

SPECIES PROFILE

Common Loon

Gavia immer

Federal Listing: Not listed

State Listing: Threatened

Global Rank: G5

State Rank: S3

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ELEMENT 1: DISTRIBUTION AND HABITAT

1.1 Habitat Description

Breeding and Nesting Habitat: Loons nest on lakes greater than 6.5 ha (16 ac) but prefer lakes smaller than 24 ha (60 ac) with clear water, small islands, and an irregular shoreline that creates coves. They are also found on major rivers. Lake size and configuration are important determinates for loon density.

Loons nest in close proximity to the water's edge and prefer the lee side of small islands, floating bog mats, and hummocks in marshes (Christenson 1981, Titus and VanDruff 1981, Yonge 1981, Dahmer 1986). Islands can provide the widest range of visibility for loons on the territory and afford better protection from mammalian predators. Marsh and mainland sites are less preferred and are most likely used in response to shoreline development (Alvo 1981, Christenson 1981, McIntyre 1988) and high conspecific densities.

Nest sites generally are within 1 m from the shoreline (Sutcliffe 1980). Available submerged and emergent vegetation is used for nest structures. Extent of the nest bowl diameter varies (27 to 38 cm), and use of depressions, or "scrape" bowls is common (Sutcliffe 1980, Loon Preservation Committee (LPC), unpublished data). Mainland nest sites are more likely to be structures as opposed to scrapes or hummocks (Sutcliffe 1980). Some loons use sites with steep drop-offs that allow for underwater approaches and exits (Olson and Marshall 1952, Christenson 1981,

McIntyre 1988), though this is not a predictor of site location (Sutcliffe 1980, Valley 1987). Strong (1987) found between-year reuse of nest sites by Common Loons to be 78-88%. Changes in nest locations were more frequent after nest failures and reuse in subsequent years occurred more often after successful nests (McIntyre 1988).

Chick Rearing Habitat: Chick rearing areas are typically in shallow water close to shore, having prey size classes suitable for feeding young, and experience less prevailing wind and waves that can separate chicks from adults. Chicks have been observed to hide among shoreline vegetation in response to threats or when left unattended (Yonge 1981, Strong and Bissonette 1987).

Winter Habitat: Near-shore coastal waters including bays, channels and inlets serve as winter habitat. Wintering loons generally use more placid waters less than 20 m in depth within 100 km from shore (Haney 1990, Jodice 1992).

1.2 Justification

Lakes and associated shorelines are under great anthropogenic pressure. The response of wildlife and aquatic ecosystems to such pressures needs to be quantitatively monitored using appropriate species. Common Loons have declined or are absent from much of their historical breeding range in North America. Between 1978 and 2000, LPC activities promoted increases in numbers of territorial loon pairs, nesting pairs, successful nests, and fledged young. However, monitoring also revealed a significant decline ($P < 0.05$) in loon reproductive success from 1982 on. Negative trends in loon breeding success have resulted in 5 successive years of declines in the adult loon population in New Hampshire.

The limited dispersal, low population densities, and low reproductive potential of loons limit LPC's ability to recover a declining loon population; only intensive management has increased New Hampshire's population since loons were listed as a state-threatened species.

1.3 Protection and Regulatory Status

Common Loons are protected from illegal take under the Migratory Bird Act of 1918 and are listed as a threatened species in New Hampshire under New Hampshire RSA 212-A, the Endangered Species Conservation Act.

1.4 Population and Habitat Distribution

Loons are widely distributed in freshwater lakes and large rivers in New Hampshire north and south of the White Mountains. Populations are sparse in western parts of Sullivan and Cheshire counties, as well as in Hillsborough county and eastern parts of Strafford and Rockingham counties.

