



U.S. Fish & Wildlife Service

STATUS ASSESSMENT AND CONSERVATION PLAN
FOR THE COMMON LOON (*GAVIA IMMER*)
IN NORTH AMERICA





U.S. Fish & Wildlife Service

**DIVISION OF MIGRATORY BIRDS
HADLEY, MA**

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FOR THE COMMON LOON (*GAVIA IMMER*)
IN NORTH AMERICA**

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I. Executive Summary

The Common Loon (*Gavia immer*), one of five loon species worldwide, is a highly visible resident of our North American waters. Its high profile nature keeps it squarely in the forefront of many aquatic-based conservation efforts. Public appeal for the loon is fully apparent when considering the number of non-governmental organizations dedicated to its conservation. Loons are well-known symbols of the northern wilderness; however, with increasing human presence and activity in formerly pristine areas, they are also serving as indicators of aquatic health. Landscape-level alterations in aquatic environments have led to serious threats throughout the loon's life cycle, yet individuals and populations are resilient and appear to have the ability to acclimate to certain habitat disturbances, sometimes within the same generation. For loons to successfully transition from a wilderness setting to one that is frequently exploited by humans will depend on our ability to better understand factors limiting their populations. This Status Assessment and Conservation Plan outlines knowledge-to-date on (1) natural history, (2) habitat requirements, (3) population distribution, estimates and trends, (4) threats to its survival and well being, (5) monitoring activities, (6) protection status, and (7) detailed strategies for safeguarding population health. Loons are our "coal mine canaries" for northern lakes; their ability to maintain healthy populations across their current range reflects favorably on our ability to maintain the integrity of aquatic ecosystems.

The Common Loon is long-lived with delayed maturity and low fecundity. In parts of its range, the loon's natural history, population dynamics, movements, and mercury levels are now well-characterized because of a long-term, landscape-level capture and color-marking program. Recent strides with high-resolution population models, habitat quality ranking models, and mercury wildlife criterion value models also provide quantitative tools for science-based policy decisions. These models and their associated databases have already contributed toward a better understanding of threats. Further efforts toward marking, sampling for contaminant and genetic profiles, and satellite telemetry will continue to provide the detailed answers for long-term and effective landscape-level conservation.

The overall population status of the Common Loon in North America is relatively healthy and robust. Total estimated breeding population is 252,000 to 264,000 territorial pairs. When incorporating the non-breeding component there are an estimated 607,000 to 635,000 adults. In spring, approximately 30% of this population migrates to the Pacific Coast and 70% to the Gulf of Mexico and Atlantic Coast. During fall migration, the young-of-the-year component increases the total population to between 710,000 and 743,000. Over 94% of the breeding loon population resides in Canada with 56% of these loons in Ontario and Quebec. Trends for the large populations in Canada are relatively unknown and difficult to estimate because surveys are limiting. Although a formal network of loon migration monitoring stations has not been established, standardized winter counts do provide some insight into Canadian breeding populations. Results from these winter counts indicate a steady increasing trend in the number of loons and a long-term recovery in the overall breeding population since the mid-1900s.



While breeding populations are increasing in parts of the U.S. range, such as some areas of New England, those in Michigan, Nova Scotia and Washington are declining. Since breeding loon dispersal distances are limiting, and therefore colonization of historical breeding areas is slow, conservation of isolated and peripheral populations is important and local or regional efforts are worthwhile. High public valuation of the loon creates the need for more localized threats, such as shoreline development, recreational activities, reservoir management, and lead poisoning, as important conservation threats to consider.

Large breeding populations in Canada's vast lake-rich areas are relatively protected from shoreline development and recreational activities. However, there remains substantial concern over numerous major threats that could negatively impact Canada's robust populations. Major threats include contamination of lakes by mercury and acid rain, bycatch from commercial fishing, direct take through hunting, marine oil spills, botulism outbreaks, and emaciation syndrome. Mercury and acid rain threats have the ability to severely impact breeding loon populations across large areas of otherwise wilderness habitat. Acute, catastrophic events, such as annual direct take, commercial fishing bycatch, marine oil spills and botulism outbreaks can have severe impacts and are areas of high concern in need of greater investigation. Lastly, emaciation syndrome provides insight into the physiological stress levels inherent to loon populations. A series of behavioral and physiological changes following severe weather and timed with the full remigial molt can result in emaciation and potential remobilization of contaminants. The large mortality event during the winter of 1983-84 in Florida is an example of the potential long-term population-level effects that emaciation syndrome can instill. These combined anthropogenic threats are the basis of population-level concerns across the loon's range. The mix of threats including acid rain, mercury contamination, and botulism outbreaks for the eastern Ontario and western Quebec breeding populations is currently of greatest concern.

The Conservation Plan outlined in this document establishes overarching monitoring, research, education, management, and policy needs. Threats to loons vary by geographic region and season. Therefore, the governing U.S. Fish and Wildlife Service and Canadian Wildlife Service offices should prioritize efforts within the five overall categories. A Joint Steering Committee is recommended to best integrate this Plan across federally-designated regions. There are 14 overarching objectives followed by associated strategies that provide direction for action. Envisioned is a network of regionally-customized plans that prioritize actions based on the following objectives and strategies.

Objective 1. Improve and network monitoring efforts at spatial and temporal levels appropriate for each area's abundance and associated threats.

Objective 2. Identify potential sink populations in the breeding range based on the Plan's population model.

Objective 3. Develop geographic linkages between breeding and wintering populations.

Objective 4. Develop a web-based information center that facilitates networking among field biologists, lab scientists, and museum curators.



Objective 5. Use the Common Loon as an indicator of mercury risk to piscivorous wildlife populations.

Objective 6. Develop a web-based information center to increase awareness of loon conservation needs and integrate standardize geo-referenced databases.

Objective 7. Promote responsible recreational fishing practices.

Objective 8. Promote changes in commercial fishing techniques.

Objective 9. Protect loon breeding habitat at a landscape level to minimize further degradation or fragmentation of suitable habitat.

Objective 10. Implement a territory ranking system to help prioritize conservation efforts.

Objective 11. Protect loon breeding habitat at a local level to sustain area populations.

Objective 12. Develop a standard process for the Federal Energy Regulatory Commission to dictate mitigation and/or other management tools that assist resource managers.

Objective 13. Connect efforts and information within this document with relevant plans.

Objective 14. Investigate, document, and summarize relevant data to assist science-based legislation and policy.



II. Taxonomy

Common name: Common Loon

Scientific name: *Gavia immer*

Order: Gaviiformes

Family: Gaviidae

No subspecies are currently recognized (American Ornithologists' Union 2003).

III. Legal Status

Breeding populations of the Common Loon are restricted to four countries: United States, Canada, Greenland, and Iceland. The Migratory Bird Act of 1918 affords protection of the Common Loon and states it is illegal for anyone to “take, possess, import, export, transport, sell, purchase, barter, or offer for sale, purchase, or barter, any migratory bird, or the parts, nests, or eggs of such a bird except under the terms of a valid permit issued pursuant to Federal regulations.”

The Common Loon is not currently and has not formerly been listed under the federal Endangered Species Act. The Common Loon was on various United States Fish and Wildlife Service (USFWS) listings as a Migratory Nongame Bird of Management Concern in the U.S (USFWS 1995). As part of the North American Bird Conservation Initiative, a new status prioritization of North American birds has been established and it currently does not include the Common Loon in the Birds of Conservation Concern list (USFWS 2002). At the state level, the Common Loon is currently listed as Endangered in Vermont and Threatened in New Hampshire and Michigan. The Common Loon is a species of Special Concern in Connecticut, Idaho, Massachusetts, Montana, New York, Washington, and Wisconsin. In Alaska, it is considered an “injured species” that has not recovered in Prince William Sound. It is designated as a species “not at risk” in Canada by the Committee on the Status of Endangered Wildlife in Canada (Vogel 1997). Europe has placed Icelandic populations of the Common Loon on the Red List (Hilton-Taylor 2000).

IV. Description

A. Morphometrics

One of the diagnostic features of the Common Loon is its large size and heavy weight. Individuals from some populations are larger than the Yellow-billed Loon (*Gavia adamsii*). Average body mass ranges from 2.7 to 7.5 kg and average wingspan ranges from 136 to 166 cm (52 to 65 inches) (Evers 2001a; BioDiversity Research Institute (BRI), unpubl. data). A geographic cline in size is well known. Individuals of interior breeding populations found in the upper Great Lakes and central Canada are smallest and loons increase in size east and west from there (Anderson et al. 1970; Storer 1988). For example, body mass of adult male loons from the upper Great Lakes average 33% less than their Maine counterparts. Ultimate size relates to



migration distance, which dictates wing loading limitations (Pennycuick 1989). Recent wing loading measurements (i.e., wing length, wing area, body circumference, and body mass) across parts of North America show that indices relate to migration distance for loons (BRI, unpubl. data). Field studies measuring egg size (Evers et al. 2003a), body mass (Evers 2001a), and wing loading indices best quantify geographic clines (Table 1). Within-region size differences are related to (1) sexual dimorphism and (2) natural variation. On average, males are 28% larger than females within the same migration cohort. Natural variation in size manifests into differential use of habitats. For example, smaller loons are more apt to use multiple-lake territories (see Table 2 for definitions of territory types) (Evers 2001a).

Table 1. Mean body mass in grams (+/- 1 sd) of breeding adult Common Loons (ordered using male weight)¹.

Region	Male body mass (g)	Female body mass (g)	Dimorphism (g)
Maine/eastern NH	6,000 +/- 393 (n = 219)	4,693 +/- 295 (n = 221)	28%
Vermont/western NH	5,900 +/- 448 (n = 69)	4,623 +/- 311 (n = 64)	28%
New York	5,566 +/- 420 (n = 59)	4,210 +/- 369 (n = 50)	32%
Canadian Maritimes	5,564 +/- 355 (n = 19)	4,498 +/- 375 (n = 21)	24%
Alaska	5,579 +/- 183 (n = 12)	4,367 +/- 260 (n = 15)	28%
Ontario (south-central)	4,927 +/- 272 (n = 14)	3,646 +/- 324 (n = 9)	35%
Quebec (western)	4,917 +/- 469 (n = 33)	3,840 +/- 373 (n = 23)	28%
Western U.S.	4,857 +/- 369 (n = 11)	3,895 +/- 463 (n = 14)	25%
Upper Great Lakes	4,504 +/- 330 (n = 429)	3,612 +/- 240 (n = 367)	25%
Saskatchewan ²	4,371 +/- 250 (n = 53)	3,321 +/- 299 (n = 25)	32%

¹Weights are only recorded in grams and are not converted into English units of pounds. To convert to pounds divide grams by 1,000 and multiply by 2.2 (i.e., 6,000 grams/1000 grams x 2.2 pounds/kg = 13.2 pounds).

²Assumes all loons captured on Walker Lake, Nevada breed in Saskatchewan (Yates et al. 2002a) and that weight during migration reasonably reflects weight during the breeding season.

B. Plumage and Molting Patterns

The molt strategy is well-documented for this Status Assessment and Conservation Plan because it plays an instrumental role to (1) identify age classes and (2) understand various life history parameters that relate to management (i.e., age of chick and relationship to standard reproductive measures).

Adult loons annually have two body molts and one remigial molt. The adult molt pattern includes a complete, protracted body molt (postnuptial) beginning between late August and early October. Non-breeding adults initiate this process earlier than adults with young. This molt replaces the familiar black and white alternate plumage to the grayish basic (winter) plumage; it begins prominently at the base of the bill. Some of the black and white body contour feathers may be retained into or throughout the winter, and there are known records of loons in complete



alternate plumage in November through January (molt can be delayed by physiological stress). Remiges are molted between late December and early April; timing varies primarily by latitudinal wintering areas (P. Spitzer, pers. com.) as well as with individual age, health, and breeding range origin. The remige molt is synchronous and therefore individuals are flightless for a period of time until complete restoration of their flight feathers (approximately a 2-3 week time period). By early April, adult loons have completed their second body molt into their alternate plumage.

A. Alternate

The alternate or breeding plumage of the Common Loon differs from its basic plumage. In breeding adults, the bill is black, eye red, and head and neck are black (showing iridescent green with certain light). The neck has a black and white chinstrap and a distinctive collar below. The white feathers of the breast, belly, and wing lining are present year-round. Scapulars and wing coverts above are characterized by large, white rectangular patterns at the feather's distal end. A white speckled appearance is repeated across the remiges and rectrices.

B. Juvenile

Loon chicks hatch with a blackish-brown down with white belly and retain this plumage until approximately two weeks of age. At this time, brown downy feathers replace the black ones. Contour feathers emerge at 4 ½ weeks. These feathers initially emerge on the upper back. Soon, upper coverts, scapulars, tertials, and remaining body feathers grow in with grayish-white contour feathers. During this time, white belly feathers replace the brown down. By 6 weeks, brown down only remains on the neck and flanks. At 7 weeks, loon chicks are in their full juvenile plumage; at 10-11 weeks, flight feathers are fully molted (McIntyre and Barr 1997).

C. Basic

In winter, from December through February, nearly all loons exhibit the typical gray, basic plumage. Winter adults have a grayish bill with usually some blackish pigment on the upper mandible; eyes remain red. A distinction can be made between first-year (immature) and older loons. Immature back and scapular feathers are rounded and have a pronounced pale edging. At a distance, an immature has a scalloped back pattern. Adults have truncated or squared back feathers without visible edging. Other methods for delineating the two age classes are (1) bill color (immature loons typically have an all-gray bill) and (2) tail feathers; immature tail feather tips may be tipped with grayish brown instead of the adult white coloring. During their first winter, immatures (nearly one-year olds) do not molt but instead delay it until a complete body and remige molt in mid-summer. In contrast to numerous published accounts based on unmarked individuals (McIntyre and Barr 1997), recent evidence now shows that some individuals molt from a basic to an alternate plumage during their third summer (equivalent to two years of age) (BRI, unpubl. data; W. Piper, pers. com.).

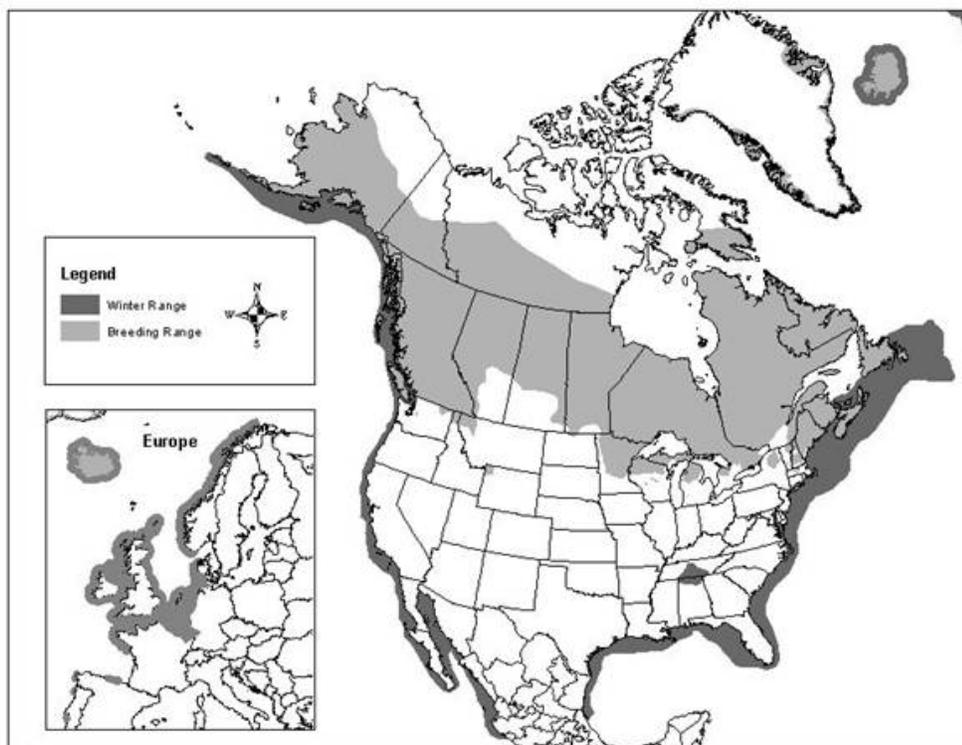


V. Geographic Distribution:

A. Breeding

The Common Loon's breeding range is restricted to freshwater habitats of North America (including Greenland) and Iceland (Figure 1). In Canada and Alaska, loons are generally found nesting north to the edge of the taiga shield. Breeding pairs rarely occur in the tundra and coastal plain areas of the Beaufort Sea (Johnson and Herter 1989), including Alaska (Meehan and Jennings *in* Johnson and Herter 1989) and are generally restricted to mainland North America except for the tundra of Baffin Island. Similar coastal plain breeding populations occur in western Greenland and Iceland. The southern extent of the loon's breeding range has retracted from historical occurrences. However, recent recolonization of some southern peripheral areas has occurred, particularly in New England.

