253.

McIntyre, J. W. 1988. The Common Loon: Spirit of Northern Lakes. University of Minnesota Press. Minneapolis, MN. 228 pp.

McIntyre, J.W. 1989. The Common Loon cries for help. National Geographic. Vol. 175 (4): 510-524.

McIntyre, J. W. and J. F. Barr. 1983. Pre-migratory behavior of Common Loons on the autumn staging grounds. Wilson Bull. Vol. 95: 121-125.

McIntyre, J. W. and J. F. Barr. 1997. Common Loon (*Gavia immer*). *In* A. Poole and F. Gill (eds.). The Birds of North America, No. 313. The Academy of Natural Sciences. Philadelphia, PA, and the American Ornithologists' Union Washington, D.C. 32pp.

McIntyre, J. W. and N.G. Cutler. 1996. Annotated Bibliography of the Loons, *Gaviidae*. North American Loon Fund. Gilford, NH. 149pp.

McIntyre, J. W. and D.C. Evers (eds.). 2000. Loons: Old History and New Findings. Proc. of a Symposium from the 1997 Meeting, American Ornithologists' Union. North America Loon Fund. Holderness, NH. 115pp.

McNicoll, M. K. 1988. Common Loon distribution and conservation in Canada. Pp. 196-214 *in* P. Strong (ed.). Papers from 1987 Conf. Loon Res. Mgmt. North American Loon Fund. Meredith, NH.

Morse, L., S. Stockwell, and M. Pokras, eds. 1993. Proceedings from the 1992 Conference on the Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish and Wildlife Service. Concord, NH. 247pp.

North American Loon Fund. 2000. Botulism outbreak in Lakes Erie and Huron causes waterbird die-off. Spring Newsletter. 8pp.

Olson, S. T. 1951. A Study of the Common Loon in the Superior National Forest of Northern Minnesota. M.S. Thesis. University of Minnesota.

Olson, S.T. and W.H. Marshall. 1952. The Common Loon in Minnesota. Minnesota Museum of Natural History. Occ. Papers No. 5.

Peterson, R.T. 1941. The Loon. National Audubon Society. New York.

Piper, W.H., D.C. Evers, M.W. Meyer, K.B. Tischler, and M. Klich. 2000. Do Common Loons mate for life? Scientific investigation of a widespread myth. Pp. 43-49 *in* J. W. McIntyre and D.C. Evers (eds.). Loons: Old History and New Findings. Proc. of a Symposium from the 1997 meeting, American Ornithologists' Union. North America Loon Fund. Holderness, NH.

Piper, W. H., J. D. Paruk, D.C. Evers, M.W. Meyer, K.B. Tischler, M. Klich, and J. J. Hartigan. 1997. Local movements of color-marked Common Loons. J. Wildlife Management Vol. 61(4): 1253-1261.

Plunkett, R. L. 1979. Major elements of a five-year comprehensive plan of research and management for the Great Lakes and Northeastern United States populations of the Common Loon, *Gavia immer*. Pp. 154-162 *in* S.

Sutcliffe (ed.). Proceedings of the North American Conf. Common Loon Res. Management Vol 2.

Powers, K.D. and J. Cherry. 1983. Loon migrations off the northeastern United States. Wilson Bull. Vol. 95: 125-132.

Rand, A.L. 1947. Geographical variation in the loon, *Gavia immer*. Can. Field Nat. Vol. 61: 193-195.

Rimmer, C.C. 1992. Common Loon (*Gavia immer*). Pp. 3-30 *in* Schneider, K. J. and D. M. Pence (eds.). Migratory Non-Game Birds of Management Concern in the Northeast. U.S. Department Interior, Fish and Wildlife Service. Newton Corner, MA.

Rimmer, C.C. 1993. Population status of Common Loons in the northeastern U.S. Pp. 93-100 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish and Wildlife Service. Concord, NH.

Rummel, L. and C. Goetzinger. 1975. The communication of intraspecific aggression in the Common Loon. Auk. Vol. 92: 333-346.

Rummel, L. and C. Goetzinger. 1978. Aggressive display in the Common Loon. Auk. Vol. 95: 183-186.

Sjölander, S. and G. Agren. 1972. Reproductive behavior of the Common Loon. Wilson Bull. Vol. 84: 296-308.

Storer, R. W. 1956. The fossil loon, *Colymboides minutus*. Condor. Vol. 58: 413-426.