Migration occurs on a wide front throughout New Hampshire, and fall migration is more protracted than spring arrival (Evers 2004). Staging primarily occurs on larger lakes, such as Lake Winnepesaukee, Squam Lake, Lake Sunapee, and Newfound Lake (LPC, unpublished data) before migration to the ocean. Loons from New England winter off the Atlantic coast from Maine south along coastal Massachusetts into Long Island Sound (LPC, unpublished data, BioDiversity Research Institute, (BRI) unpublished data).

1.5 Town Distribution Map

See Figure 1: Distribution of Common Loons In New Hampshire

1.6 Habitat Map

N/A

1.7 Sources of Information

Information on Common Loon habitat, population distribution, and status is from LPC's database and technical field reports, the Status and Assessment Plan for Common Loons in North America (Evers 2004), and peer-reviewed journals.

1.8 Extent and Quality of Data

The Common Loon is one of the most intensively monitored and managed species in New Hampshire. Statewide surveys have been conducted annually by LPC since 1976.

1.9 Distribution Research

The distribution of loons in New Hampshire is well known (see section 1.4). Identification of potential habitat is currently in progress through habitat modeling efforts. Little is known about wintering populations of loons. Cape May Bird Observatory in New Jersey monitors loons during migration in the Northeast. Christmas Bird Counts provide limited wintering loon information, but volunteer observations are not primarily focused on loons. Annual wintering data will enhance current state loon population monitoring and trend analyses and will serve to flag injury from oil spills, contaminants, and other disturbances on the wintering grounds that have the potential of harming breeding success.

ELEMENT 2: SPECIES/HABITAT CONDITION

2.1 Scale

Modeling of suitable habitat, in combination with known dispersal distances of loons, suggest distinct populations north and south of the White Mountains (J. Gear, USEPA, personal communication). This assessment is born out by genetic markers in loon blood (McMillian 2004). Levels of management and challenges facing loons also differ north and south of the White Mountains (LPC, unpublished data).

2.2 Relative Health of Populations

Northern and southern loon populations have increased significantly ($P < 0.05$) since 1977; however, the northern population has shown a significant decrease ($P < 0.05$) over the last 10 years. The northern population has lower reproductive success than the southern population, but the reproductive success of both populations has trended upward ($P < 0.05$) over time (LPC, unpublished data).

2.3 Population Management Status

- Rafts were provided to 11% of northern territorial pairs and 8% of southern pairs in 2004.
- Signs and rope lines were placed around 6% of nests in northern New Hampshire and 28% of nests in southern New Hampshire in 2004.
- On Lake Umbagog, water levels are managed for stability during critical nesting periods for 20 territorial loon pairs.
- Taken together, 53% of territorial loon pairs in northern New Hampshire benefited from management efforts as compared to 27% of territorial pairs in southern New Hampshire in 2004.

2.4 Relative Quality of Habitat Patches

Efforts to quantify habitat quality are currently under way. A pilot study in central New Hampshire found a correlation between a loon habitat ranking index and productivity, indicating it as a suitable predictive model of habitat quality for loons.

2.5 Habitat Patch Protection Status

The Comprehensive Shoreland Protection Act RSA 483-B was created in 1994 to protect against activities affecting water quality by setting minimum standards and requirements for the use of land within 250 feet of the water's edge. Loon nests on protected shoreline remain vulnerable to recreational use of public waters.

2.6 Habitat Management Status

See section 2.3

2.7 Sources of Information

Information on habitat patch protection status was obtained from NHDES. Data on rafts, water-level management, and signs were derived from LPC's database.

2.8 Extent and Quality of Data

The Common Loon is one of the most intensively

monitored and managed species in New Hampshire. Statewide surveys have been conducted annually by LPC since 1976.

2.9 Condition Assessment Research

Research is needed to determine the minimum number of territorial pairs necessary to sustain a loon population in New Hampshire, and to determine carrying capacity, longevity, and mortality of sub-adult and adult loons. This information needs to be understood in a spatially explicit way to avoid local extinctions and can be accomplished by identifying habitat availability and the structure of the state's metapopulation and subpopulations.