Figure 1. Breeding and winter distribution of the Common Loon¹.



¹ Breeding range southern periphery is delineated by known breeding pairs, while the northern periphery indicates general knowledge-to-date and does not include disjunct breeding pairs. The offshore wintering range is delineated by continental shelf bathymetry.



In the United States, the Common Loon currently breeds in disjunct areas of western and eastern Washington, northern Idaho (breeding attempts are intermittent), northwestern Montana, a disjunct area in northwestern Wyoming (Yellowstone National Park and Teton National Forest), north-central North Dakota (Turtle Mountains), the upper Great Lakes (south through the northern Minnesota, Wisconsin and Michigan's Lower Peninsula), New York's Adirondack Mountains and parts of the St. Lawrence River, much of New England north of Massachusetts, and central Massachusetts. In Canada, the southern extent of the loon's breeding range reaches the U.S. border except in southeastern Alberta and southern Saskatchewan and far south-central Ontario.

B. Summer Nonbreeding

In summer, nonbreeding Common Loons may be found throughout much of North America. One- and two-year olds generally remain on the ocean; however, there is evidence from banded individuals that these young loons are mobile. Several immature loons banded in the Great Lakes have been reobserved or recovered from the mid-Atlantic Coast (particularly along the North Carolina barrier islands) (BRI, unpubl. data) and from as far north as the Canadian Maritimes (McIntyre 1988). A small percentage of one- and two-year old loons migrate to interior lakes. At Whitefish Point, Michigan migrant loons in basic plumage are regularly observed in late May and early June; in New England and western U.S. small numbers of loons in basic plumage regularly overwinter on interior lakes.

Not all summering loons in alternate plumage are breeding. Standardized datasets in New England (e.g., Taylor and Vogel 2003; Hanson et al. 2002) indicate that approximately 15-20% of the adult loons are nonbreeding individuals. These nonbreeders represent a broad cross-section of breeding experience. Many are subadults (those individuals that have not yet bred). Evers et al. (2000) found some banded loons not breeding until 11 years of age. However, many of the nonbreeding individuals are also experienced breeders that were displaced from their territory. The time it takes for these loons to reestablish a territory ranges from same-season occupancy to several years. Nonbreeding loons are generally very mobile while searching for a breeding territory. Therefore, loons in alternate plumage are regularly found on lakes and other waterbodies, such as rivers, that are considered low quality breeding habitat and are generally unoccupied by established territory holders. The nonbreeding cohort regularly uses marine environments as well.

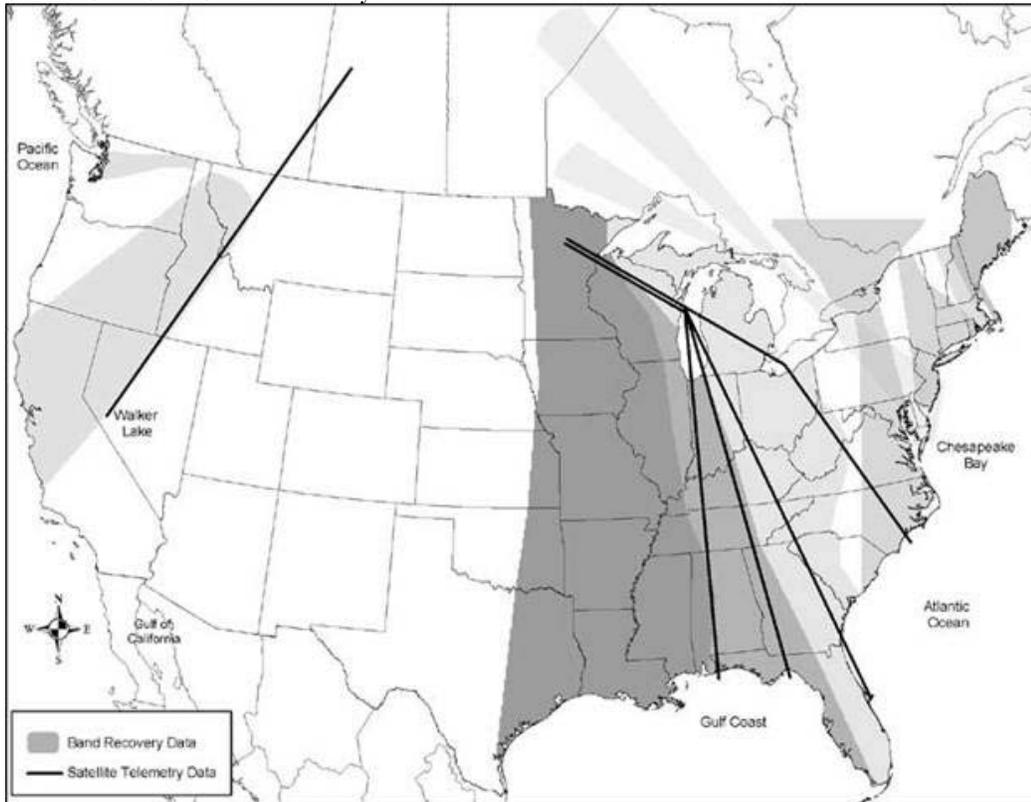
C. Migration

Loons are diurnal migrants and initiate long-distance migratory flights in the morning (Williams 1973; Ewert 1982; Powers and Cherry 1983). Fall migration is more protracted than spring migration. Overland migration altitudes ranged from 1,500 to 2,700 meters in New York (Kerlinger 1982). Major migration routes and staging areas have been identified through observations (Svingen 2000), band recoveries (McIntyre 1988; Evers et al. 2000; BRI unpubl. data) and satellite telemetry (Kenow et al. 2002; Yates et al. 2002a) (Figure 2). Because wing loading is related to migration distance (Pennycuik 1989), body mass also provides insight into linking breeding and wintering areas (BRI, unpubl. data).



The combined knowledge of band recoveries, satellite telemetry location information, morphometric information, and known migratory movements provide baseline evidence for constructing a map linking breeding and wintering areas (Figure 3). Migratory movements along the Atlantic Coast are both coastal and offshore (Powers and Cherry 1983) and likely represent Canadian Maritime, far eastern Quebec, Newfoundland, and western Greenland breeding populations. The very large loons in Maine, New Brunswick, and eastern New Hampshire do not migrate far and primarily overwinter in the Gulf of Maine, while smaller loons from other New England breeding populations, and New York, migrate to Long Island Sound south to New Jersey. Large numbers of fall migrants originating from Ontario and Quebec, stage on Lake Ontario (Ewald and Sherony 2000), move through the Finger Lakes area of New York (Evans et al. 1994), and arrive in Chesapeake Bay. Their arrival regularly coincides with fall movements of a favored prey species, Atlantic menhaden (*Brevoortia tyrannus*) (Spitzer 1993).

Figure 2. Known migratory connections between breeding and wintering areas for Common Loons based on band recoveries and satellite telemetry data.



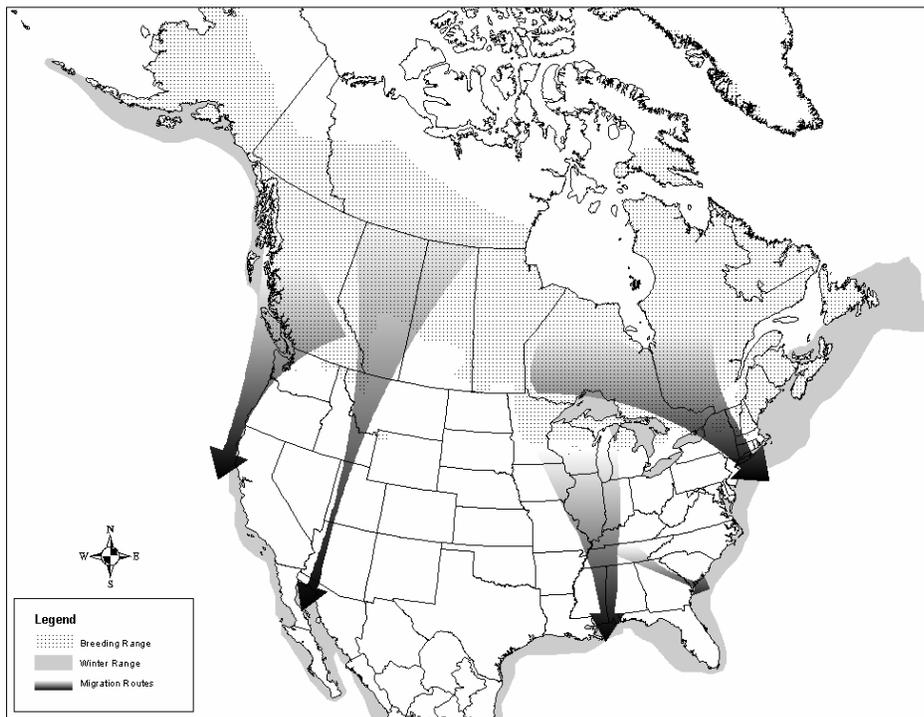
¹Based on published data (Evers et al. 2000; Kenow et al. 2002) and unpublished band recovery data from BRI and satellite telemetry data (Yates et al. 2002a).

Upper Great Lakes populations in Michigan and Wisconsin migrate along the southern Great Lakes and use an overland migration route to the Gulf of Mexico (Alabama east along the



Florida coast) and eastern Florida. Some individuals stage on lakes along the way and even overwinter in larger reservoirs in Tennessee (Kenow et al. 2002) and Alabama (Belant et al. 1991). Minnesota and Wisconsin breeding populations have two migration routes (both of which generally use the Great Lakes as staging areas): the primary one moves south to the Gulf of Mexico from Mississippi west to Texas, while the second documented route uses the southern Great Lakes to make an easterly migration to the mid-Atlantic (Eberhardt 1984; Evers et al. 2000; Kenow et al. 2002). Mid-continent populations in Manitoba, western Ontario, and likely eastern Nunavut travel eastward, using Hudson Bay and the Great Lakes as staging areas, and then moving southeastward to the mid-Atlantic (McIntyre 1988). Some loons likely originating in eastern Manitoba-western Ontario are known to use large lakes in Minnesota such as Mille Lacs and Winnibigoshish.

Figure 3. General migratory connections between breeding and wintering areas for Common Loons based on band recoveries, satellite telemetry data, morphometrics, and population monitoring efforts.



Mid-continent breeding populations found in areas such as central and northern Saskatchewan use a migration route that crosses the Rocky Mountains in Montana and remains east of the Sierra Nevada Mountains, using lakes such as Walker and Pyramid in Nevada and Flaming Gorge Reservoir on the Utah-Wyoming border for both spring and fall staging areas (based on satellite transmissions from five loons; Yates et al. 2002a). Western U.S. breeding loons migrate to the mid-Pacific Coast (e.g., Montana recoveries from California). Little is known how breeding loons in Alberta, western Nunavut, Yukon, Alaska, and British Columbia are



distributed along the Pacific Coast. Few Common Loons likely make a trans-Pacific migration to the Asian coast. Eastern Greenland breeding loons likely migrate and overwinter in Iceland and other parts of western Europe in the North Sea. It is unknown whether the Icelandic breeding population remains for the winter or migrates to western Europe (A. Peterson, pers. com.).

D. Winter

Common Loons primarily overwinter on the Pacific and Atlantic (including the Gulf of Mexico) coasts (Figure 1). Loons commonly occur along inshore waters but may range up to 62 miles (100 km) offshore across the continental shelf (Lee 1987a; Haney 1990; see also Kenow et al. 2002). Southern range limits are the Florida Keys (Evers and Jodice 1995) and in Mexico loons regularly overwinter along the entire Baja California peninsula and uncommonly range further south into central Mexico on both the Atlantic and Pacific Coasts (Edwards 1998). Northern limits on the western side of the Atlantic Coast are along the Newfoundland shoreline; Merkel et al. (2002) did not record Common Loons during intensive March surveys along southwestern Greenland. Eastern Atlantic Coast wintering areas are around Iceland and along the western European shores of the North Sea. On the Pacific Coast, wintering loons range north into the Aleutian Islands of Alaska. Interior overwintering loons are a minor component of the population. Some overwintering areas are weather dependent, while others are regularly used, such as reservoirs of central Tennessee and northern Alabama.

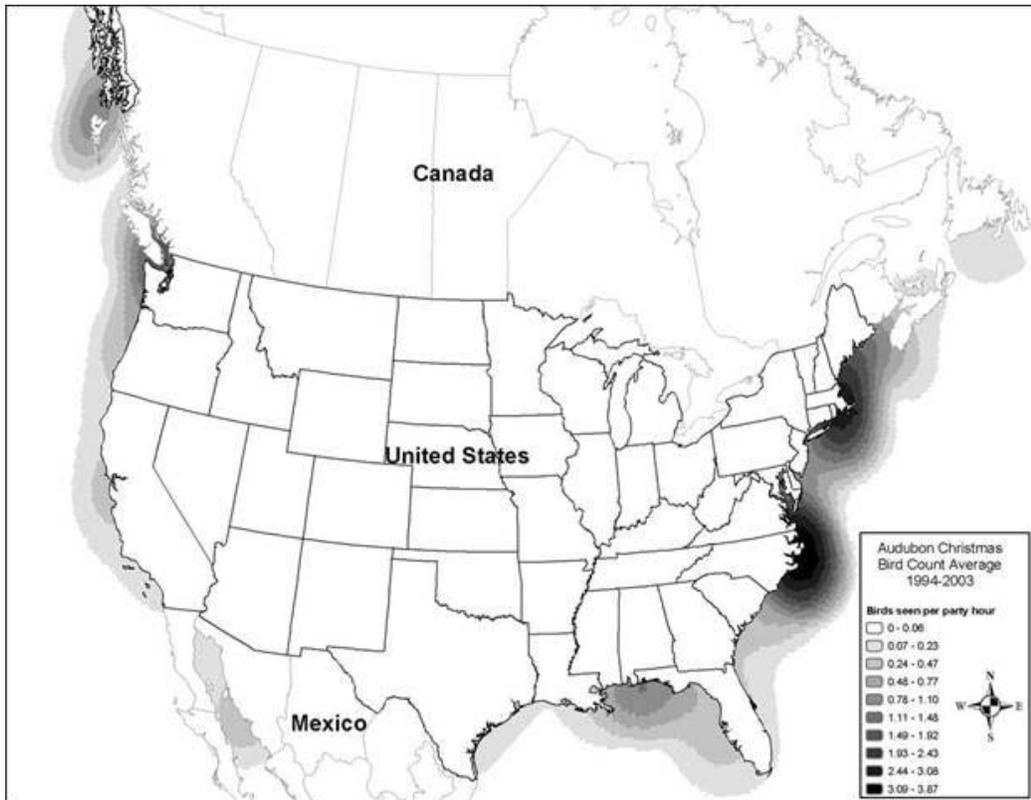
Based on data summaries, in 2002, an estimated 710,000 to 743,000 loons initiate the fall migration (including approximately 607,000 to 635,000 adults and 103,000 to 108,000 juveniles). The number of adults is based on estimated breeding loon counts and calculated number of juveniles is based on a 25-year, statewide database in New Hampshire that shows 17% of the fall loon population is comprised of young-of-the year (Taylor and Vogel 2003)). Based on known and speculated loon migratory movements (Figure 3), approximately 30% of the Common Loon population overwinters on the Pacific Coast and 70% on the Atlantic and Gulf coasts.

1. Pacific Coast

On the Pacific Coast, wintering loons are found from the Alaskan Aleutian Islands south to Baja California (both west and east coasts) (McIntyre and Barr 1997). Pacific Coast winter populations likely represent breeding populations from Montana, Saskatchewan, Nunavut, and Northwest Territories, west to the Coast. Using the estimated number of breeding loons (see Table 8), there is an estimated fall migration of 215,000 to 221,000 loons (184,000 to 189,000 adults and 31,000 to 32,000 juveniles) to the Pacific Ocean. Christmas Bird Counts indicate Common Loon densities are greatest in the Pacific Northwest (from Oregon north to Queen Charlotte Islands, British Columbia) and around the Monterey Bay, California area (Figure 4). Band recoveries of two loons from breeding populations in Montana indicate overwintering in central and southern California (Figure 2). Loons breeding in central and northern Saskatchewan likely overwinter in the Gulf of California (based on satellite telemetry studies on Walker Lake, Nevada) (Yates et al. 2002a).



Figure 4. Wintering loon densities based on standardized winter counts, 1994-20031.