Storer, R.W. 1978. Systematic notes on the loons (*Gaviidae*: Aves). Breviora. Vol. 448: 1-8.

Storer, R.W. 1988. Variation in the Common Loon (*Gavia immer*). Pp. 54-65 *in* P. Strong (ed.). Papers from 1987 Conf. Loon Res. Mgmt. North American Loon Fund. Meredith, NH.

Storer, R.W. 2002. The Metazoan Parasite Fauna of Loons (Aves: *Gaviiformes*), its Relationship to the Birds' Evolutionary History and Biology, and a Comparison with the Parasite Fauna of Grebes. University Michigan, Ann Arbor, MI. 44pp.

Strong, P.I.V. 1985. Habitat Selection by Common Loons. Ph.D. Diss. University of Maine. Orono, ME.

Strong, P.I.V. 1987a. Reuse of nesting and nursery areas by Common Loons. J. Wildlife Management. Vol. 51: 123-127.

Strong, P. I. V. (ed.). 1987b. Papers from the 1987 Conference on Loon Research and Management. North American Loon Fund. Meredith , NH. 214pp.

Strong, P.I.V. 1995. Call of the Loon. NorthWord Press. Minnetonka, MN. 143pp.

Sutcliffe, S.A. 1978. Pesticide levels and shell thickness of Common Loon eggs in New Hampshire. Wilson Bull. Vol. 90: 637-640.

Sutcliffe, S.A. (ed.). 1979. The Common Loon – Proceedings of the Second North American Conference on Common Loon Research and Management. National Audubon Society. New York. 162pp.

Sutcliffe, S.A. 1980. Aspects of the Nesting Ecology of the Common Loon in New Hampshire. Unpublished. M.S. Thesis. University of New Hampshire. Durham, NH.

Sutcliffe, S.A. 1982. Prolonged incubation behavior in Common Loons. Wilson Bull. Vol. 94: 361-362.

Tate, J. and J. Tate. 1970. Mating behavior of the Common Loon. Auk. Vol. 87: 125-130.

Taylor, K. 1988. Loon. Kip Taylor. Saranac Lake, NY. 175pp.

Vermeer, K. 1973a. Some aspects of the breeding and mortality of Common Loons in east-central Alberta. Can. Field Nat. Vol. 87: 403-408.

Vermeer, K. 1973b. Some aspects of the nesting requirements of Common Loons in Alberta. Wilson Bull. Vol. 85: 429-435.

Walcott, C., D. Evers, M. Froehler, and A. Krakauer. 1999. Individuality in "yodel" calls recorded from a banded population of Common Loons, *Gavia immer*. Int. J. Animal Sound and its Recording. Vol. 10: 101-114.

Williams, L.E. 1973. Spring migration of Common Loons from the Gulf of Mexico. Wilson Bull. Vol 85: 238.

Woolfenden, G.E. 1973. Selection for a delayed simultaneous wing molt in loons (*Gaviidae*). Wilson Bull. Vol. 79: 416-420.

Yeates, G.K. 1950. Field notes of the nesting habits of the Great Northern Diver. Brit. Birds. Vol. 43: 5-8.

Yonge, K. 1981. The Breeding Cycle and Annual Production of the Common Loon (*Gavia immer*) in the Boreal Forest Region. M.S. Thesis. University of Manitoba. Winnepeg, Manitoba.

Young, K. E. 1983. Seasonal and Temporal Patterning of Common Loon (*Gavia immer*) Vocalizations. M.S. Thesis. Syracuse University. Syracuse, NY.

Mercury and Loons

Barr, J.F. 1986. Population Dynamics of the Common Loon (*Gavia immer*) Associated with Mercury-Contaminated Waters in Northwestern Ontario. Occ. Paper No. 56, Canadian Wildlife Service. Ottawa, ON, Canada. 25pp.

Counard, C.J. 2001. Mercury Exposure and Effects on Common Loon (*Gavia immer*) Behavior in the Upper Midwestern United States. Unpublished M.S. Thesis. University of Minnesota. St. Paul, MN.

Driscoll, C.T., V. Blette, C. Yan, C.L. Schofield, R. Munson and J. Holsapple. 1995. The role of dissolved organic carbon in the chemistry and bioavailability of mercury in Adirondack Lakes, Water, Air, and Soil Pollution. Vol. 80: 499-508

Ensor, K.L., D.D. Helwig, and L.C. Wemmer. 1992. Mercury and Lead in Minnesota Common Loons (*Gavia immer*). Minnesota Pollution Control Agency, Water Quality Division. St. Paul, MN. 32pp.