ELEMENT 3: SPECIES AND HABITAT THREAT ASSESSMENT

3.1.1. Development (Habitat Loss and Conversion)

(A) Exposure Pathway

The quality of loon breeding habitat is affected by shoreline development through vegetative modification or removal, creation of structures in close proximity to traditional nesting sites, increased predator densities, and human activity. Often sites favored by loons for nesting and chick rearing, such as islands and quiet bays, are of prime development value. Loons, particularly those breeding pairs that are unaccustomed to people, are likely to locate nest and nursery sites distant from human presence (Alvo 1981, LPC, unpublished data). Therefore, shoreline development in high quality loon breeding habitats, such as island habitats, can restrict use of these habitats by a territorial pair. Furthermore, loon presence attracts potential property owners.

Raccoons (*Procyon lotor*) are widely considered the most influential egg-predator of loons. Densities of raccoons and other opportunistic predators, such as gulls and corvids are generally correlated with increasing shoreline development (Evers 2004).

Removal of shoreline vegetation causes erosion and an increase in water temperatures. Ensuing sedimentation and phosphorus enrichment of the lake can contribute to excessive algae and aquatic weed growth, reduced water clarity and quality, and changed prey density and aquatic food webs.

(B) Evidence

Habitat degradation and loss because of shoreline development have been cited as reasons for declines in local breeding populations and in reproductive success (Alvo 1981, Dahmer 1986, McIntyre 1988). Erosion at construction sites is a leading cause of water quality problems in New Hampshire waterbodies (NHDES 2003).

3.1.2 Recreation (Boats and Jet Skis)

(A) Exposure Pathway

Non-motorized watercrafts, such as canoes and kayaks, have access to shallow water near loon nesting and brood sites, which can lead to nest abandonment. Additionally, canoeists and kayakers are more apt to use remote areas and have a greater ability for stealth. This type of activity is most detrimental during early incubation when egg investment is lowest and the likelihood of nest abandonment is highest. Disturbance from sailboats and windsurfing has not been quantified. Anecdotal and behavioral evidence suggests a sail can be perceived as a visual threat, and therefore has the potential to disrupt nesting and brooding activity, even in areas of high recreational use (LPC, unpublished data).

Loons can habituate to moderate use of motorboats. Recreational motor boating represents a greater disturbance and risk to loon adults and young in open water than to those nesting and foraging in shallow water. Habituation to boating activity can dull response times in loons, making them more susceptible to collisions (LPC, unpublished data).

Personal watercraft can cause significant damage since they have a shallow draft and are able to closely approach nests and shorelines at high speeds. Repeated travel of personal watercraft near nest sites or loon families for extended periods of time can disrupt incubation, expose eggs to predators, or impede parental care of young (Burger 1998).

Excessive angler use of shallow, vegetated areas of lakes through wading and boating can disturb nesting and foraging activity (Titus 1978, Titus and VanDruff 1981, Christenson 1981, Kelly 1992). The increased popularity of fishing tournaments offering substantial prizes can create an unfortunate incentive for improper practices. In New Hampshire and Maine, vulnerable nesting pairs are vigorously monitored during bass tournaments, as some participants

regularly disregard posted and cordoned-off nest enclosures (LPC, unpublished data.).

(B) Evidence

Washouts of loon nests and blunt trauma mortality to loons from boats have been documented by Maine Audubon Society (unpublished testimony), Jaruzel (1998), Miconi et al. (2000).

Fourteen percent (32/227) of loon mortality in New England from 1989 to 1996 was due to boat trauma (Miconi et al. 2000).

Though loons on lakes with high human use flush at shorter distances and less readily than those on low use lakes (Smith 1981, Titus and VanDruff 1981), any increase in activity near the nest site may serve to attract predators (McIntyre 1977, 1988). Kelly (1992) found that time off-nest was significantly less for flushes related to natural causes than those caused by human disturbance. Christenson (1981) found that adults with young moved away when boats were present. The energetic cost of this is unknown; however, movement in response to boating activity increases the likelihood of chicks being separated from adults and decreases time spent feeding young.