¹The 1994-2003 average of the CBC data was taken for each CBC search circle (7.5 mile radius). These data were analyzed using the Density function in the ESRI's ArcGIS Spatial Analyst Extension. This function takes point values and spreads them over a grid surface, giving areas with higher values greater weight. A default search radius was used. These data were displayed using the Natural Breaks classification scheme, which creates groupings based upon patterns inherent to the data (D. Kramer and W. Goodale, pers. com.).

Common Loons rarely overwinter in Russia. In Kamchatka, Gerasimov and Kalyagina (1997) did not observe Common Loons in the spring migration of 3,200 mixed species of loons in 1993 or 6,300 in 1994. However, Common Loons could be sparingly distributed further south; recent evidence from satellite transmissions of northern Alaska breeding populations of Red-throated and Yellow-billed Loons shows them overwintering along the western Pacific Ocean, south and west to coastal China (J. Schmutz, pers. com.).

2. Atlantic Coast

On the Atlantic Coast, Common Loons overwinter from Newfoundland south to Florida and west through the Gulf of Mexico to Texas and south to central Mexico. Atlantic Coast winter populations likely represent breeding populations from Manitoba, Nunavut, North Dakota, and Minnesota and all areas east. Using the estimated number of breeding loons (see Table 8), there



is a fall migration of 495,000 to 522,000 loons (423,000 to 446,000 adults and 72,000 to 76,000 juveniles) to the Atlantic Ocean. Christmas Bird Counts (Figure 4) and other observations indicate densities are greatest in the Gulf of Maine south into eastern Long Island Sound, New York, Chesapeake Bay area and North Carolina (Haney 1990). In the Gulf of Mexico, densities are greatest along the Florida Panhandle and Alabama coastline (Jodice 1993), Mississippi Sound in Mississippi, and Barataria and Vermilion Bays in Louisiana (R. Russell, pers. com.). A total of 80 band recoveries since 1990 provide insight for linking breeding loons from the Great Lakes, New York, New England, and eastern Canada to their wintering areas. Great Lakes breeding loons indicate a primary wintering area in the eastern Gulf of Mexico and the eastern Florida coast (Evers et al. 2000). Breeding loons from Minnesota have also been documented overwintering in the mid-Atlantic off the North Carolina coast (Evers et al. 2000, Kenow et al. 2002).

Approximately 3,500 to 4,500 Common Loons overwinter in the United Kingdom (Lack 1986) and smaller numbers are scattered across western Europe coastlines, including Iceland (Snow and Perrins 1998). Breeding loons from western Greenland likely overwinter along the western Atlantic coast while individuals from eastern Greenland and Iceland likely overwinter along the coast of western Europe (primarily the United Kingdom). Loons overwintering in Iceland may represent both eastern Greenland (Gudmundson 1972) and Iceland breeding populations (A. Peterson, pers. com.).

VI. Natural History

A. Reproductive phenology

Pair bonds do not persist beyond the breeding season, and therefore loons commence spring migration independent of a mate (BRI, unpubl. data). Spring arrival to nesting lakes depends on time of ice-out. While some individuals arrive in the southern periphery of their range in mid- to late March (i.e., Washington, southwestern Michigan, and in southern New England), loons generally begin moving *en masse* in early to mid-April along both the Pacific and Atlantic coasts. Large congregations of loons assemble in the northern end of the Gulf of Mexico in early April. Spring migration peaks in early May in the northern Great Lakes (Ewert 1982). Migrants generally congregate on large waterbodies, including such areas as the Great Lakes and Mississippi River, and conduct daily reconnaissance flights to their nesting area. Males may precede females to their breeding territories by several days, particularly along the southern periphery of their range (K. Taylor, pers. com.). In northern latitudes, initial arrival may be more uniform. Established territories are filled before transitional territories (Table 2).

High site fidelity by both sexes assures regular pairing of same individuals as the previous year. Based on observations of color-marked individuals, territory switching (see between-year territory fidelity section 5.B.) and divorce rates have been well-studied (Piper et al. 2000; Evers 2001a). The annual divorce rate for a Wisconsin study area was estimated at 23% (Piper et al. 2000); this agrees with study sites in Michigan (Evers et al. 2000) and New England (BRI, unpubl. data). In southern areas of the loon's breeding range, nesting is generally initiated 4-6 weeks after arrival. In more northern latitudes the pre-incubation period is briefer. Peak nesting season is in June. Loons have a monogamous breeding strategy (Piper et al 1997a). Usually two



eggs are laid in the first nesting attempt. Incubation is equally shared by both adults (Evers 1994b; Paruk 1999, 2000). Three-egg nests are rare and confirmed origin from a single female is undocumented. Incubation lasts from 26 to 29 days; eggs hatch asynchronously, usually within 24 hours of one another. First-nest failures are common. Second nesting attempts occur 1-3 weeks after the first nest failure. Mate-switching peaks follow nest failures. Female switches result in approximately half of the re-nesting attempts compared to males (BRI unpubl. data). Based on statewide data from New Hampshire 17% of the nesting pairs re-nested after their first nest failure between 1998 and 2002; although 41% re-nested in 1997 when there was an early summer storm event that created widespread nest failures (K. Taylor, pers. com.).

Biparental care of young is generally equal (Evers 1994b; Mager 2000). In New Hampshire, a standardized, statewide long-term database indicates average overall nesting success rates of 75% and rate of chick survival of 73% (Taylor and Vogel 2003). Success in hatching eggs and survivorship of chicks is related to weather, predation rates, parasites, anthropogenic factors, and density-dependent factors. Sibling rivalry regularly limits the survival of younger and smaller chicks. Nonterritorial adult conspecifics likely pose one of the greatest threats to chick survival, an effect accentuated in areas of high loon density.

Adults migrate independent of one another and of their chicks. Local or social flocking starts in late-summer, usually on large lakes or lakes that contain unsuccessful territorial pairs (Paurk 2004). Fall migration generally begins in September at high latitudes and October in low latitudes and by late November most of migrants have arrived in their wintering areas. Peak migration in the lower Great Lakes ranges from late October to late November (Svingen 2000).

Table 2. Descriptions and definitions of breeding status.

Status / Type	Definition
Established territory	Paired adults occupying a territory for at least three consecutive weeks for three consecutive years.
Transitional territory	Paired adults occupying a territory for less than three consecutive weeks and/or less than three consecutive years.
Breeding adults	Established territory holders and those with transitional territories that attempted breeding that year.
Non-breeding adults	Territorial and non-territorial holders (e.g., “floaters”) that did not breed that year
Buffer population	Encompasses non-territorial holders and those with transitional territories that are not breeding.

B. Between-year territory fidelity:

1. Breeding

Between-year territory fidelity of breeding adult loons is best explained in a spatially-explicit context and should be examined by sex class and territory type. From 1989 to 2000, over 1,500



breeding adult loons (52% males and 48% females) were color-marked from 505 territories on 313 lakes and followed for one to 12 subsequent years (Evers 2001a). Loon territories (n=505) within New England and the Upper Great Lakes were categorized into one of three territory types: multiple, whole, or partial (Table 3). Between-year territory fidelity was significantly different among territory types, regions, and sexes. There were neither no significant difference in overall territory fidelity between sexes (80% in males, 82% in females), nor regional differences between sexes for multiple and whole lake territories. The overall trend in fidelity by territory types for New England increased from multiple-lake to partial-lake to whole-lake territories. As in New England, breeding adult loon territory fidelity in the Great Lakes Region was highest in whole-lake territories. Significant differences in fidelity existed between sexes within multiple-lake territories in both regions. Males and females on partial-lake territories exhibited significantly greater territory fidelity in New England versus the Great Lakes. Sexual size dimorphism was significant between geographic regions and territory types and potentially explained differences in territory fidelity. Between-year territory fidelity may indicate habitat quality and even predict declining population trends, therefore its use as a high resolution, long-term population monitoring tool for early detection of acute and chronic stressor events is recommended by Evers (2001a).

Table 3. Adult breeding Common Loon between-year territory fidelity by study region, territory type, and sex¹.

Region	MLT Male	WLT Male	PLT Male	Overall Male	MLT Female	WLT Female	PLT Female	Overall Female	Overall MLT	Overall WLT	Overall PLT
New England	70%	84%	80%	80%	83%	87%	84%	85%	75%	86%	82%
Great Lakes	71%	84%	73%	80%	81%	85%	72%	81%	76%	84%	72%
Overall Total	71%	84%	77%	80%	81%	85%	79%	82%	76%	85%	78%

¹Percent return rate is followed by number of returning individuals divided by number of potentially returning individuals). Dashed-bars below percentages indicate insignificant differences between territory types for males and females (p>0.05) (from Evers 2001a). Overall total sample size was 1,924 reobservations. Acronyms account for: MLT=multiple-lake territories, WLT=whole lake territories, and PLT=partial lake territories. Definitions for these territory types are in Table 7.

2. Winter

Outside their breeding territories, loons generally do not exhibit territoriality toward conspecifics or other piscivorous birds (Daub 1989, Ford and Gieg 1995, Evers and Jodice 1995). Between-year winter site fidelity is unknown and requires monitoring of known individuals. Wintering adult loons exhibit site tenacity. One- and two-year olds do not experience a mid-winter flightless period, are likely more mobile, and therefore exhibit less site tenacity than adults.



C. Territorial behavior and density limitations

In a breeding loon population near carrying capacity, high quality territories are actively defended. Territoriality is expressed through male-only yodel calls. Yodels are unique within a certain geographic area (Miller 1988), although individuals are known to alter their yodel structure between years (Walcott et al. 1999; Walcott and Evers 2000). Competition for breeding territories is evident during intrusions by nonbreeding loons. Many intrusions end with the territory holder chasing the intruder off the territory, however, an estimated 15% of intrusions result in a territory takeover (Evers 2001a). Most of these territory takeovers occur before first-nests and immediately following a nest failure. Territory switches are significantly more frequent on partial lake territories than on whole lake territories and may be related to the physical ease of a nonbreeding loon entering a territory from a common foraging area on a large waterbody (Evers 2001a).

Loon habitat is rarely uniform across the landscape. Therefore, density rates and patterns are difficult to quantify unless estimates are for large landscapes. A single-season, large-scale standardized survey effort across 60,000 acres of suitable lake habitat in northern Maine found 2.4 territorial pairs/1,000 acres (or per 400 ha) (Evers 2002b).

As loon densities (i.e., number of territorial pairs) increase, divorce rates increase and reproductive success apparently declines. Recovering breeding populations in New Hampshire are prominent examples of these relationships. Along the New Hampshire and Maine border, Lake Umbagog breeding populations have increased at a rate of 10% per year over a 25-year period and have exhibited an associated decline in reproductive success that is likely density-dependent (Evers 2002). Increasing divorce rates reduce production of young. Prior to a divorce, an average of 1.4 and 1.2 chicks hatched, respectively for males and females, while the year following a divorce, males hatched 0.20 young and females 0.17 young.

D. Demography

The Common Loon is a classic example of a K-selected species: long-lived and a relatively low lifetime reproductive performance. Its life history strategy indicates evolution in stable habitats and populations that hover at carrying capacity. Concentrated capture, color-marking, and reobservation efforts over the past 14 years by BioDiversity Research Institute (e.g., Evers et al. 2000; Evers 2001a) and collaborators (e.g., Piper et al. 1997b; Meyer et al. 1998) now provide a solid foundation for quantifying demographic features that were previously unexplored. Spatially-explicit differences in demographic parameters likely exist. Much of the following information is based on marked populations in New England and the upper Great Lakes.

1. Population Structure

Not all adults returning to their breeding area attempt to nest or even establish a territory. Approximately 54% of the summer adult loon population in New Hampshire attempts nesting. Some loons establish territories but do not attempt nesting while other loons represent subadults that have yet to breed (primarily < 6 years of age) and older adults that have been displaced from



established territories. On average, 68 +/- 6% of established territorial pairs attempt nesting in New Hampshire (Taylor and Vogel 2003); in Saskatchewan, Yonge (1981) documented a 3-year rate of 77%. The remaining pairs guard their territory through the breeding season. Loons, like other birds, have a certain percentage of their breeding population that does not attempt nesting each year (i.e., the nonbreeding or buffer population; see definition in Table 2). The buffer population is important to withstand catastrophic events. In New Hampshire the average proportion of loons in the buffer population is 19% (Table 4).

Table 4. Age and breeding status cohorts of the New Hampshire Common Loon breeding population, 1976-2002¹.

	Number of nesting adults	Number of non-nesting adults (paired)	Number of non-nesting adults (unpaired) ⁴	Number of fledged young
Mean annual number	198	98	70	75
May-June "snapshot" ²	54%	27%	19%	n/a
September "snapshot" ³	45%	22%	16%	17%

¹Data from Taylor and Vogel 2003)

²Based on the total number of returning spring migrants (n= 366).

³Based on the total number of fall migrants (n=441) and assuming nearly all summering adults survive.

⁴Also characterized as the buffer population.

Fitness is likely a particularly important contributor to the loon's population structure. In avian populations not all individuals have equal abilities in producing young; a relatively small cohort of the breeding individuals (e.g., 15%) may be responsible for over half the successful productivity (Newton 1992). Croskery (1990) inferred this phenomenon in a breeding population of Common Loons in northwestern Ontario, while direct measurements in western Maine indicate approximately 20% of the breeding population produces 50% of the young (BRI, unpubl. data; 1995-2002). Non-breeding individuals spend their summers in common-use areas and frequently intrude into established territories. The impacts of high intrusion rates can be measured through between-year territory fidelity.

2. Adult annual survivorship and lifespan

An analysis of nearly 1,500 reobservations of New England and Great Lakes breeding loons indicate an adult annual survivorship average of 91% (BRI unpubl. data; M. Mitro, pers. com.). This annual rate of adult survival is similar to other long-lived birds with same life histories (e.g., Atlantic Puffins with 95% (Glutz and Bauer *in* Johnsgard 1987) and Short-tailed Shearwater with 90% (Wooller et al. *in* Newton 1992)). There was no statistical difference between male and female rate of annual survival in the loon dataset. Because this estimate reflects the average survival of unknown aged adults, it is more of an average for a cohort of breeding adults that have been followed for 1-14 years (Evers 2001a) than an annual rate for the entire life of the individual. Annual survival probability varies throughout the life of Common Loons.

3. Immature annual survivorship and breeding age

Immature loons (fledged young to three years of age) first return to breeding areas at age three (BRI unpubl. data; W. Piper pers. com.). Annual survivorship for the first three years averages



41% (BRI unpubl. data; M. Mitro, pers. com.). Although immature loons molt into their alternate plumage at age two, they generally do not return to breeding areas until after two consecutive winters. Average first-year breeding age is estimated at six years (range, 4-11 years) (Evers et al. 2000; W. Piper, pers.com.).

4. Dispersal

Loons have a poor ability to recolonize new areas. Breeding adults generally do not have intra-season movements > 4 km from their previous-year's breeding territory and have not been recorded dispersing greater than 20 km (Evers 2001a). Of 103 usurped established territory holders found one-year later, females tended to move farther than males (i.e., males were more likely to remain within 2 km of their former territory and remain in their neighborhood) and established territories were more likely to occur and were closer to former territories than non-territorial outcomes (Table 5) (Evers 2001a). Usurped territory holders were less likely to breed the following year, indicating at least a temporary cost of dispersal.

Table 5. Summary of dispersal distances for adult Common Loons formerly on established breeding territories¹.

Parameter	Sample	Mean	Stand. Dev.	Range	F value ¹	p value
All individuals	103	3.5 km	+/- 3.8	0.4-20.3 km		
A. Male	57	3.0 km	+/- 3.8	0.4-20.5 km	1.81	P=0.180
B. Female	46	4.0 km	+/- 3.7	0.5-20.3 km		
A. Non-territorial outcome	33	4.5 km	+/- 5.5	0.4-20.5 km	3.70	P=0.046
B. Territorial outcome	70	3.0 km	+/- 2.5	0.6-15.8 km		
A. Between-lake movement	44	4.5 km	+/- 4.6	0.5-20.5 km	11.4	P=0.001
B. Within-lake movement	59	2.1 km	+/-1.4	0.4-7.4 km		

¹From Evers 2001a.

²ANOVA tested differences between paired parameter means (A and B) with accompanying probability (p) values.

Loons generally return to their breeding areas at three years of age and returning reobserved individuals within pre-described study areas were found within an average of 13 km of their natal lake area (Evers et al. 2000). Some of these non-breeding adults have been reobserved 92 km from their natal lake area and likely represent the primary population component to colonize new areas.