Evers, D.C., J.D. Kaplan, M.W. Meyer, P.S. Reaman, W.E. Braselton, A. Major, N. Burgess, and A. M. Schuehammer. 1998. A geographic trend in mercury measured in Common Loon feathers and blood. Environmental Toxicology and Chemistry. Vol. 17(2): 173-183.

Evers, D.C., O.P. Lane, C. DeSorbo, and L. Savoy, 2002. Assessing the Impacts of Methylmercury on Piscivorous Wildlife using a Wildlife Criterion Value Based on the Common Loon, 1998-2001. Report BRI 2002-08 submitted to the Maine Department of Environmental Protection. BioDiversity Research Institute. Falmouth, ME. 57pp.

Evers, D.C. and P.S. Reaman. 1998. A Comparison of Mercury Exposure Between Artificial Impoundments and Natural Lakes Measured in Common Loon and Their Prey. Unpublished report submitted to Central Maine Power Co. by BioDiversity Research Institute. Falmouth, Maine. 40pp.

Evers, D.C., K.M. Taylor, A. Major, R.J. Taylor, R.H. Poppenga, and A.M. Scheuhammer. 2003. Common Loon eggs as indicators of methylmercury availability in North America. Ecotoxicology. Vol 12 (1-4): 69-81.

Fevold, B.M., M.W. Meyer, P.W. Rasmussen, and S.A. Temple. 2003. Bioaccumulation patterns and temporal trends of mercury exposure in Wisconsin Common Loons. Ecotoxicology. Vol 12 (1-4): 83-93.

Kenow, K., S. Gutreuter, R.K. Hines, M.W. Meyer, F. Fournier, and W. Karasov. 2003. Effects of methylmercury exposure on the growth of juvenile Common Loons. Ecotoxicology. Vol. 12 (1-4): 171-182.

Lorey, P. and C.T. Driscoll. 1999. Historical trends of mercury deposition in Adirondack lakes. Environmental Toxicology and Chemistry. Vol. 33 (5): 718-722.

McIntyre, J.W., J.T. Hickey, K. Karwowski, C.L. Holmquist, and K. Carr. 1992. Toxic chemicals and Common Loons in New York and New Hampshire, 1978-1986. Pp. 73-91 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and Its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish Wildlife Service. Concord, NH.

Meyer, M.W., D.C. Evers, T. Saulton, and W.E. Braselton. 1995. Common Loons (*Gavia immer*) nesting on low pH lakes in northern Wisconsin have elevated blood mercury content. Water, Air, and Soil Pollution. Vol. 80: 871-880.

Meyer, M.W., D.C. Evers, J.J. Hartigan, and P.S. Reaman. 1998. Patterns of Common Loon (*Gavia immer*) mercury exposure, reproduction, and survival in Wisconsin, USA. Environmental Toxicology and Chemistry. Vol. 17 (2): 184-190.

New York State Department of Health, Division of Environmental Health Assessment. 2002. 2002-2003 Health Advisories: Chemicals in Sportfish and Game. 21pp. http://www.health.state.ny.us/nysdoh/environ/fish.htm.

Nocera, J. J. and P. D. Taylor. 1998. *In situ* behavioral response of Common Loons associated with elevated mercury (Hg) exposure. Conservation Ecology [online]. Vol. 2 (2): 10.

Scheuhammer, A.M. and P.J. Blancher. 1994. Potential risk to Common Loons (*Gavia immer*) from methylmercury exposure on acidified lakes. Hydrobiologia. Vol. 279/280: 445-455.

Scheuhammer, A.M., C.M. Atchison, A.H. K. Wong, and D.C. Evers. 1998a. Mercury exposure in breeding Common Loons (*Gavia immer*) in Central Ontario, Canada. Environmental Toxicology and Chemistry. Vol. 17 (2): 191-196.

Scheuhammer, A.M., A.H.K. Wong, and D.Bond. 1998b. Mercury and selenium accumulation in Common Loons (*Gavia immer*) and Common Mergansers (*Mergus merganser*) from eastern Canada. Environmental Toxicology and Chemistry. Vol. 17 (2): 197-201.

Schoch, N. and D.C. Evers. 2002. Monitoring Mercury in Common Loons: New York Field Report, 1998-2000. Unpublished report, BRI 2001-01, submitted to U.S. Fish and Wildlife Service and NYS Department of Environmental Conservation. BioDiversity Research Institute. Falmouth, ME. 18pp.