3.1.3. Recreation (Lead Shot and Sinkers)

(A) Exposure Pathway

Lead poisoning in loons in New Hampshire is a direct result of ingesting a Pb object, virtually always a Pb sinker or jig (LPC, unpublished data). Lost or discarded Pb sinkers and jigs are ingested with stones to grind food in the gizzard, with fish that have broken free from an angler's line, or by striking at a sinker or jig on the line. Lead mortality peaks in mid-summer, coincident with peak tourism and angling pressure (LPC, unpublished data), and the presence of swivels and hooks in close to half of the Pb-killed loons suggests that direct ingestion as a result of current fishing practices, rather than the reservoir of tackle on lake bottoms, is the major source of mortality.

Once swallowed, stomach acids and the grinding action of the gizzard dissolve Pb sinkers and jigs. Lead is absorbed into the blood and body tissues. Lead affects nerve impulse transmission causing systemic paralysis and neurological dysfunction, evidenced by head shaking, gaping, wing droop, and eye droop. Other symptoms include green feces, listlessness, lethargy, emaciation, increased occurrence in shallow waters,

and frequent bouts of beaching with progression of the condition (LPC, unpublished data). There is no effective treatment for lead poisoning in loons; the ingestion of a single lead sinker or jig can be fatal.

(B) Evidence

Lead poisoning from the ingestion of Pb fishing sinkers and jigs is the largest single cause of known adult loon mortality in New Hampshire and has significantly increased over time ($P < 0.001$) (LPC, unpublished data, Tufts University Wildlife Clinic, unpublished data).

Thirteen studies have confirmed a direct link between the ingestion of Pb sinkers and Pb-headed jigs and mortality of Common Loons. Lead poisoning has been identified as a significant cause of Common Loon mortality throughout England, Eastern Canada, and the United States.

3.1.4. Mercury

(A) Exposure Pathway

Mercury (Hg) is a result of anthropogenic sources such as municipal and medical waste incinerators and coal-fired power plants (Swain et al. 1992, USEPA 1997, NESCAUM 1998). Mercury is a highly mobile contaminant with the ability to cycle through land, air, and water. One of its organic forms, methylmercury, bioaccumulates in upper trophic level wildlife, including loons and other piscivorous birds (see Meyer et al. 1995, Evers et al. 1998, 2003, 2005).

Mercury deposition models developed by the USEPA (1997) indicate the northeastern United States to be at particular risk to elevated levels of Hg deposition. Nearly fifty percent of this deposition is from sources within the region. One of the highest exposure areas predicted in these models is the southeastern corner of New Hampshire.

Concentrations of Hg in loon eggs and in adult loons, and the accumulation of Hg in individual loons over time, suggest that current levels of Hg emissions are high enough to pose a threat to loons and other wildlife in New Hampshire. Overall, at least 19% of New Hampshire's adult loon population is at risk to physiological, behavioral, or reproductive impact. At risk individuals have been shown to fledge 37% fewer young. The Hg risk for southern New Hampshire loon populations is at least 32%, while in southeastern New Hampshire the risk is at least 89%

(D.C. Evers, unpublished report).

(B) Evidence

The Common Loon has been nationally identified by a USEPA-led working group as one of the best indicators of persistent bioaccumulative toxins, including Hg, in lakes (Wolfe et al. 2004, Evers et al. 2005).

3.2 Sources of Information

Literature review and LPC unpublished data.

3.3 Extent and Quality of Data

Development and associated recreational pressures on lakes have been implicated in loon population declines and reduced breeding success (Titus and Van Druff 1981, Jung 1987, Strong and Bissonette 1987, Kelly 1992). However, loons can successfully breed on water bodies despite disturbance (Jung 1991, K. Taylor and H. Vogel, Loon Preservation Committee, unpublished report) and can adopt adaptive strategies in response to human activity (Alvo 1981, Christenson 1981, Titus and Van Druff 1981, Jung 1987).