5. Productivity

Rate of reproductive success has been repeatedly measured across much of the loon's range, particularly in the southern periphery. Estimated overall productivity is best determined by counting the number of territorial pairs and fledged young within a target area (or # of chicks



fledged / # of territorial pairs). Because the number of young actually fledging is a difficult parameter to substantiate, most monitoring programs use an appropriate surrogate of “chicks > 6 weeks of age” (i.e. are nearly in full basic plumage). Chick mortality after 6 weeks is generally quite minimal and is therefore likely a suitable predictor of fledging rate. Multi-year studies based on standardized methodologies that estimate overall productivity are known from Alaska (Smith 1981), Alberta (Vermeer 1973), Maine (Evers et al. 2003b), Michigan (Evers et al. 2000), Minnesota (Olson and Marshall 1952; Titus and VanDruff 1981; McIntyre 1978a; Mooty 1993), New Hampshire (Taylor and Vogel 2000, 2003), New York (Parker and Miller 1988; Schoch 2003), Nova Scotia (Kerekes et al. 1994), Ontario (Croskery 1990), Quebec (Kerekes and Masse 2000), Saskatchewan (Yonge 1981), and Vermont (Hanson et al. 2002) (Table 6).

Results from these 17 standardized studies indicate overall productivity averages 0.53 +/- 0.19 across parts of North America (with a range of 0.29 to 0.96). Many available studies did not collect information for (1) established territorial pairs, (2) loon chicks > 6 weeks of age, (3) were limited to few lakes and/or (4) were for one year. They are not included in the following table but are insightful and can be found in the North American Loon Fund Proceedings series (Sutcliffe 1979, Strong 1988a, Morse et al. 1993, McIntyre and Evers 2000).

Table 6. Geographic comparison of overall reproductive success of the Common Loon¹.

Region	Years	Average # of territorial pairs	Annual CF/TP*	Source
Alaska (Kenai NWR)	1979-1980	33	0.48	Smith 1981
Alberta	1972	26	0.40	Vermeer 1973
Maine (Rangeley Lakes)	1987-2002	50	0.29	Evers et al. 2003b
Michigan (east. Upper Peninsula)	1990-1996	19	0.51	Evers et al. 2000
Michigan (Isle Royale NP)	1990-1998	16	0.79	Evers et al. 2000
Michigan (Ottawa NF)	1985-1998	37	0.76	Evers et al. 2000
Michigan (Seney NWR)	1987-1998	9	0.59	Evers et al. 2000
Minnesota (Itasca SP)	1957-1976	25	0.29	McIntyre 1978a
Minnesota (BWCA)	1950-1989	52	0.37	Mooty 1993
Montana (statewide)	1999-2002	63	0.66	Bissell pers. com. (2003)
New Hampshire (statewide)	1976-2002	148	0.52	Taylor and Vogel 2003
New York (Adirondacks)	1984-1985	157	0.96	Parker and Miller 1988
Nova Scotia (Kejimikujik NP)	1988-1995	39	0.28	Kerekes and Masse 2000
Ontario (northwestern)	1983-1986	254	0.32	Croskery 1990
Quebec (La Mauricie NP)	1987-1996	24	0.61	Kerekes and Masse 2000
Saskatchewan (central)	1973-1975	99	0.53	Yonge 1981
Vermont (statewide)	1981-2001	26	0.72	Hanson et al. 2002
Average +/- between-site variation			0.53 +/- 0.19	

¹ Overall loon reproduction is measured by the number of chicks fledged divided by the number of territorial pairs per year. Chicks >6 weeks of age are defined as fledged. In most cases, territorial pairs were not distinguished between established and transitional territories.

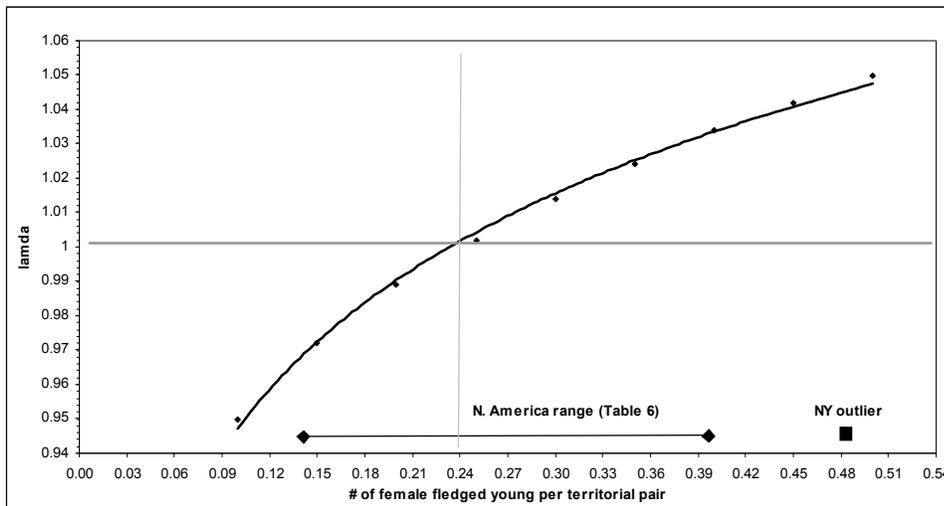
Standardized long-term, statewide monitoring programs, such as found in New Hampshire and Vermont, are invaluable datasets for gaining insight on long-lived species. In New Hampshire, the Audubon Society of New Hampshire's Loon Preservation Committee (LPC) has high-resolution productivity data over a 27-year period. Those data show an overall productivity rate of 0.52 +/- 0.09 with a range of 0.30 to 0.73 (or 143% difference between the lowest and highest) (Taylor and Vogel 2003). In Vermont, the Vermont Institute of Natural Science has similar



standardized data over a 21-year period; overall productivity is 0.72 +/- 0.15 with a range of 0.35 to 0.98 (Hanson 2002). During their respective time periods, breeding loon populations in these two states have experienced a substantial overall increase and although they continue to increase in Vermont, numbers have stabilized in New Hampshire. These long-term databases establish average long-term variability within an area of approximately 20% (even though outlier years with extremely low or high productivity occur once every decade). Therefore, single year overall productivity numbers have limited value. Based on the New Hampshire database, a recommended heuristic is that six or more consecutive years of monitoring are needed to confidently predict average productivity rates.

The agreement of overall productivity rates among spatial (i.e., North American mean) and temporal (i.e., New Hampshire's 27-year database) means and a recently developed model indicate that approximately 0.48 fledged young per territorial pair is needed for a stable and sustainable breeding population (Figure 5). This model provides an important reference tool for evaluating impacts of potential stressors.

Figure 5. Population model based on demographics collected between 1991-2000 from color-marked adult and juvenile loons in New England and the Great Lakes¹.



¹An age-structured matrix population model was used to estimate population growth rates. The model integrated reproductive and survival rates and life history information including average age at first breeding (six years) and longevity (30 years). Reproductive rates were estimated using fledging rates. Juvenile and adult annual survival rates (41% and 91%, respectively) were estimated from band-resight and band-recovery data. We quantified the sensitivity of population growth rate to model parameters by systematically varying the fledging rate, survival from age one to three, and adult survival in the model (model constructed with assistance; M. Mitro, pers. com.).

6. Lifetime reproductive performance (estimated)

The lifetime reproductive performance (LRP) for a species can be estimated with the following known parameters: (1) mean number of fledged young, (2) average age at first breeding, and (3) average longevity. Although a maximum of two chicks may be produced each year, an average



of 0.48 young annually fledge per territory (Figure 5). Should an average adult loon breed for 24 years (average age of first-breeding at 6 years and average age of last-breeding at 30 years), approximately 12 young would be produced. Of these, an average of 41% return to their natal breeding area at age three (Piper, pers. com.) and even fewer survive to breeding age. Therefore, calculated LRP for a loon is 12 fledged young of which 4-5 likely survive to breeding age. Large pelagic birds, such as shearwaters (*Puffinus* spp.) and fulmars (*Fulmarus* spp.), have similar life expectancies, life history strategies, and LRPs (Botkin and Miller 1962, Bradley et al. 1989). Long-lived species also exhibit age-dependent declines in productivity (Newton 1992); the Common Loon probably follows similar patterns. The lifespan of the Common Loon is still unknown and can only be estimated until individuals banded as juveniles live their entire lifespan.

E. Diet

1. Breeding

Loons are obligate fish-eaters. They are opportunistic predators, however, they favor fish that have an erratic swimming behavior or fusiform shape (Barr 1996). Yellow perch (*Perca flavescens*) and centrarchid species such as pumpkinseed (*Lepomis gibbosus*) and bluegill (*Lepomis macrochirus*) are favored for these reasons. Adult loons in Ontario have a daily fish intake of approximately 960g and a family of loons with two chicks can consume upwards of 423 kg in one breeding cycle (Barr 1996). New England, *in situ* mercury (Hg) studies by Evers et al. (2003b) substantiate and further quantify the preference of perch by loons; adult blood Hg levels strongly correlate with yellow perch Hg levels ($r^2=0.72$ for males and $r^2=0.75$ for females) on lakes with coldwater and warmwater fisheries. Similar studies relating loon blood Hg levels with other fish species indicate low preference for sucker and salmonids species when perch or centrarchids are present. The relatively consistent sexual dimorphism measured in loons (irrelevant of geographic area, average difference in body mass between sexes is 28%) may be partly explained by foraging efficiency through reduced competition within pairs that results in a larger available prey base.

Loons forage on many other species of prey and frequently rely on the temporary abundance of a prey item. Because loons capture and swallow small prey items underwater it is difficult to substantiate their entire prey repertoire. Larger items can be documented though. At Seney National Wildlife Refuge, Michigan adult loons regularly forage on bullheads (*Ictalurus* spp.) and crayfish (BRI, unpubl. data). Large fish >12 inches are regularly taken as well, including northern pike (*Esox lucius*), chain pickerel (*Esox niger*) and lake trout (*Salvelinus namaycush*) (BRI, unpubl. data and LPC, unpubl. data). Loons regularly feed on salmonids; however, the straight-lined escape method salmonids use likely creates a harder scenario for capture. Loons foraging on lakes inhabited by salmonids apparently prefer other prey items such as perch (Evers et al. 2003b) and chubs (Seiler et al. 2003). Conversely, lakes that are recently stocked with salmonids are a rich prey source for loons.

2. Migration and Winter



Migratory staging areas are likely important resting as well as refueling sites. Loons actively feed at fall staging areas, such as at Lakes Winnibigoshish and Mille Lacs in Minnesota (McIntyre and Barr 1979; Hertz et al. 2000), Walker Lake in Nevada (L. Neel, pers. com.), and Lake Erie (Roblee 2002). Fall migration timing may also overlap with shifting marine prey resources. Mid-November influxes of fall loon migrants into Chesapeake Bay coincide with Atlantic menhaden movements (Spitzer 1993).

In winter, loons have two general foraging strategies: solitary and group. Solitary foraging likely results in high use of evenly-spaced fish prey, such as Atlantic croaker (*Micropogonias undulatus*) and spot (*Liostomus xanthurus*), while group foraging is more effective for patchy prey abundance such as schools of gulf silversides (*Mendidia peninsulae*) (Vlietstra 2000). Large prey items that are difficult to swallow underwater, such as crabs and flounder, are often observed as a food source.

F. Predators and Parasites

Adults: There are few natural predators of adult Common Loons. In the breeding range, Bald Eagles (*Haliaeetus leucocephalus*) attack incubating loons (Miller 1988, Vlietstra and Paruk 1997; M. Meyer, pers. com.) and have been observed at adult loon carcasses (BRI, unpubl. data), although distinguishing between a scavenging event and a mortality event is difficult. Even though eagles will commonly kill large prey items and wing-row to shore, they can only lift one-third of their body weight. Adult loons normally exceed this limitation. Therefore, overt predation on adults by eagles is likely a rare event. In winter, predation of adult loons by sharks has been documented (Forrester et al. 1997). Other predation events undoubtedly occur but are likely relatively random scenarios.

Eggs: Although incubating adults are attentive, potential egg predators or other disturbances within their territory may displace them. The raccoon (*Procyon lotor*) is the mammalian predator with the greatest documented impact on eggs; Sutcliffe (1978, 1980) attributed 37-63% of the nest failures in New Hampshire to raccoon predation. More incidental predation by mammals is from mink (*Mustela vison*), fisher (*Mustela pennati*) (J. Mager pers. com.) and striped skunk (*Mephitis mephitis*) (McIntyre 1977a). River otter (*Lutra canadensis*), canids and other larger predators likely opportunistically take eggs. Compared to mammalian predators, potential avian counterparts are more oriented toward opportunistic findings of unattended nests. If an incubating adult is forced off the nest because of human disturbance or if it is preoccupied by an intruding conspecific, the unattended eggs can quickly attract potential predators. Major avian predators include the Herring Gull (*Larus argentatus*) (BRI, unpubl. data), American Crow (*Corvus brachyrhynchos*) (McIntyre 1977a, Sutcliffe 1978, Titus and VanDruff 1981), and Common Raven (*Corvus corax*). Common Ravens are likely the only bird with the ability to carry a loon egg away from the nest (Alvo and Blancher 2001, J. Fair, pers. com.). Incidental avian predation has also been associated with the Ring-Billed Gull (*Larus delawarensis*) (Olson and Marshall 1952) and Bald Eagle (R. Spencer, pers. com.; M. Meyer, pers. com.). Eggs with holes and contents not completely emptied characterize avian predation.

Chicks: Loon chicks are vulnerable to predation and conspecific mortality, particularly during the first few weeks, when they lack the ability to remain underwater and swim substantial



distances. Smaller chicks are more vulnerable than larger chicks (Sutcliffe 1978; Kenow et al. 2003a). Chicks become less of a predator target as they become larger and improve in their escape abilities (partly because of downy feather loss and molt into more streamlined contour feathers). At six weeks of age, most of the body feathers are molted and chicks have a greater ability to escape predators and aggressive conspecifics. The list of known chick predators is long and varied. Known primary predators likely include common snapping turtles (*Chelydra serpentina*) (LPC, unpubl. data), large predatory fish (Kenow et al. 2003a) that may include northern pike (*Esox lucius*), muskellunge (*Esox masquinongy*) and largemouth bass (*Micropterus salmoides*), Bald Eagles (LPC, unpubl. data; M. Meyer, pers. com.; Kenow et al. 2003a), and Herring and Ring-billed Gulls (McIntyre 1988). Bald Eagles are a primary predator, as exhibited by the vocal and agitated response of adult loons, particularly those accompanied by chicks. Site-specific predation is known by Great Black-backed Gulls (*Larus marinus*) (in Nova Scotia, J. Kerekes, pers. com.) and fisher (in Michigan, J. Mager, pers. com.; in Wisconsin, Kenow et al. 2003a). Eagles are particularly well-known chick predators; although, there are many cases of coexistence between nesting eagles and loons. Although Osprey (*Pandion haliaetus*) are occasionally mentioned as potential chick predators, this is unlikely and there are no substantiated predation events.

Various authors have described parasite loads. Chafel and Pokras (1993) documented 45% of the 20 loons necropsied had endoparasites, including trematodes, cestodes, and nematodes. They found none of the chicks exhibiting gross parasites or parasitic lesions (although 80% had internal parasites); however, Kenow et al. (2003) found that high internal parasite loads likely contributed to the mortality of two chicks in Wisconsin. Blood parasites were found in 16% of 104 Common Loons in the upper Great Lakes, including *Leucocytozoon* spp. and *Plasmodium* spp. (Cooney et al. 1995).

VII. Habitat Requirements

A. Breeding Season

Lake Characteristics: Loons prefer lakes >60 acres (>24 ha) with clear water, an abundance of small fish, numerous small islands, and an irregular shoreline that creates coves; however, they are found in a wide variety of freshwater aquatic habitats. Lake size and configuration are important determinates for loon density. Habitat heterogeneity is particularly difficult to quantify and typically requires an evaluation for what constitutes high and low quality. Loons likely have an overall habitat use pattern that follows Pulliam and Danielson's (1991) "ideal pre-emptive distribution" model where an individual selects the best available site and prevents other individuals from occupying that site.

Loon territories can be categorized into three major types: multiple- (MLT), whole- (WLT), and partial-lake territories (PLT)(Table 7). As observed in other bird studies (e.g., Holmes et al. 1996), Evers (2001a) showed that between-year territory fidelity is a good measure of habitat quality and ranked from lowest to highest quality territories: MLT, PLT, and WLT. Loon pairs residing on small lakes are classified as MLTs. Piper et al. (1997b) found all Wisconsin and Michigan loon pairs on lakes < 60 acres (<24 ha) to use at least one other lake during the breeding season. Breeding Common Loon adults do not regularly carry prey from satellite lakes



to their natal lake; although exceptions are known (Parker 1985) and may be related to acid-rain induced lowering of prey concentrations (Alvo et al. 1988). Lower lake-size limitations are driven by physical “take-off” requirements and the juxtaposition of nearby lakes where breeding adults can forage: known lower limits are 11 and 13 acres (4.4 ha and 5.2 ha) in Michigan (Miller and Dring 1988 and Evers et al. 2000, respectively), and 16 acres (6.4 ha) in Wisconsin (Zimmer 1979).