Simonin, H.A., S.P. Gloss, C.T. Driscoll, C.L. Schofield, W.A. Kretser, R.W. Karcher, and J. Symula. 1994. Mercury in Yellow Perch from Adirondack drainage lakes (New York, US). Pp. 457-469 *in* C.J. Watras, J. W. Huckabee (eds.). Mercury Pollution: Integration and Synthesis. Lewis, Boca Raton, FL.

Simonin, H.A. and M.W. Meyer. 1998. Mercury and other air toxics in the Adirondack region of New York. Environmental Science and Policy. Vol. 1: 199-209.

Thompson, D. R. 2000. Mercury in birds and terrestrial animals. Pp. 341-355 *in* W.N. Beyer, G. H. Heinz, A.W. Redmon-Norwood (eds.). Loons: Old History and New Findings. Proc. N. Am. Loon Fund. Meredith, NH.

US EPA. 2000. Mercury White Paper. www.epa.gov/ttn/uatw/combust/utiltox/hgwt1212.html. 4pp.

Acid Rain and Loons

Crane, C. 1989. Of loons, lakes, and acid rain. Animals. Vol. 122: 10-15.

Driscoll, C.T., G.B. Lawrence, A.J. Bulger, T.J. Butler, C. S. Cronan, C. Eager, K. F. Lambert, G. E. Likens, J. L. Stoddard, and K.C. Weathers. 2001a. Acidic deposition in the northeastern U.S.: sources and inputs, ecosystem effects, and management strategies. Bioscience. Vol. 51 (3): 180-198.

Driscoll, C.T., G.B. Lawrence, A.J. Bulger, T.J. Butler, C. S. Cronan, C. Eager, K. F. Lambert, G. E. Likens, J. L. Stoddard, and K.C. Weathers. 2001b. Acid rain revisited: advances in scientific understanding since the passage of the 1970 and 1990 Clean Air Act Amendments. Hubbard Brook Research Foundation. Science Links Publication. Vol. 1 (1). 20pp.

Driscoll, C.T., K.M. Driscoll, K.M. Roy, and M.J. Mitchell. 2003. Chemical response of lakes in the Adirondack region of New York to declines in acidic deposition. Environmental Science & Technology. Vol 37 (10): 2036-2042.

Dybas, C.L. 2001. Blowing smoke. Adirondack Life. Vol. 32 (8): 58-70.

General Accounting Office. 2000. Acid Rain Emissions Trends and Effects in the Eastern United States. GAO/RCED-00-47. 6pp.

NYS Governor Press Release. 2002. Governor Pataki Proposes Toughest Acid Rain Controls in the Nation. www.state.ny.us/governor/press/year02/feb14_1_02.htm.

Residents Committee to Protect the Adirondacks. 2000. Acid rain bill becomes law: pollution credits trading is restricted. The Park Report. Vol. 6 (2): 18-21.

Wayland, M. and D. McNicol. 1990. Status Report on the Effects of Acid Precipitation on Common Loon Reproduction in Ontario: the Ontario Lakes Loon Survey. Canadian Wildlife Service. Ontario. Tech. Report. Series No. 92. 26pp.

Human Disturbance and Loons

Bauer, P. 2001. Growth in the Adirondack Park: Analysis of Rates and Patterns of Development. Residents Committee to Protect the Adirondacks.

Cristenson, B.L. 1981. Reproductive Ecology and Response to Disturbance by Common Loons in Maine. M. S. Thesis. University of Maine, Orono, ME.

Eschbacher, T. L. and E.G. Schartzberg. 2000. The Effects of Lake Recreational Activity on the Daily Behavior of the Common Loon (*Gavia immer*) on Cranberry Lake, New York. Unpublished report submitted to SUNY ESF, Cranberry Lake Biological Station.

Franson, J. C. and D.J. Cliplef. 1993. Causes of mortality in Common Loons. Pp. 2-7 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish Wildlife Service, Concord, NH.

Heimberger, M., D. Euler, and J. Barr. 1983. The impact of cottage development on Common Loon reproductive success in central Ontario. Wilson Bull. Vol. 95: 431-439.

Kelly, L.M. 1993. The effects of human disturbance mitigation on Common Loon productivity in northwestern Montana. Pp. 246-247 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish Wildlife Service, Concord, NH.