Effects of Pb toxicity on loon mortality are well documented, as are levels of Hg in loons in New Hampshire and the effects on loon reproduction.

3.4 Threat Assessment Research

- Efforts are currently under way to assess the relative threat of shoreline development and other factors in order to address overall loon habitat quality. Developing a science-based ranking system to facilitate cooperative restoration efforts in prioritizing habitat of the highest quality is needed for long-term management and protection.
- Continued monitoring of mortality to determine effectiveness of current lead (Pb) tackle legislation is necessary. Research on the mechanisms and severity of various boating activities on likelihood of nesting, hatching success, and chick survivorship needs continuation.
- Continued tracking of Pb mortality to determine effectiveness of current Pb tackle legislation is necessary. Research is needed to assess the persistence of Pb sinkers and jigs in the environment.
- Further research is needed to determine other populations of loons at risk of Hg poisoning in New

Hampshire, to connect known biological hotspots for mercury deposition on lakes and loon territories with source origins in New Hampshire, and to increase our knowledge of Hg in aquatic systems.

ELEMENT 4: CONSERVATION ACTIONS

4.1.1 Artificial Nesting Islands (“Rafts”) Category: Restoration and Management

(A) Direct Threat

Loss of nesting habitat from shoreline development, increased nest predators, and artificial water level fluctuations.

(B) Justification

Rafts can facilitate successful nesting for loons that have been displaced from traditional nesting sites due to shoreline development. Rafts also protect nesting loons from water level fluctuations that can flood or strand nests, and provide a measure of protection against mammalian predators associated with shoreline development. DeSorbo et al. (unpublished manuscript) found that nest success in raft nesting loons was higher than that for naturally nesting loons on lakes with and without water level changes. The LPC floats approximately 40 rafts each year in New Hampshire and is experimenting with covers to reduce avian predation and reduce the responsiveness of loons to boaters.

(C) Conservation Performance Objective

Maintain a nesting success rate of 1.2 or higher chicks hatched per raft nesting loon pair.

(D) Performance Monitoring

Monitoring of raft loon nesting loon success will be carried out as part of LPC’s regular monitoring duties.

(E) Ecological Response Objective

Long-term ecological response will be to maintain stable or increasing loon populations in southern and northern New Hampshire.

(F) Response Monitoring

Monitoring of raft nesting loon success and population levels will be carried out as part of LPC’s regular monitoring duties.

(G) Implementation

The LPC possesses the expertise and infrastructure to build, place, and maintain rafts. A significant expansion of LPC’s raft program will require additional personnel and funding.

(H) Feasibility

The LPC is well situated to carry out a raft management program; however, rafts are labor-intensive and an imperfect solution to factors limiting loon nesting success. Rafts are deployed and used as nesting platforms in order to mitigate potential human threats to incubating loon pairs until these threats can be addressed by more permanent solutions.

4.1.2 Signs and Rope Lines

Category: Habitat Protection

(A) Direct Threat

Recreation

(B) Justification

Recreational activities likely play a role in loon hatching and fledging. Territorial pairs on highly developed lakes with signs and float lines surpassed the hatching success of territories without such restrictions (K. Taylor and H. Vogel, Loon Preservation Committee, unpublished report). Use of exclosures should be based on site-specific nest failure history and an understanding of typical lake use patterns. Kelly (1991) recommends floating 3 to 6 signs, approximately 137 m from the nest site for optimal buffering capacity. Exclosures should be removed soon after hatch to maximize public acceptance and compliance.

(C) Conservation Performance Objective

Maintain a nesting success rate of at least 1.2 chicks hatched per protected nest site.

(D) Performance Monitoring

Monitoring of nest sites cordoned off during incubation will be carried out as part of LPC’s regular monitoring duties.

(E) Ecological Response Objective

Long-term ecological response will be to maintain stable or increasing loon populations in southern and northern New Hampshire.