WLT holders remain on their nesting lake throughout the breeding cycle and may share their lake with non-breeding adults. The number of territorial pairs on larger lakes depends on lake configuration, nest site abundance and juxtaposition, and prey availability. Minimum lake size required for two territorial pairs in Wisconsin was 252 acres (101 ha) (n=1,746 lakes; Zimmer 1979), in Maine was 294 acres (118 ha) (n=133 lakes; Evers 2001a), and in New Hampshire was 309 acres (124 ha) (n=136 lakes; K. Taylor, pers. com.).

Water quality is an important habitat feature for breeding loon success. Loons are visual predators, therefore clear water is crucial for foraging efficiency. The benefits in prey availability is apparent through a Michigan study that documented time spent foraging for adults in turbid water was significantly greater than that in clear water (Gostomski and Evers 2001). Water clarity can be measured with a secchi disk or with specially-designed probes and instruments. Secchi disk readings of 5 feet or less (1.5m) alter loon foraging behavior (Barr 1986). Total suspended solid measurements at Seney National Wildlife Refuge, Michigan, indicate preference by breeding pairs for lakes that have <28 Nephelometric Turbidity Units (NTU); lakes over that level were not used for nesting purposes (BRI, unpubl. data).

Table 7. Descriptions and definitions of territory types.

Status / Type	Definition
Multiple-lake territory	Paired adults using two or more lakes during a breeding cycle to provide the required resources. Multiple-lake territories are only those that require flight to access another lake.
Whole-lake territory	Paired adults restricted to one lake for the entire breeding cycle. The territory may or may not encompass the entire lake, however, a second territory is not present on the same lake.
Partial-lake territory	Paired adults sharing a lake with other established or transitional territory holders. Common foraging areas used by non-breeding adults frequently exist.

Nest Site Habitat: Loons nest in close proximity to the water’s edge and prefer small islands, floating bog mats, and marshy hummocks. Preference is for small island sites, primarily the lee side (Olson and Marshall 1952, Sutcliffe 1980, Titus and VanDruff 1981, Yonge 1981, Dahmer 1986, Jung 1987). Islands provide the widest range of visibility on the territory and afford better protection from mammalian predators. Floating sphagnum bog mats afford particularly high nesting success (Reiser 1988) because they can move with water level fluctuations related to natural and anthropogenic forces. Marsh and mainland sites are of lower preference and most likely occur in response to lack of islands, shoreline development (Alvo 1981, Christenson 1981, McIntyre 1988) and high conspecific densities. In cattail (*Typha* spp.) marshes and other



emergent wetlands with tall vegetation, muskrat (*Ondatra zibethicus*) houses provide suitable nesting platforms (Munro 1945). Beaver (*Castor canadensis*) houses may also be used (K. Taylor, pers. com.).

Nest sites are generally located within 4 feet of the water's edge (although water level drawdowns can extend their limits and >50 foot (>15 m) pathways have been documented, J. Fair, pers. com.). Available submergent and emergent materials are used for nest structures. Extent of the nest bowl diameter varies (11.2 to 15.2 inches; 27.9 to 38.1 cm), and use of depressions, or "scrape" bowls is common (Sutcliffe 1980, K. Taylor, pers. com.). Mainland nest sites are more likely to be constructed as bowls opposed to scrapes or hummocks (Sutcliffe 1980). Others have reported a preference for nest sites with steep drop-offs that allow for underwater approaches and exits (Olson and Marshall 1952, Christenson 1981, McIntyre 1988, Ruggles 1994), however Sutcliffe (1980) and Valley (1987) did not find this to be a predictor of site location. Strong et al. (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 occurred more often after successful nesting.

Foraging Habitat: Loons prefer foraging in clear waters of littoral zones; they tend to avoid deeper parts of lakes. Foraging by breeding adults and their young are generally in relatively shallow areas < 16.5 feet (<5 m) in depth and within 165 to 500 feet (50 to 150 m) from the shoreline (Strong and Bissonette 1989; Ruggles 1994; McIntyre and Barr 1997). Preferred prey species and size classes, such as 4 to 6 inches (10 to 15 cm) yellow perch (*Perca flavescens*) are found in this zone (Barr 1996).

Chick Rearing Habitat: Chick rearing areas or nurseries share much of the same attributes as foraging areas. They are typically in shallow water close to shore, with prey size classes suitable for feeding young. These areas experience less prevailing wind and waves that can separate chicks from adults. Chicks hide among shoreline vegetation in response to threats or when left unattended (Yonge 1981, Strong and Bissonette 1989, Ruggles 1994).

B. Migration

Loon migratory habitat requirements have been little studied. Loon populations with short-distance overland movements from breeding to wintering areas likely do not regularly use staging areas. However, for long-distance migrant staging areas are particularly crucial for rest and replacing lost body reserves. Because loons forage in staging areas, prey availability is an important requirement and therefore requires a mix of abundant prey and relatively clear water. Large lakes and rivers with such habitat requirements are used by interior migrants (McIntyre and Barr 1979; McIntyre and Barr 1983; Hertz et al. 2000), while ocean-going migrants are most likely to use inshore areas (Powers and Cherry 1983).

C. Winter and Nonbreeding Seasons

Wintering and nonbreeding loons generally use inland coastal waters including bays, channels, coves and inlets. Offshore habitats (> a few miles) appear to be rarely occupied (Lee 1987a,b; Haney 1990). Use of specific marine habitat is dictated primarily by prey availability, which is



influenced by water depth, clarity and salinity gradients, and tide lines (McIntyre 1978b; Lee 1987b; Haney 1990, Vlietstra 2000). Haney (1990) found loons generally using waters up to approximately 130 feet (40m) in depth and < 54 miles (<90 km) offshore; peak use was in areas <70 feet (<20m) in depth. Areas, such as river mouths, with highly turbid water are generally avoided because they limit foraging success (Daub 1989; Haney 1990; Jodice 1993). Interior, freshwater areas, such as southern U.S. reservoirs and large slow-moving rivers, are commonly used as wintering habitat, but their use is largely influenced by weather. Although the southern Great Lakes generally remain open through the winter, loons are relatively rare there at that time and those that attempt to overwinter may be physically compromised and unable to complete the migration.

VIII. Population Estimates and Trends:

A. Breeding

Total populations and trends are well known in the contiguous United States; they are less known, but are now quantified for Alaska, the Canadian Provinces, Greenland, and Iceland (Table 8). Population estimates are relatively speculative in Canada where most population estimates are extrapolated from loon counted during aerial waterfowl surveys conducted by the Canadian Wildlife Service (i.e., surveys are not loon-oriented and therefore may not emphasize loon observations or represent the best survey time periods). Traditional abundance trendlines based on Breeding Bird Survey Routes (BBS) are not used here because (1) BBS routes poorly reflect loon population trends (Robbins et al. 1986), (2) higher resolution monitoring data is available for populations in the United States, and (3) BBS routes in the heart of the loon's breeding range are rare or do not exist. However, they do provide some insight for areas of abundance.

1. Alaska

Alaska breeding populations are primarily restricted to the southern, forested portions of the state. Densities are greatest in the lakes region of the Kenai and Alaska Peninsulas, considerably lower across much of central and eastern Alaska, and nearly absent north of the Brooks Range and in tundra habitats elsewhere (Groves et al. 1996). Its distribution and densities have likely changed little in the past century with the exception of increasing local pressures and loss breeding habitat in the Anchorage Bowl and Mat-Su Valley areas. Recent estimates based on waterfowl aerial surveys of National Wildlife Refuges (Groves et al. 1996) and other areas indicate 3,600 to 6,000 territorial pairs (Tankersley and Ruggles 1993). Alaska and Minnesota have the largest breeding populations of Common Loons in the U.S.

2. British Columbia

Common Loons breed throughout British Columbia with centers of abundance in the southwestern and southern part of the province: the Thompson-Okanagan and Fraser Plateaus and the Fraser Basin region (Campbell et al. 1990). It is a common breeder on large coastal islands, including Vancouver and Queen Charlotte, and far less common on small coastal islands.



There has not been a recorded historical decline or range retraction in British Columbia, although limited Breeding Bird Survey routes indicate a significant increase from 1967 to 1998 (Scheuhammer et al. 2003). Based on extrapolation from aerial waterfowl surveys, current estimates are 25,000 territorial pairs (A. Breault, pers. com.).

3. Far northern Canada

The Birds of the Yukon Project documented Common Loons in June through August, although most of the observations were in southern Yukon (Vogel 1997). The loon's rarity along the Yukon coastal plain is indicated by an early 1970 survey that estimated fewer than 10 individuals (Johnson and Herter 1989); a similar abundance pattern is known along the Alaskan coastal plain where intensive surveys are conducted (Larned et al. 2001). In the Northwest Territories and Nunavut, Common Loons are generally restricted to forested portions (Godfrey 1986); breeding records on the Beaufort Sea coastal plain exist but are rare (Johnson and Herter 1989). Exceptions are in northern Quebec and on southern Baffin Island's tundra (Godfrey 1986). An estimated 50,000 territorial pairs occur across the northern tier of Canada; centers of abundance appear to be in the Mackenzie and Keewatin Districts of the Northwest Territories. Population estimates are rough extrapolations from aerial surveys and population trends are relatively unknown.

4. Western contiguous U.S.

Breeding loons were historically found across the northwestern part of the U.S. in small and discontinuous numbers. A handful of nesting records exist from northern California and western Oregon, although it appears that breeding loons in these two states have been extirpated for several decades (Corkran 1988). Idaho's small breeding population also disappeared during the mid-1900s. By the mid-1980s, breeding pairs still survived in Montana, Washington, and Wyoming. In the 1990s, population trends remained steady in Wyoming but were unstable in Montana and Washington. Recent monitoring indicates that while western Washington is on the verge of losing its breeding population, the number of territorial pairs in eastern Washington and northern Idaho are increasing. An estimated 94 territorial pairs occur in these four western states.

Historically, at least 12 lakes had nesting pairs of loons in Idaho (Fitch and Trost 1985). Except for a territorial pair straddling the Wyoming-Idaho border (nest in Wyoming), loons appear to have been extirpated in Idaho in the mid-1900s. In the 1990s, loons were regular summer residents and in 1998, the first successful loon breeding record was documented in the Idaho panhandle on Lake Pend Oreille (Taylor 2001). Although the 5 or so territorial pairs remain irregular nesters, continued annual same-site sightings throughout the summer promise permanent restoration.

Montana has the largest breeding population of loons in the contiguous U.S. west of the Great Plains. Current distribution is concentrated north of Missoula and west of the Continental Divide in the northwest corner of the state and is similar to the historical range. Areas of concentrations are in the Tobacco-Stillwater drainage, the Clearwater-Swan drainage and a group of lakes near Kalispell. Approximately 20-30 territorial pairs are in Glacier National Park (S.



Gniadek, pers. com.). The population appears to be stable or slightly increasing. Montana has dedicated increased resources in protecting the remaining pairs and their habitats.

While Washington has a poorly substantiated historical record of breeding evidence, nesting records are known from both sides of the Cascade Mountains (Richardson and Spencer 1999). Although urban development associated with Seattle and Tacoma is responsible for displacing breeding pairs from lakes, complete protection of lake shoreline habitat for several reservoirs that serve as municipal water supplies provided sufficient habitat for at least five territorial pairs. This success may have been temporary as only one pair remained in 2002 (D. Paige, pers. com.). In northeastern Washington, a single and very successful breeding pair in the Okonogan highlands was first located in 1985. Since then, the area's number of loon pairs has slowly grown to four pairs (Richardson and Spencer 1999, D. Poleschook, pers. com.). In summary, although Washington's breeding population may have rebounded from lows in the early and mid 1900s to 14 territorial pairs in the mid-1990s, recent monitoring efforts indicate a severe decline to just 5 territorial pairs in 2002 (D. Poleschook and G. Gumm, pers. com.).

In Wyoming, the historical and current distribution and abundance of breeding loons are similar, primarily because Yellowstone National Park and the Shoshone National Forest protect the available lake habitat. The number of territorial pairs in Yellowstone National Park range from 12 to 18 (T. McEaney, pers. com.). Although individuals use lakes in Grand Teton National Park, the approximately 7 breeding pairs outside of Yellowstone National Park are confined to Shoshone National Forest (Cerovski et al. 2000).

5. Prairie Provinces

Loons are widespread in Manitoba and, except for far southern prairielands, in Alberta and Saskatchewan. A total of 12,500 to 15,000 territorial pairs occur across these three provinces. Declines in some of the more populated areas have occurred (McNicholl 1988). In Alberta, loon numbers are collected by the Federation of Alberta Naturalists and represent opportunistic observations. Estimates therefore lack standardization. Alberta and Saskatchewan population estimates are substantially lower than estimates in Manitoba. Loon populations are better known in Saskatchewan than other Prairie Provinces because of a detailed breeding bird atlas (Smith 1996). Breeding loons are distributed throughout the northern and central part of the province south to Redberry Lake, Yorkton region, Nickel Lake, and Moose Mountain (Smith 1996). Similar to southern Alberta, lakes south of these areas often are shallow and have poor fish stocks. Satellite telemetry efforts have linked north-central Saskatchewan breeding loons to a spring and fall staging area on Walker Lake, Nevada (Yates et al. 2002a). Spring migration counts on Walker Lake have documented at least 1,400 loons. Assuming this entire cohort of migrants breed in Saskatchewan, at least one-third to one-fourth of that province's loons stage on Walker Lake. In Manitoba, breeding loons are found province-wide, except for the prairie areas of the south. Concentrations appear to be greatest in west-central Manitoba. Yonge (1981) conducted a study in that area on Hanson Lake, Saskatchewan (just west of the Manitoba border) and documented a very high density of 10 pairs/1,000 acres. He considered this density to be typical of area lakes.



6. U.S. Great Lakes

Loon populations in the U.S. Great Lakes region have suffered the greatest loss in historical range and are currently in the greatest need for further conservation efforts. Breeding populations are now extirpated in Illinois, Indiana, Iowa, and Ohio and restricted to the northern portions of Minnesota, Wisconsin and Michigan (McIntyre and Barr 1997). Yet, the U.S. Great Lakes region supports over half of the loon breeding population in the U.S. (5,900 to 7,200 territorial pairs), or three-quarters in the contiguous U.S (Table 8). There are important areas of loon concentrations in the upper Great Lakes within federally and state protected areas, however, private in-holdings creating mixed shoreline ownership weaken effectiveness for their long-term protection

In Michigan, high concentrations of suitable lake habitat in southeastern and southwestern parts of the state formerly contained an abundant number of territorial pairs (Barrows 1912). While New England breeding populations are recovering from such range losses, Michigan's southern range of breeding loons is still retracting. Even as recent as the late 1980s, breeding loons were more widespread in southwestern Michigan than they are today (Evers and McPeck 1987). Breeding populations within federally-owned areas include those in Seney National Wildlife Refuge, Hiawatha and Ottawa National Forest, and Isle Royale National Park. Hiawatha National Forest and other areas of the eastern Upper Peninsula, including the Lake Superior State Forest, have experienced local declines in loon populations that are likely related to regular mortality events from large-scale fishery activities in the surrounding Great Lakes.

The Common Loon breeding range in Wisconsin traditionally extended from the southern tier of counties northward (Kumlien and Hollister 1951) but today is restricted to the northern one-third of the state. North central Wisconsin, particularly the two-county area including Oneida, and Vilas has the greatest concentration of breeding loons. Federally-protected areas such as Chaquamegon and Nicolet National Forests provide nesting habitat, while Apostle Islands National Lakeshore primarily protect over-summering areas for non-breeding loons. The first statewide survey of Common Loon breeding status and distribution in 1976 and 1977 documented a population of 1,300 adult loons (Zimmer 1982). Loon population estimates calculated every five years since 1985 are based on a stratified random survey conducted by LoonWatch of the Sigurd Olson Environmental Institute of Northland College. The 1985 survey found the adult loon population had reached $2,334 \pm 197$, a 78% increase over the 1976-77 estimate (Olson 1986, Strong 1988b). The number of adult loons in Wisconsin has increased with each survey to $3,131 \pm 278$ in 2000 (Gostomski and Rasmussen 2001), with a statistically significant increase between 1985 and 1995 (Daulton *et al.* 1997).