Miconi, R., M.A. Pokras, and K. Taylor. 2000. Mortality in breeding Common Loons: how significant is trauma? Pp. 19-24 *in* J. W. McIntyre and D.C. Evers (eds.). Loons: Old History and New Findings. Proc. of a Symposium from the 1997 meeting, American Ornithologists' Union. North America Loon Fund. Holderness, NH.

NYCRR Part 210. 2003. Emission and Labeling Requirements for Personal Watercraft Engines.

Ream, C. 1976. Loon productivity: human disturbance and pesticide residue in northern Minnesota. Wilson Bull. Vol. 88: 427-432.

Residents Committee to Protect the Adirondacks. 2000. Jet ski home rule regulation bill is signed by Governor Pataki. The Park Report. Vol. 6 (2): 15-17.

Smith, E. L. 1981. Effects of Canoeing on Common Loon Production and Survival on the Kenai National Wildlife Refuge. M.S. Thesis. Colorado State University. Fort Collins, CO.

Stockwell, S.S. and J. Jacobs. 1993. Effects of lakeshore development and recreational activity on the reproductive success of Common Loons in southern Maine. Pp. 222-234 *in* L. Morse, S. Stockwell, and M. Pokras (eds.). Proc. 1992 Conf.: The Loon and its Ecosystem: Status, Management, and Environmental Concerns. U.S. Fish and Wildlife Service, Concord, NH.

Titus, J. R. 1977. Response of the Common Loon "*Gavia immer*" to Recreational Pressure in the Boundary Waters Canoe Area. Ph.D. Thesis. State University of NY. Syracuse, NY.

Titus, J. R. and L. Van Druff. 1981. Response of the Common Loon to Recreational Pressure in the Boundary Waters Canoe Area, Northeastern Minnesota. Wildlife Monograph No. 79. Wildlife Society.

Vogel, H. 1999. Impacts of Boats and Personal Watercraft on Loons and Other waterbirds in New Hampshire. Unpublished report. 3pp.

Fishing: Lead Poisoning and Fishing Line Entanglement

Englebright, S. 1994. An Informational Fact Sheet on a Bill to Prohibit the Manufacture, Sale, and Use of Lead, Brass, and Zinc Sinkers and Other Fishing Related Equipment. 7pp. NYS Assembly, 4th Assembly District, Suffolk County.

Forsell, D.J. 1999. Mortality of Migratory Waterbirds in Mid-Atlantic Coastal Anchored Gill Nets during March and April, 1998. Unpublished report submitted to U.S. Fish and Wildlife Service. 29pp.

Locke, L.N., S.M. Kerr, and D. Zoromski. 1982. Lead poisoning in Common Loons (*Gavia immer*). Avian Diseases. Vol. 26: 392-396.

Scheuhammer, A.M. and S.L. Norris. 1995. A Review of the Environmental Impacts of Lead Shot Shell Ammunition and Lead Fishing Weights in Canada. Occ. Paper No. 88. Canadian Wildlife Service. Ottawa, ON, Canada. 54pp.

Sidor, I.F., M.A. Pokras, A. R. Major, and R. M. Miconi. 2003. Mortality of the Common Loon in New England, 1988-1999. J. Wildlife Diseases. Vol. 39 (2): 306-315.

Stone, W. B. and J. Okoniewski. 2001. Necropsy findings and environmental contaminants in Common Loons from New York. J. Wildlife Diseases. Vol. 37 (1): 178-184.

Nest Platforms for Loons

DeSorbo, C. and D.C. Evers. 2002. Aziscohos Lake Common Loon Population Survey and Management Report: 2001 Season and Third Five-Year Monitoring Report (1997-2001). Report BRI 2002-03 submitted to FPL Energy Maine Hydro. BioDiversity Research Institute, Falmouth, ME. 65pp.

Fair, J.S. 1979. Water level fluctuations and Common Loon nest failure. Pp. 57-63 *in* S. Sutcliffe (ed.). Proceedings of the North American Conf. Common Loon Resource Management. Vol 2.

Mathisen, J.E. 1969. Use of man-made islands as nesting sites for the Common Loon. Wilson Bulletin. Vol. 81: 331.

McIntyre, J.W. and J. E. Mathisen. 1977. Artificial islands as nest sites for Common Loons. J. Wildlife Management Vol. 41 (2): 317-319.