(F) Response Monitoring

Monitoring loon pairs in northern and southern New Hampshire will be carried out as part of LPC's regular monitoring duties.

(G) Implementation

An effective design for floating signs and a protocol for roping off nest sites is well established. The LPC possesses the expertise and infrastructure to build, place, and maintain signs and ropes. A significant expansion of LPC's ropes and signs program will require additional personnel and funding.

(H) Feasibility

LPC is well situated to carry out an extensive management program that includes the use of signs and rafts at vulnerable nest sites. However, these techniques are labor-intensive and are an imperfect solution to threats to nesting loons. Rafts and signs can mitigate potential human threats to incubating loon pairs until these threats can be addressed by more permanent solutions.

4.1.3. Boating and Lead

Category: Education and Outreach

(A) Direct Threat

Recreation (Lead Shot and Sinkers)

(B) Justification

Trauma from boats and lead poisoning resulting from the ingestion of Pb fishing tackle have been identified as leading causes of Common Loon mortality throughout Eastern Canada and the United States. Also see sections 3.1.2 and 3.1.3

(C) Conservation Performance Objective

Reduce boating collisions and ingestion of Pb objects in New Hampshire. The current state ban needs to be accompanied by outreach programs and should increase the availability of non-Pb alternatives. Education efforts need to promote responsible fishing and boating practices and continue and expand Pb-exchange programs and increase penalties for use of illegal sinker and jigs. These measures might include forfeiture of license and/or disqualification during fishing tournaments if loon sanctuaries and enclosures are disregarded.

(D) Performance Monitoring

Monitoring of presentations and attendance can be carried out as part of LPC's regular monitoring duties. LPC field biologists can track distribution of non-Pb alternatives.

(E) Ecological Response Objective

The long-term ecological response will be to reduce mortality in order to maintain stable or increasing loon populations in southern and northern New Hampshire.

(F) Response Monitoring

Tracking the causes of loon mortality can be carried out as part of LPC's long-term collaborative mortality study with Tufts University Wildlife Clinic, North Grafton, Massachusetts.

(G) Implementation

LPC regular and field staff can educate through formal and informal contacts in the field.

(H) Feasibility

The LPC is situated to carry out some outreach and non-Pb sinker distribution but is limited by staffing constraints.

4.1.4 Mercury and Lead

Category: Regulation and Policy

(A) Direct Threat

Mercury, Recreation (Lead Shot and Sinkers)

(B) Justification

Lead poisoning resulting from the ingestion of Pb fishing tackle has been identified as a leading cause of Common Loon mortality throughout Eastern Canada and the United States. A long-established culture of Pb use among the angling community and the reluctance of manufacturers to reduce Pb production in favor of alternatives have made voluntary efforts ineffective. Mercury bioaccumulates and biomagnifies in upper trophic level wildlife, including loons and other piscivorous birds, and impairs reproduction (see Meyer et al. 1995, Scheuhammer 1987, 1991). Also see section 3.1.4.

(C) Conservation Performance Objective

End the use of Pb objects in lake systems. Current state-by-state patchwork approach to Pb legislation should be changed to a national ban on Pb accompanied by outreach programs and increasing the availability of non-Pb alternatives. Reduce Hg emissions from known sources in New Hampshire.

(D) Performance Monitoring

Monitoring would assess the effectiveness of efforts to reduce mortality from ingesting Pb tackle and blood Hg levels in loons.

(E) Ecological Response Objective

Long term ecological response will maintain a stable or increasing loon population in southern and northern New Hampshire by keeping loon Hg body burdens below known thresholds (i.e., below 3.0 ppm for blood and below 1.3 for eggs).

(F) Response Monitoring

Monitoring of population levels will be carried out as part of LPC's regular monitoring duties.

(G) Implementation

The LPC will create relationships with legislators and create reports to summarize impacts of Pb and Hg on loons.