In Minnesota, the loon's breeding range historically extended south to the Iowa border and west to the Red River Valley (Janssen 1987). Today, breeding loons can be found across the northern two-thirds of the state (north of the Minnesota River) with the greatest density in the north-central and northeastern regions (Hanson 1996; Strong and Baker 2000). Several breeding populations have been well studied in Minnesota including those in the Boundary Waters Canoe Area (Olson and Marshall 1952) and at Itasca State Park (McIntyre 1975). Various state forests provide important state-protected habitat for breeding loons, as do federal areas such as Chippewa and Superior National Forests and Voyageur's National Park. The latter area contains



large lakes with water levels dictated by dams where loon productivity (Reiser 1988), demographics (Evers et al. 2000), and Hg exposure (Evers et al. 1998, Bischoff et al. 2002) are well-characterized. The first statewide population estimate in 1989 calculated 11,626 +/- 1,272 adult Common Loons (Strong and Baker 2000). Subsequent standardized monitoring efforts for six, 100-lake index areas (based on protocols by Hanson 1996) show no significant declines from 1994 to 2002 (Baker 2000; MLMP 2002).

There are few areas along Great Lake shorelines that support nesting loons. Isle Royale National Park, Michigan is one exception and its Lake Superior shoreline likely represents the largest concentration of territorial pairs nesting on a Great Lake (an average of 30 territorial pairs in 2003) (Kaplan, pers. com.). Even within Isle Royale's deep coves and bays, major seiches ranging from 10-60 cm (4-24 inches) can inundate nests (Evers 1995), although recent research indicates recreational activities (e.g., canoes and kayaks) are most responsible for lowered breeding success (Kaplan 2003).

7. Ontario and Quebec

Well over half of North America's breeding loons are in Ontario and Quebec. Ontario has more loons than other Canadian provinces and contains over one-third of the continent's breeding loon population with an estimated 97,000 pairs (Wayland and McNicol 1990). Historically, loons occurred across Ontario and even nested on Lake Erie, however they are now nearly absent as a breeding species from the Carolinian Forest Zone of southwestern Ontario (Cadman et al. 1987). Densities are lowest along the Hudson Bay lowlands and far northern Ontario, while they are highest in the Precambrian Shield area. High population densities continue into western and central Quebec, where most of that province's 50,000 territorial pairs occur. Densities are lower in eastern Quebec, including the Ungava Peninsula (McNicholl 1988). Similar to Ontario's distribution patterns, breeding Common Loons are rare within Quebec's Hudson and James Bay lowlands. Because there are few lakes, loons are nearly absent within the lower St. Lawrence River watershed. Along the north shore area of the Gulf of St. Lawrence, Common Loon densities are also low in the relatively treeless landscape.

Population trends in Ontario are better known than most provinces because of (1) a large volunteer network directed by the Canadian Lakes Loon Survey (CLLS) and (2) helicopter surveys for American Black Ducks (*Anas rubripes*) that are based primarily on randomly-located plots. Results from CLLS best indicate reproductive success, of which a significant decline was documented between 1987 and 1997 (Weeber 1999). Recent analysis indicates that the proportion of territorial pairs that are successful in producing young continues to decline (R. Weeber, pers. com.). This decline is most pronounced on "acid stressed" (those with a pH of 5-6) or acidic (<pH of 5) lakes. In Quebec, an area with lake characteristics similar to those in Ontario, helicopter surveys for breeding American Black Ducks indicate stable numbers of territorial pairs since 1980 (Scheuhammer et al. 2003), although there are no province-wide long-term brood counts as conducted in Ontario.

The viability of the breeding loon population in Ontario and Quebec is vital to the long-term health of the Common Loon. This large population is at the crossroads of several large-scale threats that require further investigation. Large areas of lakes with potential impact from



acidification (McNichol 2002; Scheuhammer et al. 2003) and atmospheric Hg deposition (Scheuhammer and Blancher 1994; Scheuhammer) have been identified. Recently, an added impact is the loss of over 10,000 Common Loons from a botulism outbreak on Lakes Erie and Ontario. Combined, these stressors form a potential population-level impact in the core of the loon's entire breeding range.

8. New England and New York

Breeding loon populations in the Northeast have experienced severe historical declines and range retractions. The historical southern periphery of the loon's breeding range included eastern Pennsylvania and Connecticut (McIntyre 1988). Regional conservation campaigns and loon-specific organizations including New Hampshire's Loon Preservation Committee, the Vermont Institute of Natural Science, and other state-oriented groups spearheaded a comeback of the species within several decades of its recorded population lows in the mid-1900s. In New England, nearly 2,000 territorial pairs are distributed across much of their historical range, including parts of southern Vermont and central Massachusetts. Approximately 250 additional territorial pairs reside in New York.

Breeding Common Loons recolonized Massachusetts in 1975 (Blodget and Lyons 1988). For several years breeding pairs were limited to Quabbin Reservoir but are now found on 7 lakes in central Massachusetts and increased to a total of 20 territorial pairs (Savoy et al. 2002). Many of these lakes have protected shoreline habitat because they are used for drinking water supplies for nearby municipalities.

In New Hampshire and Vermont, the loon's comeback has been well-documented. In New Hampshire, the number of territorial pairs has more than doubled from 87 in 1980 to 199 in 2002 (Taylor and Vogel 2003). The core area of breeding loons is in central New Hampshire on Squam and Winnepesaukee Lakes and surrounding smaller lakes. As the population has increased over time, loons have recolonized and continue to expand throughout southern New Hampshire and have reoccupied much of northern New Hampshire, north of the White Mountains (Brennan 2003). Even in northern New Hampshire, loon numbers were at historical lows in the mid-1970s. In 1976, only 8 territorial pairs were found on Lake Umbagog and by 2000 this population had increased to 31 territorial pairs (Evers 2002).

In Vermont, a similar increasing population trend has been observed, although this state's population started from a much smaller number. In 1983, only 12 territorial pairs were known but by 2002 a total of 59 territorial pairs were counted including five pairs in southern Vermont. Currently, there are no territorial pairs on Lake Champlain and little or no evidence of historical nesting (Hanson et al. 2002).

In Maine, the breeding population was far more buffered to historical human disturbance than nearby New England states. Still, southern areas of Maine were considered to have depressed numbers in the mid-1900s (Cross 1979; Sawyer 1979). Since the 1970s, breeding loon populations appear to have reoccupied some of the more southern areas of Maine and overall populations appear to have slightly increased. Statewide surveys estimated from 3,000 to 4,000



Table 8. Estimated number of Common Loons based on their North American breeding range¹.

REGION	Estimated # of territorial pairs	Estimated # of adults	Population trend	Information source
UNITED STATES	11,783 to 15,529	29,515 to 37,285		
Alaska	3,600 to 6,000	8,890 to 13,200	Stable	Groves et al. 1996; Tankersley and Ruggles 1993
Idaho	5	12	Stable	J. Taylor, pers. com. (2003)
Maine	1,700	4,100	Stable	BRI, unpubl. data; S. Gallo, pers. com. (2003)
Massachusetts	20	48	Increasing	BRI, unpubl. data
Michigan	500 to 775	1,251 to 1,937	Stable/Decr.	Zimmerman and Selzer 2002
Minnesota	4,142 to 5,159	10,355 to 12,897	Stable	R. Baker, pers. com. (2003)
Montana	62	160	Stable	L. Kelly, pers. com. (2003)
New Hampshire	199	515	Stable	Taylor and Vogel 2003
New York	216 to 270	804 to 1,036	Increasing	Parker and Miller 1988
North Dakota	14	48	Decreasing	BRI, unpubl. data
Vermont	48	135	Increasing	Hanson et al. 2002
Washington	5	12	Decreasing	Poleschook & Gumm, pers. com. (2003)
Wisconsin	1,250	3,131	Stable	Gostomski and Rasmussen 2001
Wyoming	22	54	Stable	Cerovski, pers. com. (2003); McEneaney, pers. com. (2003)
CANADA	240,075 to 246,575	576,296 to 591,896		
Alberta	1,000	2,400	Stable	Evers 2000
British Columbia	25,000	60,000	Stable	Scheuhammer et al. 2003
Manitoba	10,000 to 12,000	24,000 to 28,800	Stable	Scheuhammer et al. 2003
New Brunswick	1,174	2,934	Stable	Stocek 1993
Newfoundland	3,000 to 7,000	7,200 to 16,800	Stable	Kerekes, pers. com. (2003)
Northwest Territories	45,000	108,000	Stable	Scheuhammer et al. 2003
Nova Scotia	1,200	2,880	Decreasing	Erskine 1992; Burgess, pers. com. (2003)
Nunavut	5,000	12,000	Stable	Scheuhammer et al. 2003
Ontario	97,000	232,800	Stable	Wayland and McNichol 1990
Quebec	50,000	120,000	Stable	Scheuhammer et al. 2003
Prince Edward Island	1	2	Stable	Kerekes, pers. com. (2003)
Saskatchewan	1,500 to 2,000	3,600 to 4,800	Stable	Scheuhammer et al. 2003
Yukon	200	480	Stable	Evers 2000
ICELAND	300	720	Stable	Peterson, pers. com. (2003)
GREENLAND	200 to 2,000	480 to 4,800	Stable	Boertman, pers. com. (2003)
TOTAL POPULATION	252,358 to 264,404	607,011 to 634,701		

¹Surveys may be a mix of actual and derived results. When a survey documents territories pairs, an estimated total adult population assumes a 20% nonbreeding component (unless total adults were known through surveys) to arrive at an estimated total number of adults. Surveys that estimate total number of adults are converted into estimated number of territorial pairs with the same 20% nonbreeding component conversion. These derivations are based on a New Hampshire 27-year statewide database (Taylor and Vogel 2003).



adults in the early to mid-1980s (Lee and Arbuckle 1988). In 1990, the statewide estimate was 3,949 adults (54% in the southern half) (Maine Audubon Society, unpubl. data). Today's estimate is based on a stratified random sample conducted by the Maine Audubon Society for the southern half of Maine and a random aerial survey conducted by the Maine Department of Inland Fisheries and Wildlife for the northern half. Combining both surveys a statewide adult loon population of 4,100 (or 1,700 territorial pairs) is estimated. Recent high resolution monitoring of lakes in the Rangeley Lakes Region (i.e., Lake Umbagog) and in the Allagash Region indicate lower than expected densities and productivity (Evers et al. 2002a,b). Further investigation is ongoing to investigate patterns and the potential need for adjusting population estimates in northern Maine. Population trends based on data from southern Maine indicate a stable number of adults (Hitchcox 2000).

Similar to other Northeast breeding loon populations, New York loons also experienced historical declines. Loons historically nested in the Finger Lakes (McIntyre 1979) and across northeastern New York. By the late 1970s, McIntyre (1978) documented a 35% decline in the number of lakes with nesting loons. Breeding populations were restricted to 9 counties representing the Adirondack Mountains and the Thousand Island area of the St. Lawrence River and accounted for an estimated 155 territorial pairs (McIntyre 1979). Trivelpiece et al. (1979), during that same time period, estimated fewer than 200 territorial pairs. In the mid-1980s, Parker and Miller (1988) estimated 216 to 270 territorial pairs, including some pairs on lakes south of the St. Lawrence River and outside of the Adirondack Park. Today, breeding populations appear to remain similar and stable, although another statewide population estimate needs to be conducted.

9. Canadian Maritimes

Total numbers for this four-province area are relatively speculative because of the unknown numbers of loons in Newfoundland. Both Nova Scotia and New Brunswick have a similar breeding population of approximately 1,200 pairs in each province. Erskine (1992) estimated that this is one-third to one-half of the species' historical abundance, although loons remain widely distributed in these two provinces. In Nova Scotia, there is concern over apparent population declines (N. Burgess, pers. com.) that may be related to the province's extremely high Hg levels (Burgess et al. 1998a, Evers et al. 1998). Areas of low lake and loon density are those with sedimentary rock parent material such as in eastern New Brunswick and western Cape Breton (Erskine 1992). Prince Edward Island has few lakes but does provide habitat for one loon pair (J. Kerekes, pers. com.). New Brunswick population trends appear to be stable or even slightly increasing (Stocek 1993). Loon population estimates and trends are not well known for Newfoundland. Although they are known to occur throughout the province, they are comparatively less common in northern Labrador (N. Burgess, pers. com.).

10. Iceland and Greenland

Loons breeding on these two islands share the unique habit of their strict use of non-forested lakes for nesting. In most other areas of their range, this habitat type is rarely used. The Icelandic breeding population is widely distributed on the island and populations have not had



noticeable changes during recent times. In Greenland, breeding loons are distributed solely along the outer margins of the southwestern and southeastern parts. Little is known about the loon distribution and population trends for Greenland. Total numbers of territorial pairs are relatively known for Iceland (A. Peterson, pers. com.); however, the estimated number on Greenland is based on loon densities from a small area and extrapolated across suitable habitat (D. Boertman, pers. com.).

B. Wintering

Population estimates and trends are difficult to establish for much of the Common Loon population in Canada, therefore wintering numbers are instrumental. The National Audubon Society's Christmas Bird Counts (CBC) are a relatively standardized method for estimating loon distribution and numbers over time. Although the CBC's narrow observational window is confounded by observer bias, weather, effort, and additions of new stations, it remains the best suite of data on wintering loon populations. To reduce observer and weather variation in the data, CBC information is provided in three-year period and as an index of individual per effort. The number of loons per party-hour did tend to increase in North America from the period of 1960 to 2003 (Figure 6), however, it was not significant ($p=0.21$, $F=1.64$). When separating the CBCs into U.S. and Canadian wintering populations there is a significant increase in the U.S. ($p=0.018$, $F=6.08$) (Figure 7).

These population trends likely reflect the gradual continental recovery of loons from lows in the late 1800s and early 1900s when breeding populations in the southern range periphery as well as migrants and wintering populations were routinely shot in large numbers (Forbush 1912; Brewster 1924). Although the Christmas Bird Counts only represent approximately 2% of the total loon population (in 2002, 14,423 counted in the U.S. and 1,605 counted in Canada) the regularity of count data since 1960 indicate a relatively high confidence in using these trend data. Inter-year variation in count data was only extreme ($> 75\%$) in 1964, 1977, and 1988. In two of these three peak years, there was a large increase in observations in one year followed by a comparatively normal count in the next year. These three peak years may represent young-of-year cohorts reflecting exceptional breeding seasons.

Figure 6. Total number of wintering Common Loons in North America during Christmas Bird Counts, 1960-2003.

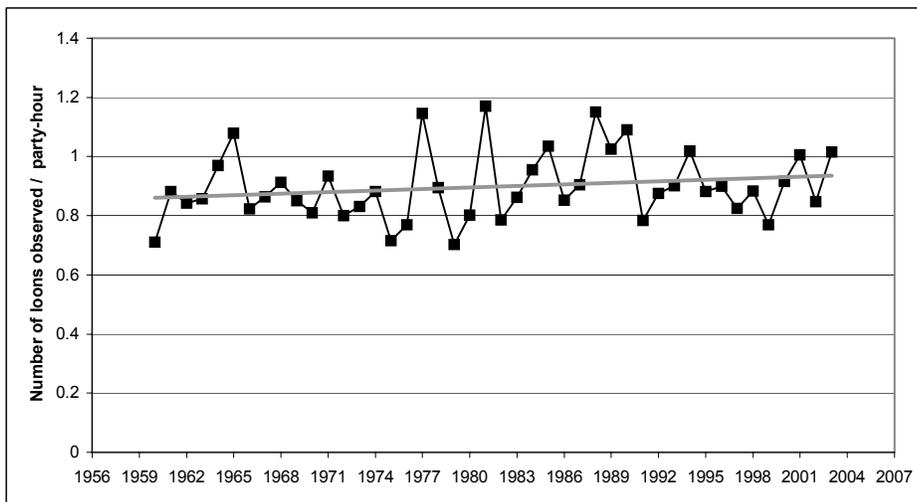
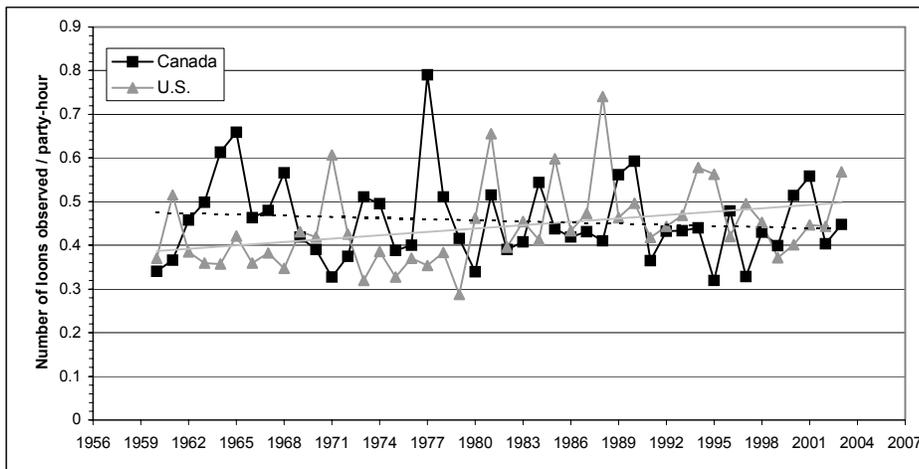


Figure 7. Total number of wintering Common Loons for the U.S. and Canada during Christmas Bird Counts, 1960-2003.