Piper, W.H., M.W. Meyer, M. Klich, K.B. Tischler, and A. Dolsen. 2002. Floating platforms increase reproductive success of Common Loons. Biological Conservation. Vol. 104: 199-203.

Sutcliffe, S.A. 1979. Artificial Common Loon nesting site construction, placement and utilization in New Hampshire. Pp. 147-153 *in* S. Sutcliffe (ed.). Proceedings of the North American Conference Common Loon Res. Mgmt. Vol 2.

Loons in New York

Arbib, R.S. Jr. 1963. The Common Loon in New York State. Kingbird. Vol. 13: 132-140.

Kandel, M., K. Roblee, W. Stone, J. Okoniewski, W. Culligan, G. Hannett, L. Tucker, and B. Edmonds. 2001. Waterbird mortality in New York waters of Lake Erie resulting from Type E botulism. Abstract of oral presentation. The Waterbird Society 25th Anniversary Meeting. Niagara Falls, Canada. The Waterbird Society. Pg. 58.

Kerlinger, P. 1982. The migration of Common Loons through eastern New York. Condor. Vol. 84: 97-100.

LaBastille, A. The endangered loon. Adirondack Life. Vol. 8: 34-38.

McIntyre, J.W. 1979. Status of Common Loons in New York from a historical perspective. Pp. 117-121 *in* S. Sutcliffe (ed.). Proceedings of the North American Conf. Common Loon Res. Mgmt. Vol 2.

Parker, K.E. 1985a. Foraging and Reproduction of the Common Loon (*Gavia immer*) on Acidified Lakes in the Adirondack Park, New York. M.S. Thesis. SUNY College of Environmental Science and Forestry. Syracuse, NY.

Parker, K.E. 1985b. Observations of a flying Common Loon carrying a fish. J. Field Orn. Vol. 56: 412-413.

Parker, K.E. 1987a. An apparent prefledged Common Loon chick found at Montezuma National Wildlife Refuge. The Kingbird. Vol 37 (4): Pp. 189-191.

Parker, K.E. 1987b. Spring migration of the Common Loon through Sullivan County, New York. The Kingbird. Vol. 37 (1): 3-5.

Parker, K.E. 1988. Common Loon reproduction and chick feeding on acidified lakes in the Adirondack Park, New York. Can. J. Zool. Vol. 66: 804-810.

Parker, K.E., R.L. Miller, and S. Isil. 1986. Status of the Common Loon in New York State. NYS Department of Environmental Conservation. Report. 73pp.

Parker, K.E. and R.L. Miller. 1988. Status of New York's Common Loon population – comparison of two intensive surveys. Pp. 145-156 *in* P. Strong (ed.). Papers from 1987 Conf. Loon Res. Mgmt. North American Loon Fund. Meredith, NH.

Sea Grant New York & Pennsylvania. 2001. Avian Botulism in Lake Erie Workshop Proceedings. Domske, H.M. and E.C. Obert (eds.). NY Sea Grant. Great Lakes Program. University of Buffalo, Buffalo, NY. 62pp.

Taylor, K. 1974. The loon. Adirondack Life. Vol. 5: 30-37.

Trivelpiece, W., S. Brown, A. Hicks, R. Fekete, and N.J. Volkman. 1979. An analysis of the distribution and reproductive success of the Common Loon in the Adirondack Park, New York. Pp. 45-55 *in* S. Sutcliffe (ed.). Proceedings of the North American Conference Common Loon Res. Mgmt. Vol 2.

Volkman, N. and W. Trivelpiece. 1980. Survival for the loon. Adirondack Life. Vol. 11: 26-31.

Miscellaneous Literature

Begon, M. and M. Mortimer. 1981. Population Ecology: a Unified Study of Animals and Plants. Blackwell Scientific Publications. Oxford, England. 200pp.

Dasmann, R. F. 1981. Wildlife Biology. John Wiley & Sons, Inc. New York, NY. 212pp.

Friend, M. and J.C. Franson (eds.). 1999. Field Manual of Wildlife Diseases: General Field Procedures and Diseases of Birds. U.S. Department. of Int. U.S.G.S. Biological Resources Division. Information and Technical Report 1999-001. 426pp.

NABCI (North American Bird Conservation Initiative). 2003. http://www.nabci-us.org.

Tri-State Bird Rescue & Research, Inc. 1990. Oiled Bird Rehabilitation: A Guide for Establishing and Operating a Treatment Facility for Oiled Birds. Wilmington, DE. 98pp.