(H) Feasibility

Legislation and policy will be conducted by LPC, NHA's Policy Department with testimony by experts from NHDES, NHFG, USFWS, and BioDiversity Research Institute, Gorham Maine.

4.2 Conservation Action Research

- The efficacy of avian guards on rafts to ameliorate avian predation in New Hampshire is yet to be established. Additional research on measures to remove nest platforms and create self-supporting loon territories is needed.
- The efficacy of signs and ropelines on lakes experiencing different levels of recreational use is yet to be fully established. Additional research on this management practice is warranted.
- Research is needed to assess the persistence of Pb sinkers and jigs in the environment and the efficacy of educational efforts to reduce Pb use and irresponsible boating.

- New Hampshire will be included in the national mercury monitoring plan currently being developed (see above "C"). Multiple Hg monitoring stations for collecting levels in the air, water, sediment, fish, and birds will be located in New Hampshire through this effort. Such a national program will be designed to link with Hg emission regulations.

ELEMENT 5: REFERENCES

5.1 Literature

- Alvo, R. 1981. Marsh nesting of Common Loons (*Gavia immer*). Canadian Field-Naturalist 95: 357.
- Burger, J. 1998. Effects of motorboats and personal watercraft on flight behavior over a colony of Common Terns. Condor 100:528-534.
- Christenson, B.L. 1981. Reproductive ecology of and response to disturbance by Common Loons in Maine. M.S. Thesis, Univ. of Maine, Orono, ME.
- Dahmer, P.A. 1986. Use of aerial photographs to predict lake selection and reproductive success of Common Loons in Michigan. M.S. Thesis, Univ. of Michigan, Ann Arbor, Michigan, USA.
- Evers, D.C., J.D. Kaplan, M.W. Meyer, P.S. Reaman, W.E. Braselton, A. Major, N. Burgess, and A.M. Scheuhammer. 1998. Geographic trend in mercury measured in Common Loon feathers and blood. Environmental Toxicology and Chemistry 17:173-183.
- 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 12: 69-81.
- Evers, D.C. 2004. Status assessment and conservation plan for the Common Loon (*Gavia immer*) in North America: final draft. United States Fish and Wildlife Service, Hadley, MA. Final Draft.
- Evers, D.C., L. Champoux, N. Burgess, A. Major, W. Goodale and R.J. Taylor. 2005. Patterns and interpretation of freshwater avian communities in northeastern North America. Ecotoxicology 14: 193-222.
- Haney, J.C. 1990. Winter habitat of Common Loons on the continental shelf of the southeastern United States. Wilson Bulletin 102:253-263.
- Jaruzel, L. 1998. Loon Watch. Northern Michigan Journal.