IX. Threats to loons

A. Human intrusion of breeding lakes

Understanding the impact of human disturbance on loons is complex. Development and recreational pressures on lakes have been implicated in declining breeding loons and reduced breeding success (Snyder and Logier 1931; Vermeer 1973; Ream 1976; Salt and Salt 1976; Alvo 1981; Titus and Van Druff 1981; Heimberger et al. 1983; Peck and James 1983; Dahmer 1986; Jung 1987; McIntyre 1988; Strong and Bissonette 1989; Semenchuk 1992; Kelly 1992). These factors likely have had, and in some cases currently have, a contributing role in shrinking loon breeding populations. Many of these studies, however, also report loons successfully breeding on waterbodies despite disturbance (McIntyre 1979; Jung 1991; Taylor and Vogel 2003) and adopting adaptive strategies in response to human activity (Titus 1978; Sutcliffe 1980; Alvo 1981; Blair 1981; Christenson 1981; Smith 1981; Titus and Van Druff 1981; Heimberger et al 1983; Jung 1987). The processes and limits of habituation are unknown and likely best addressed through understanding site-specific scenarios. The loon’s ability to acclimate suggests that properly designed efforts to ameliorate impacts from disturbance have a high potential for success.

1. Shoreline development

Habitat degradation and loss because of shoreline development have been generally cited as reasons for declines in local breeding populations and their reproductive success (McIntyre 1988). Often sites favored by loons for nesting and chick-rearing, such as islands and quiet bays, are of prime development value or use (such as campsites). Furthermore, loon presence attracts



potential property owners, and as such, real estate on lakes supporting loon pairs is at a premium. The quality of loon breeding habitat is impacted by shoreline development through (1) vegetative and substrate modification or removal, (2) enhancing predator densities, and (3) by the overall presence of human activity.

When vegetation is removed, both erosion and water temperatures tend to increase (Liddle and Scorgie 1980). Ensuing sedimentation and phosphorus enrichment of the lake thereby contributes to excessive algae and aquatic weed growth, changing prey composition, and patterns of vegetative growth. This effectively reduces water clarity and quality (Moss 1977). Erosion at construction sites is a leading cause of water quality problems in New Hampshire waterbodies (K. Taylor, pers. com.). Urban, suburban, and town stormwater runoff is an increasing source of declining water quality. The U.S. Environmental Protection Agency has now delegated authority of the National Pollution Discharge Elimination System (NPDES) to states and will likely place a higher emphasis on regulating nonpoint pollution through stormwater runoff.

Generally, shoreline development is accompanied by increases in some species of loon predators (McIntyre 1988). Raccoons are widely considered to be the most influential egg-predator of loons and their densities are generally correlated with increasing shoreline development (Sutcliffe 1980). Other wildlife associated with increasing human habitation are various species of gulls and corvids. All of these species have acclimated to human habitation and to byproducts such as increased food availability from inappropriate waste disposal.

Loons, particularly those breeding pairs that are unaccustomed to people, are likely to relocate nest and nursery sites distant from high human presence (Smith 1981; Titus and Van Druff 1981; Kaplan 2003). Therefore, shoreline development in high quality loon breeding habitat, such as island habitats, can modify use of the most suitable areas by a territorial pair.

2. Recreational use

Motorboats: Boating may or may not be a threat to breeding loons, depending on boater awareness and how acclimated loons are to boating. In Ontario, the degree of recreational boating did not significantly impact productivity (Ashenden 1988). Recreational boating represents a greater disturbance and risk to loons in open water than those nesting and foraging in shallow water. Habituation to boating activity can dull response times in loons, making them more susceptible to collisions (K. Taylor, pers. com.). Thirty-nine percent of all loon mortality in New England was from trauma, with boat impacts contributing 36% to that total (Miconi et al 2000). Christenson (1981) found that adults moved further distances with their young when boats were present. The energetic cost to this is unknown, however, movement in response to boating activity increases the likelihood of chicks being separated from adults, which may result in increased mortality.

Personal watercraft: Personal watercraft differs from conventional motorboats in their design, use, and effects on wildlife and the environment (Burger 1998; Chin 1998). Personal watercraft can cause significant damage since they have a shallow draft, are able to closely approach nests and shorelines at high speeds, and are loud, making it difficult to hear loon vocalizations. Washouts of loon nests and blunt trauma mortality to loons from this type of watercraft have



been documented (Maine Audubon Society 1997; Jaruzel 1998; Miconi et al 2000). Disruption of loons by personal watercraft is not limited to nest failure and direct mortality. Repeated travel in a localized area is a common mode of operation (Snow *in* Chin 1998). The presence of a 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.

Non-motorized watercraft: As with personal watercraft, non-motorized watercrafts, such as canoes and kayaks, have the ability to access shallow water areas typical of loon nesting and brood sites. Additionally, canoeist and kayakers are more apt to use remote areas, and have a greater ability for stealth. This type of activity is most detrimental during nest initiation when egg investment is lowest and the likelihood of abandonment highest. Kelly (1992) found flushing distances decreased as incubation progressed (week 1 = 129 m, week 2 = 121 m, week 3 = 91 m, and week 4 = 64m). Though loons on lakes with high human use flush at shorter distances and less readily (Smith 1981; Titus and VanDruff 1981), any increase in activity near the nest site may serve to attract predators (McIntyre 1977a;1988). Kelly (1992) found that the average time off-nest was significantly less for flushes related to natural causes (8 minutes) as opposed to those caused by human disturbance (24 minutes). Disturbance from sailboats and wind-surfing has not been documented, however anecdotal and behavioral evidence suggest a flapping 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 unpubl. data).

Anglers: Impacts from irresponsible angling practices can be considerable. Excessive angler use of the shallow, vegetated areas of lakes through wading and boating practices disturbs nesting and foraging activity (Zimmer 1979; Titus 1978; Titus and VanDruff 1981; Christenson 1981; Kelly 1992). Improperly disposed monofilament and fishing tackle pose great risk to mortality from entanglement and lead (Pb) poisoning (see "Lead"). The increased popularity of fishing tournaments offering substantial prizes can create an unfortunate incentive for improper practices during the loon's breeding season. 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 (K. Taylor, pers. obs.).

Planes: The impact of floatplanes on breeding lakes is not quantified, however male loons regularly yodel in response to floatplanes flying over or into their territory. This suggests a possible perception of territorial threat. Loons can acclimate to regular floatplane use and can even maintain a breeding territory and regularly fledge young. Other types of low-flying planes or even ultralights can elicit a response from a territorial loon pair.

B. Direct anthropogenic take

Sport and game hunting of loons was far more common at the turn of the 20th century than today. Historically (before the federal Migratory Bird Treaty Act of 1918), loons were killed because of their perceived threat to gamefish (Bent 1919). Mortality from sport shooting was even linked to local population declines (Forbush 1912; Brewster 1924), such as in New Hampshire (Hammond and Wood 1976) and the Pacific Northwest (Corkran 1988). Illegal take through recreational hunting in the U.S. and Canada is now rare, although still regularly occurs as confirmed through radiographs (Franson and Ciplef 1993, Pokras et al. 1993, Miconi et al.



2000, Franson et al. 2003, Sidor et al. 2003).

Annual subsistence harvest of loons is still common and practiced across Alaska, northern Canada, and Greenland. Earnst (2003) summarized the harvest in Alaska; from 1987-1997, 567 Common Loons were taken in the Yukon-Kuskokwim Delta and from 1995-1996 195 Common Loons were reported taken on St. Lawrence Island. In general, annual take in Alaska appears to be far less than that in Canada. The Cree, Inuit, and Naskapis practice subsistence hunting in Quebec per subsistence agreements. Recent annual harvests in Quebec totaled nearly 4,500 loons (primarily Common Loons) (J. Rodrigue, pers. com.). Harvest of Common Loons in Labrador is relatively rare (N. Burgess, pers. com.). Regular take and market sales in Greenland occur (J. Nyeland, pers. com.).

C. Commercial fishing activities

Common Loons are frequently incidentally captured in nets set by commercial and tribal fishing interests. This bycatch can be a substantial mortality event in some areas.

1. Breeding and migration

Commercial fishnet bycatch from freshwater areas, such as in northern Lakes Michigan and Huron and along the southern shore of Lake Superior, are well documented (Carey 1993). For decades, trap nets with long, strung-out wings (or leads), have been used by commercial and tribal fisheries to capture schools of salmonids (e.g., trout) and coregonids (e.g. whitefish). Loons are attracted to the fish activity and readily enter the heart area of the trap net. This part of the net is enclosed on top, and in deep areas, is completely submerged and often drowns the trapped loon. Shallow sets, where the top of the net is at the water surface, have an even greater impact. The loon is able to surface but remains trapped under the net and its struggling movements attract nearby loons that are eventually caught in the same way and drown (pers. obs.). Evers (1994a) sighted at least 50 migrant loons captured this way in one net over a one-week period on Lake Superior, Michigan.

Gill nets in large waterbodies across North America are regularly used by commercial and tribal fishing interests. In the 1960s and 1970s, Vermeer (1973) documented fishnet mortality in several lakes in the Northwest Territories and Manitoba.

2. Winter

A similar well-documented area in marine habitats is the mid-Atlantic coast from Long Beach, New Jersey south to Cape Hatteras, North Carolina. In the winter of 1998, Forsell (1999) documented bycatch in commercial gillnets and found 21% of the bird mortality (or 503 individuals) were Common Loons. Although the area's bycatch is even greater for the Red-throated Loon (*Gavia stellata*), the waterbird vulnerability index for the Common Loon was second only to the Red-throated Loon. The mid-Atlantic coast represents some of the higher densities of Common Loons for the Atlantic Coast and such an annual take constitutes a major threat to long-term conservation.



D. Marine oil spills

Marine oil spills are a major threat to seabirds, including the Common Loon (White and Frink 1991). Since the early 1900s, multiple oil spills have regularly accounted for loon mortality events numbering into the hundreds in Florida (Forrester et al. 1997). Several recent oil spills illustrate similar impacts in Alaska and New England. In March 1989, the Exxon Valdez spilled 11 million gallons of oil across approximately 1,300 miles of shoreline (Maki 1991) and killed an estimated 375,000 seabirds (Ford et al. 1996). Of that total, 216 Common Loon carcasses were recovered. Pre-spill loon counts compared to annual March counts since the spill indicates the Common Loon has still not recovered from the oil spill. In January 1996, the tank barge North Cape spilled 828,000 gallons of home heating oil off the Rhode Island coast, killing an estimated 400 loons (NOAA et al. 1999). Models based on the population dynamics of color-marked individuals indicate approximately 3,900 loon-years were lost. Unlike past mitigation efforts, on-site replacement of this injury was deemed logistically impractical. Therefore, state and federal trustees made a precedent-setting decision that the mitigation of this injury would instead focus on the purchase of lake shoreline breeding habitat in New England. The multi-million dollar injury that was paid by the responsible party for the loon-years lost was administered through the U.S. Fish and Wildlife Service (USFWS). In an effort to identify the highest quality breeding loon habitat, surveys were conducted in Maine and purchase priorities were related to the highest quality shoreline habitat. A six-year monitoring effort of productivity by the newly protected pairs will quantify an assessment of post-injury mitigation of loon-years lost. A similar approach may be used for assessing injury and compensating the lost of approximately 200 Common Loons killed during an oil spill in Buzzard's Bay, Massachusetts (Taylor et al. 2003).

E. Reservoir Management

Reservoirs are generally created by dams for hydro-electric and storage purposes. Some reservoirs are created by damming riverine habitat while others raise the water levels of existing lake basins. Therefore, in some cases new loon nesting habitat is created and in others nesting habitat is expanded. Hydrological management is generally dictated by the dam's purpose. Some reservoirs are used for water storage that may be needed by downstream users over a period of time (e.g., municipal water supplies or certain minimal flow requirements by pulp and paper mills). In these reservoirs, water levels generally peak after spring runoff and then slowly decline over the summer with another peak in fall. Many of these reservoir types are lowered considerably during the winter. Other reservoirs, including some with hydroelectric facilities (or peaking reservoirs), have daily water level fluctuations, as water spills through the facility to generate electricity during peak energy usage. In most scenarios, the loon's shoreline nests are impacted by either drawdowns or floodings. In the U.S., the Federal Energy Regulatory Commission (FERC) oversees the licensing of dams (Canada does not have a corresponding legal entity). Licenses are generally issued for 20-25 years. Within the past decade, FERC license renewals depend on settlement agreements that are collectively generated with the responsible company and resource stakeholders. The International Joint Commission (IJC) plays a similar role as FERC for reservoirs along the U.S. – Canadian border.



Increasing public concern about the impacts of dams on wildlife resources, including breeding loons, has generated a relatively new view on how reservoirs are managed. Historically, water level fluctuations from both storage and peaking reservoirs have had significant deleterious impacts to loon nesting success. Increasing water levels easily inundate nests while decreasing water levels isolate nests, increasing the difficulty of incubation exchanges as well as enhancing predation (Fair 1979). In Voyageurs National Park's Rainy, Namakan, and Kabetogoma Lakes in Minnesota an average of 60-70% of loon nests failed because of the hydrological regime (Reiser 1988). In the Rangeley Lakes' reservoirs in Maine, significant negative impacts to nesting loons by water level fluctuations were documented on Aziscohos Lake (Fair and Poirier 1993; DeSorbo and Evers 2001) and Richardson and Mooselookmeguntic Lakes (Savoy and Evers 2001a, b) until settlement agreements established changes in either water level management or instituted the use of rafts. For the past decade, FERC has increasingly commented on changing hydrological management schemes that minimize impacts to nesting loons. Relicensing efforts may now require either a steady water level throughout the nesting season (June and July) or mitigation of nest losses through a long-term artificial nest platform and monitoring program.

Because annual and summer water level fluctuations are significantly correlated with adult female and juvenile loon blood Hg concentrations ($p < 0.05$), reservoirs are also being investigated for their contribution toward methylmercury (MeHg) production and availability (Evers and Reaman 1998).

F. Contaminants

The use of piscivorous birds as indicators of aquatic contaminants is well-established (Peakall 1992; Burger 1993). The Common Loon serves that role for a variety of persistent bioaccumulative toxins including Hg (Evers et al. 1998, Meyer et al. 1998, Scheuhammer et al. 1998; Scheuhammer et al. 2001; Evers et al. 2003), Pb (Pokras and Chafel 1992, Franson et al. 2003, Scheuhammer et al. 2003), and organochlorines (Sutcliffe 1978, Fox et al. 1980, Frank et al. 1983, Haseltine et al. 1983; McIntyre et al. 1993). Conservation and research efforts have primarily focused on the exposure and impacts of Hg and Pb.