APPENDIX 1: LOON MONITORING AND RESEARCH ORGANIZATIONS

Adirondack Cooperative Loon Program
P.O. Box 195
Ray Brook, NY 12977
(518) 891-8836
aclp2@juno.com
www.adkscience.org/loons

Alaska Loon Watch
USFWS Migratory Bird Mgmt.
1011 E. Tudor Rd. MS 201
Anchorage, AK 99503
(907) 786-3517

BioDiversity Research Institute
19 Flaggy Meadows Road
Gorham, ME 04038
(207) 839-7600
www.briloon.org

Canadian Lakes Loon Survey
Bird Studies Canada
P.O. Box 160
Port Rowan, Ontario
Canada, N0E 1M0
(888) 448-2473
www.bsc-eoc.org/cllsmain.html
aqsurvey@bsc-eoc.org

Common Loon Protection Project
Maine Audubon Society
P.O. Box 6009
Falmouth, ME 04105
(207) 781-2330, fax: (207) 781-6185

Gatineau Fish & Game Club
Box 550
Maniwaki, QC
Canada J9E 3K6
(819) 465-2289

Lake of the Woods District Property Owners Association
Box 1160
Kenora, ON
Canada P9N 3X7
www.lowdpoa.com

Loon Lake Loon Association
P.O. Box 75
Loon Lake, WA 99148
(509) 233-2145
www.loons.org

Loon Preservation Committee
Audubon Society of New Hampshire
P.O. Box 604
Moultonborough, NH 03254
(603) 476-5666, fax: (603) 476-5497
www.loon.org

Loon Watch
Sigurd Olson Environmental Institute
Northland College
Ashland, WI 54806
(715) 682-1220, fax: (715) 682-1308
www.northland.edu/soei

Massachusetts Aquatic Conservation Society
P.O. Box 934
Attleboro, MA 02703
www.MACSLoons.org

Massachusetts Division of Fish and Wildlife
Natural Heritage & Endangered Species Program
One Rabbit Hill Rd.
Westboro, MA 01581
(508) 792-7270x152

Michigan Loon Preservation Association
Michigan Audubon Society
6011 W. St. Joseph
P.O. Box 80527
Lansing, MI 48908-0527
www.michiganloons.org

Minnesota Department of Natural Resources
Nongame Program
500 Lafayette Rd.
St. Paul, MN 55146
(612) 297-2276

Montana Loon Society
6525 Rocky Point Rd.
Polson, MT 59860-9520
(406) 883-5797

New York Loon Conservation Project
Audubon Society of New York, Inc.
46 Rarick Rd.
Selkirk, NY 12158
(518) 767-9051
www.audubonintl.org/programs/asny

North American Loon Fund
40046 North shore Lane
Loon Lake WA 99148
info@LoonFund.org
www.LoonFund.org

Oikos Research Foundation
Dr. J.W. McIntyre, Director
8 Sherman Circle
Utica, NY 13501

Panhandle Loon & Wetlands Project
Idaho Panhandle National Forests
3815 Schreiber Way
Coeur d'Alene, ID 83815
(208) 765-7206

QLF/Atlantic Center for Environment
55 South Main St.
Ipswich, MA 01938-2396
(508) 356-0038x401
www.qlf.org

Vermont Loon Recovery Project
Vermont Institute of Natural Science
27023 Church Hill Rd.
Woodstock, VT 05091
(802) 457-2779
www.vinsweb.org

Walker Lake Working Group
P.O. Box 476
Mina, NV 89422
(702) 573-2581
www.walkerlake.org

Washington Department of Fish & Wildlife
600 Capitol Way N.
Olympia, WA 98501-1091
(360) 902-2200

APPENDIX 2: ADDITIONAL INFORMATION ABOUT THE PARTNERS OF THE ADIRONDACK COOPERATIVE LOON PROGRAM

Wildlife Conservation Society's Adirondack Communities and Conservation Program:

The Wildlife Conservation Society (WCS) believes in the intrinsic value of the diversity and integrity of life on Earth, and in the importance of wildlife and wilderness to the quality of human life. WCS saves wildlife and wildlands by understanding and resolving critical problems that threaten key species and large, wild ecosystems around the world. In 1995, WCS established the Adirondack Communities and Conservation Program (ACCP) in order to inform and help resolve debate regarding conservation and development in the Adirondack Park of New York State. ACCP is a community-based conservation program that works with Adirondack communities and organizations to identify key issues and information needs about conservation in the Park