- Jodice, P.G.R. 1992. Distribution of wintering loons in the northeastern Gulf of Mexico. In: The loon and its ecosystem: status, management, and environmental concerns. Proceedings from the 1992 American Loon Conference, Bar Harbor, ME, pp. 172-177
- Jung, R.E. 1987. An assessment of human impact on the behavior and breeding success of the common loon (*Gavia immer*) in the northern Lower and eastern Upper Peninsulas of Michigan. University of Michigan.
- Kelly, L.M. 1992. The effects of human disturbance on Common Loon productivity in northwestern Montana. M.S. Thesis, Montana State Univ., Bozeman, Montana, USA.
- Mason, R, M. Abbot, D. Bodaly, R. Bullock, C. Driscoll, D.C. Evers, S. Lindberg, M. Murray, and E. Swain. 2005. Monitoring the response to changing mercury deposition. Environmental Science and Technology, pp 14a-22a.
- McIntyre, J.W. 1977. The Common Loon: Part II. Identification of potential predators on Common Loon nests. Loon 49:96-99.
- McIntyre, J.W. 1988. The Common Loon: Spirit of Northern Lakes. University of Minnesota Press.
- McMillan, A.M., M.J. Bagley, and D.C. Evers. 2004. Preliminary analysis of Common Loon (*Gavia immer*) genetic structure in Northeast North America based on five microsatellite loci. 18th Annual Meeting Society for Conservation Biology, New York.
- Meyer, M.W., D.C. Evers, T. Daulton 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, 80:871-880.
- Miconi, R., M. Pokras, and K. Taylor. 2000. Mortality in breeding Common Loons: How significant is trauma? Pp. 19-24 in J. McIntyre and D.C. Evers (eds.). Loons: Old history and new findings. Proceedings of a Symposium from the 1997 meeting, American Ornithologists' Union. North American Loon Fund, Holderness, New Hampshire, USA.
- NESCAUM. 1998. Northeast states and eastern Canadian Provinces Mercury Study: A Framework for Action. NESCAUM/NEWMOA/NEIWPCC/EMAN.
- NHDES website 2003 – www.des.state.mh.us
- Olson, S., and W.H. Marshall. The Common Loon in Minnesota. 1952. Minneapolis, Minnesota, Minnesota. Museum of Natural History, University of Minnesota.
- Scheuhammer, A.M. 1987. The chronic toxicity of aluminum, cadmium, mercury, and lead in birds: a review. Environmental Pollution, 46:263-295.
- Scheuhammer, A.M. 1991. Effects of acidification on the availability of toxic metals and calcium to wild birds and mammals. Environmental Pollution 71: 329-375.
- Smith, E.L. 1981. Effects of canoeing on Common Loon production and survival on the Kenai National Wildlife Refuge, Alaska. M.S. Thesis, Colorado State Univ., Fort Collins, CO.
- Strong, P.I.V. 1987. Reuse of nesting and nursery areas by Common Loons. Journal of Wildlife Management 51:123-127.
- Strong, P.I.V., and J.A. Bissonette. 1987. Effects of nest-site loss on Common Loons (*Gavia immer*). Canadian Field-Naturalist 101:581-583.
- Sutcliffe, S.A. 1980. Aspects of the nesting ecology of Common Loons in New Hampshire. M.S. thesis. University of New Hampshire, Durham, New Hampshire, USA.
- Swain, E.B., D.R. Engstrom, M.E. Brigham, T.A. Henning, and P.L. Brezonik. 1992. Increasing rates of atmospheric mercury deposition in midcontinental North America. Science 257:784-787.
- Titus, J.R. 1978. Response of the Common Loon (*Gavia immer*) to recreational pressure in the Boundary Waters Canoe Area, northeastern Minnesota. Ph.D. dissertation, SUNY, Syracuse, NY.
- Titus, J.R., and VanDruff. 1981. Response of the Common Loon to recreational pressure in the Boundary Waters Canoe Area, northeastern Minnesota. 1981. Bethesda, Maryland, Wildlife Society.
- USEPA. 1997. An ecological assessment for anthropogenic mercury emissions in the United States. Report to Congress, U.S. Environmental Protection Agency, Washington, D.C.
- Valley, P.J. 1987. Common Loon productivity and nesting requirements on the Whitefish chain of lakes in North-Central Minnesota. The Loon 59: 3-10.
- Vermeer, K. 1973. Some aspects of breeding and mortality of Common Loons in East-Central Alberta. Canadian Field-Naturalist 87:403-408.
- Wolfe, M.F., T. Atkeson, W. Bowerman, J. Burger, D.C. Evers, M. Murray, and E. Zillouix. 2004.

Wildlife indicators in M. Newman (ed.). Mercury in North America. SETAC Press, Pensacola, Florida: in press.

Yonge, K.S. 1981. The breeding cycle and annual production of the Common Loon (*Gavia immer*) in the boreal forest region. M.Sc. thesis, University of Manitoba, Winnipeg.

Distribution of Common Loon in New Hampshire

Distribution
■ Known
■ Potential



0 10 20 40 Miles

Known = confirmed breeding observations as reported in the NH Natural Heritage Bureau's Element Occurrence Database and Loon Preservation Committee records.
Potential = possible breeding and other observations from the same data sources.