For more information, contact:

The Wildlife Conservation Society
2300 Southern Boulevard
Bronx, NY 10460
(718) 220-5100
www.wcs.org

Adirondack Communities and Conservation Program
7 Brandy Brook Ave., Suite 204
Saranac Lake, NY 12983
(518) 891-8872
www.wcs.org/adirondacks

Natural History Museum of the Adirondacks:

The mission of the Natural History Museum of the Adirondacks is to inspire a broad public understanding of the systems that shape and sustain life in the Adirondacks. The concept of developing the Natural History Museum of the Adirondacks was first introduced in 1998, and has since flourished. The Museum will be located in Tupper Lake, along the banks of the Raquette River, a site that reflects the scenic topography of the Adirondack Park. The Museum has developed an interactive website, and several citizen science programs, including its involvement with the Adirondack Cooperative Loon Program.

For more information, contact:

The Natural History Museum of the Adirondacks
P.O. Box 897
Tupper Lake, NY 12986
(518) 359-7800
www.adknature.org

New York State Department of Environmental Conservation:

The Department of Environmental Conservation is the state agency directed toward protecting and enhancing the environment of New York State. The mission of the Department, as described in the New York State Environmental Conservation Law, is to: "conserve, improve, and protect its natural resources and environment, and control water, land and air pollution, in order to enhance the health, safety and welfare of the people of the state and their overall economic and social well being." The DEC is responsible for administration and enforcement of the Environmental Conservation Law.

<u>**For more information, contact:**</u>

Division of Fish, Wildlife, and Marine Resources, Bureau of Wildlife
New York State Department of Environmental Conservation
625 Broadway
Albany, NY 12233
(518) 402-8919
www.dec.state.ny.us

BioDiversity Research Institute:

BioDiversity Research Institute (BRI) is a Maine-based nonprofit group dedicated to progressive environmental research and education. Avian research and aquatic toxicology are the primary focus of BRI's work. Loons and other piscivorous (fish-eating) birds that are high in the food chain are used as indicators of the health and condition of the aquatic environment.

<u>**For more information, contact:**</u>

BioDiversity Research Institute
19 Flaggy Meadows Road
Gorham, ME 04038
(207) 839-7600
www.briloon.org

Audubon Society of New York State, Inc.:

The Audubon Society of New York State, Inc. is an independent state Audubon society that works to administer its lands for protection of water quality and wildlife habitat, and to encourage public education and involvement in wildlife conservation and water quality protection. ASNY runs the New York Loon Conservation Project, which has monitored the migratory and breeding populations of loons in New York State since 1987.

<u>**For more information, contact:**</u>

Audubon Society of New York State, Inc.
46 Rarick Rd.
Selkirk, NY 12158
Telephone: 518-767-9051
www.audubonintl.org/programs/asny

APPENDIX 3: WEBSITES ABOUT LOONS

Adirondack Cooperative Loon Program
http://www.adkscience.org/loons

BioDiversity Research Institute
http://www.briloon.org

Canadian Lakes Loon Survey
http://www.bsc-eoc.org/cllsmain.html

Darwin Long's Interesting Loon Site
http://members.aol.com/djl4loons

Greg Nelson's Loon Photos
http://www.gmnphotography.com

Joe Nocera's Common Loon Site
http://dragon.acadiau.ca/~acwern/jnocera/JNOCERA.HTM

Journey North's Loon Site
http://www.learner.org/jnorth/spring1999/species/loon/index.html

Loon Preservation Committee
http://www.loon.org

Loon Watch
http://www.northland.edu.soei

Massachusetts Aquatic Conservation Society
http://www.MACSLoons.org

Michigan Loon Preservation Association
http://www.michiganloons.org

New York Loon Conservation Project
(Audubon Society of New York, Inc.)
http://www.audubonintl.org/programs/asny

North American Loon Fund
http://www.loonfund.org

University of Minnesota – Common Loons
http://www.consbio.umn.edu/loon

Vermont Loon Recovery Project
Vermont Institute of Natural Science
http:/www.vinsweb.org

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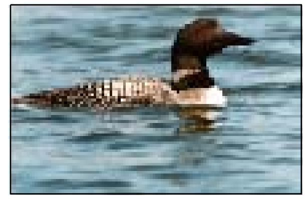

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16	Feeding Young	Gregory M. Nelson
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Nina Schoch

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