1. Mercury

a. Exposure:

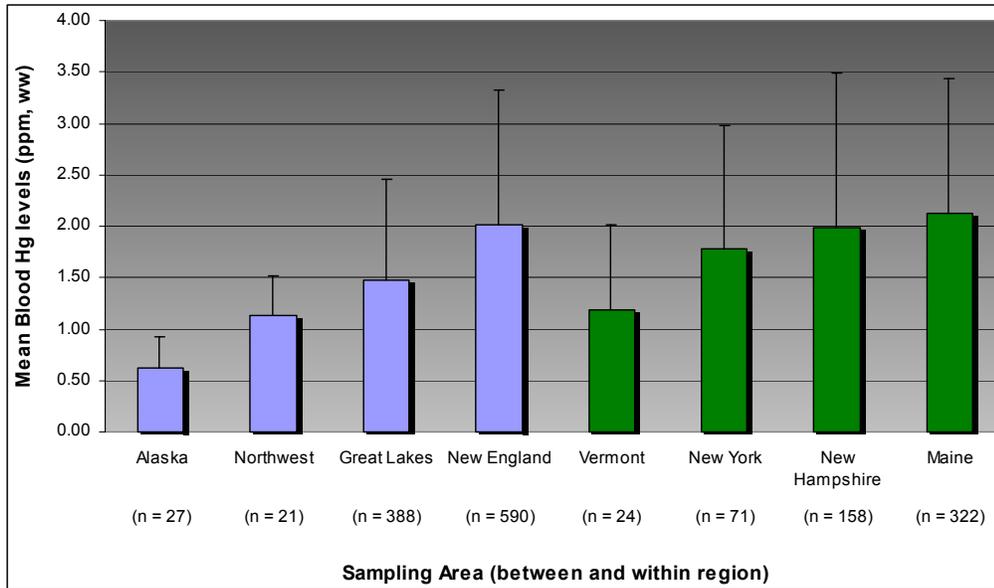
Exposure to Hg in aquatic wildlife is a serious threat in many parts of North America (Thompson 1996; Evers et al. 1998a; Wolfe 1998; Wolfe and Norman 1998; Spalding et al. 2000; Evers et al. 2003a). Mercury deposition and MeHg availability is now sufficiently elevated in the Northeast region to cause impacts on wildlife (Welch 1994; Burgess et al. 1998a; Nocera and Taylor 1998; Evers 2001b; Evers et al. 2003a). Based on the USEPA probability-based sampling efforts, Yearley et al. (1998) predicted that 98% of New England's lakes contained fish with MeHg levels "exceeding critical values for piscivorous birds". Recent efforts indicate that this prediction is too high, however, Evers et al. (1998a, 2003a) found Common Loons breeding in New York and New England had the highest mean blood and egg Hg levels in the United States, while juvenile loon blood Hg levels were four times those of the designated



reference site in Alaska. Because adult blood Hg levels strongly correlate with prey Hg levels, blood Hg levels represent MeHg availability from the nesting lake (Evers et al. 2002a). Egg Hg levels also represent prey Hg levels from the nesting lake as egg-female blood Hg levels strongly correlate (Evers et al. 2003a).

Although the sampling of loons indicates a west to east trend in geographic differences in MeHg availability across North America, (Figure 8), within-region differences are primarily related to the hydrological and biogeochemical factors documented by numerous studies (Watras and Huckabee 1994). In New England, within-region loon blood Hg levels appear to be similar in Maine, New Hampshire, and New York and tend to be lower in Vermont.

Figure 8. Mean blood Hg levels (+/- SD) of adult Common Loons in U.S. regions and within New England.



Outside of New England and New York, Hg “hotspots” have been identified in many other areas across the loon’s breeding range including north-central Wisconsin and the western Upper Peninsula of Michigan (Evers et al. 1998a, 2003a; Meyer et al. 1998; Fevold et al. 2003), a small area in northeastern Minnesota (Counard 2001), acidified lakes in central Ontario (Scheuhammer and Blancher 1994; Scheuhammer et al. 2001), western Quebec (Champoux et al. 2004), and certain lakes associated with mining activities in British Columbia (A. Scheuhammer, pers. com.). An area with some of the highest recorded loon blood Hg levels in North America is Kejimikujik Provincial Park, Nova Scotia; loon blood Hg levels are often >7.0 ppm (wet weight, ww) and these levels have been related to significantly lower loon productivity (Burgess et al. 1998a). Many of these “hotspots” exist because lake hydrology and biogeochemistry creates conditions for elevated MeHg availability.



Although it is now well-established that the availability of MeHg is high in the Northeast, and that Hg sources for these areas are generally of atmospheric origins (NESCAUM 1998), there are other areas of the loon's North American range where "hotspots" are effluent-based. Some of these, such as the English-Wabigoon River system in western Ontario, are areas where large amounts of Hg were released directly into the aquatic environment from a historic chlor-alkali plant. This well-studied Hg "hotspot" had areas where loon reproductive success was severely hampered. Barr (1986) found impaired reproduction when prey fish Hg levels exceeded 0.30 ppm (ww) and no reproduction when fish exceeded 0.40 ppm (ww). Long-term monitoring programs now show this area to have less Hg in the system (Parks 1988; Parks et al. 1991).

Other sites are more problematic when pinpointing the source of Hg. Loons use Walker Lake in Nevada as a migratory staging area on their way to their Saskatchewan breeding areas (Yates et al. 2002a). This cohort of loons likely overwinters on marine environs near Baja California. Blood and feather samples of these migratory loons when captured on Walker Lake indicate extreme contamination with Hg. Some individual loons have blood Hg levels >9.0 ppm (ww) and 52% are over 3.0 ppm (ww) (Seiler et al. 2003). Further studies are being conducted to determine Hg source and potential Hg contamination in nearby lakes or on the wintering areas (Yates et al. 2002a), however, known Hg contamination of nearby waterbodies indicates local inputs (Henny et al. 2002; Seiler et al. 2003).

Mercury exposure does not appear to be as severe in marine environments where loons overwinter compared to breeding lakes. For example, loons captured and blood sampled in mid-winter on the Pacific Coast, Gulf of Mexico, and Atlantic Coast had blood Hg levels <1.0 ppm (ww) (n=89, BRI, Unpubl. data).

b. Effects:

Geographic characterization of loon Hg exposure profiles has been quite thorough, however, understanding the effects, particularly at the population level is still not well-known. Research by several investigators in the past decade have provided corollary evidence relating Hg exposure with differences in behavior, physiology, reproduction, and survivorship. These findings include behavior modifications in chicks (Nocera and Taylor 1998; Counard 2001) and increased lethargy in adults (Evers et al. 2003b). As body burdens of Hg increase one of the more obvious behavioral changes is the decrease in time spent on the nest by incubating adults. Incubating pairs with blood Hg levels >4.0 ppm (ww) incubated their eggs for 85% of the time. Whereas in controls, where Hg levels were <1.0 ppm (ww), they incubated their eggs 99% of the time (Evers et al. 2003b). In contrast to field studies, Hg-dosing trials for laboratory-reared loon chicks documented no overt effects at Hg levels found across North America (Kenow et al. 2003b). Rapid excretion of Hg through the feathers likely provided protection against Hg toxicosis (Fournier et al. 2002; Kenow et al. 2003b).

Measurable effects of Hg on loon productivity have been documented in at least three areas of North America. Barr (1986) found Ontario loons had impaired reproduction when fish Hg levels were >0.30 ppm (ww). In the Canadian Maritimes, Burgess et al. (1998) found a significant inverse relationship with loon productivity and blood Hg levels. In Maine and New Hampshire, Evers et al. (2003b) had similar findings, in which loons with blood Hg levels >3.0 ppm (ww)



produced 37% fewer fledged young than the control group of loons with blood Hg levels <1.0 ppm (ww) (n=217 territories and 946 territory-years). Physiological changes are also known where loons with high blood and feather Hg levels have significantly (1) higher corticosterone levels, (2) greater flight feather asymmetry (Evers et al. 2003b), and (3) smaller egg mass (Evers et al. 2003a).

c. Risk Assessment

Based on findings from numerous studies investigating the exposure and combined behavioral, physiological and reproductive effects of Hg in loons and other waterbirds a preliminary risk matrix is possible (Table 9). The estimated risk of Hg to loons can be separated into four broad categories: (1) Low risk represents a no observed adverse effect level (NOAEL) and is suitable for use as a control; (2) Moderate risk represents Hg levels that have an unknown impact to loons; (3) High risk indicates documented significant differences in behavioral, physiological, and reproductive endpoints from “controls;” and (4) Extra High risk represents overt effects from Hg such as nest abandonment and little or no reproduction.

Table 9. Preliminary risk matrix using four categories for Hg (ppm) in the Common Loon.

Matrix	Type	Low	Moderate	High	X High	Reference Base
Egg	ww ¹	0-0.5	0.5-1.3	1.3-2.0	>2.0	Evers et al. 2003
Blood-Adult	ww	0-1.0	1.0-3.0	3.0-4.0	>4.0	Burgess et al. 1998a, Evers et al. 2003b
Feather	fw ¹	0-9	9-20	20-35	>35	Thompson 1996, Evers et al. 2003b

¹ Weight wet (ww) and fresh weight (fw)

Characterization of the potential Hg risk to Common Loon populations can be based on such a risk matrix. Large-scale opportunistic sampling efforts provide an appropriate approach for extrapolating potential Hg risk across geographic areas of interest. A geographic profile assessing potential risk to Hg has been developed for blood (Figure 9) and eggs (Evers et al. 2003b). There is general agreement between these two, independently sampled tissues across North America. Maine breeding loon populations are potentially most at risk (30%) and between 13% and 19% of the other New England loon populations are at risk to Hg effects. Evers et al. (2003b) showed similar risks to breeding loon populations using egg Hg levels.

A more statistically rigorous approach that randomly selects lakes further provides confidence while characterizing an area for Hg risk. This probability-based sampling method is currently being conducted in Maine, New Hampshire, New York and Vermont using U.S. EPA random sampling schemes developed by the Regional Environmental Monitoring Program (REMAP). Comparisons of results-to-date indicate similar risk assessments between the two sampling strategies/

Results from national risk assessment studies indicate that northeastern North America has the greatest risk to potential population level impacts for Common Loons. Although individual level impacts have been shown by several studies, ecological policy and management are based on population-level effects. A collaborative approach among state and federal agencies and many nongovernmental organizations and companies now provides the information needed to estimate population-level impacts by linking a spatially-explicit population model for New England



(Figure 5) with tissue Hg data. According to this approach, states with lower Hg risk such as Vermont are not impacted at the population-level, however, high Hg risk areas such as parts of Maine and particularly in Kejimikujik National Park show negative population trends. Further investigations into the correlation of Hg levels and loon reproductive success are needed.

Another method to assess potential risk of Hg in loons is with a wildlife criterion value (WCV). A generic, national WCV has been derived for Hg by the USEPA (Nichols et al. 1999). A WCV basically identifies the amount of Hg in the water column that is deemed harmful to wildlife. The model establishes linkages among (1) water column Hg, (2) fish Hg for various trophic levels, and (3) Hg levels of a high trophic level species of wildlife that, ideally, can be related to population-level effects. The model's formula basically uses a test dose with associated uncertainty factors as the numerator and ingestion of Hg as the denominator. Development and refinement of a spatially-explicit WCV for Maine and New York is currently ongoing and will provide a high-resolution model based on impacts to Common Loons (Evers et al. 2003b). This version uses a population-level endpoint in the model with *in situ* measurements versus the USEPA model that was based on individual-level endpoints in captivity.

2. Lead

Lead affects nerve impulse transmission causing systemic paralysis. This neurological dysfunction is the source of many of the clinical signs of acute Pb poisoning such as head-shaking, gaping, wing and eye droop. Chronic toxicosis has been associated with immunosuppression, decreased weight, body fat and muscle mass (Sidor et al 2003, M. Pokras, pers. com.). Other in-field diagnostic symptoms include green feces, disorientation and lethargy causing less frequent dives in depth and duration, increased occurrence in shallow waters and frequent bouts of beaching with progression of condition (K. Taylor, pers. com.). Lethargic behaviors may predispose lead-poisoned loons to boat collisions (Miconi et al. 2000).

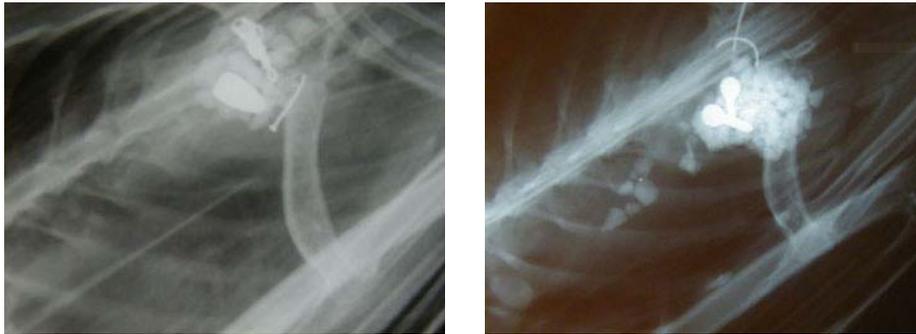
Lead poisoning resulting from the ingestion of Pb fishing tackle has been identified as a significant cause of Common Loon mortality throughout Eastern Canada and the United States. The toxic effects of Pb are well documented and confirm a direct link between ingestion of Pb fishing tackle and mortality (McIntyre 1988; McNicholl 1988; Ensor et al. 1992; Pokras and Chafel 1992; Franson et al. 1993; Pokras et al. 1993; Poppenga et al. 1993; Scheuhammer and Norris 1996; Miconi et al. 2000, Franson et al. 2003, Sidor et al. 2003). In a nationwide waterbird study (based on live bird sampling), Franson et al. (2003) found loons to have the highest incidence of Pb ingestion (3.5%). In New England, a 14-year study diagnosing causes of mortality in 522 Common Loons documented 44% of the breeding adults died from Pb toxicosis (Sidor et al. 2003). Substantial rates of Pb-related mortality are also known for Michigan (T. Cooley, pers. com.) and Minnesota (P. Perry, pers. com.).

Radiographs were used *in situ* to document Pb ingestion (Franson et al. 2003) and relate blood Pb levels from wild birds. Blood Pb concentrations in live-captured loons without Pb in the gizzard average less than 0.05 ppm and range up to 0.12 ppm (BRI, unpubl. data). Based on the live recovery of beached New Hampshire loons with Pb poisoning (as proven by radiographs) (Figure 9), and follow-up monitoring, most or all loons die after ingesting Pb sinkers. Blood Pb levels of these dead loons ranged from 0.24 to 0.80 ppm, ww (LPC, unpubl. data; n=21). The



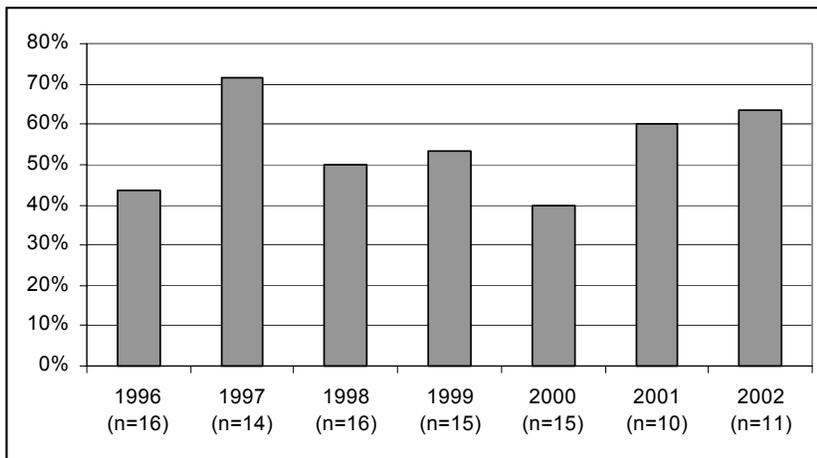
Canadian Wildlife Service found Pb sinkers or Pb-headed jigs in all loon carcasses with lethal concentrations of Pb in the liver (Scheuhammer and Norris 1996).

Figure 9. Pb objects radiographed in the gizzards of two different Common Loons.



Population-level impacts from the ingestion of Pb objects are unclear and requires further investigation (Scheuhammer et al. 2003). However, mortality of adult loons from ingestion of Pb sinkers or jigs can be locally significant. In New Hampshire, the ingestion of Pb sinkers and jigs accounted for 40 to 71% of identified annual adult mortality during an ongoing study (Figure 10). Further analysis of the New Hampshire database reflects highest rates of mortality during July (even though loons are present on their breeding territories from May through September)

Figure 10. Mortality rate of Common Loons through ingestion of lead sinkers and jigs in New Hampshire, 1996-2002¹.



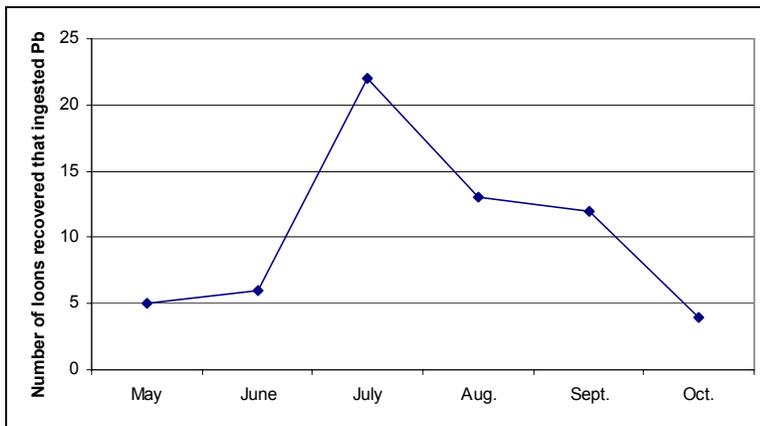
¹Sample size reflects total number of dead adult loons recovered for each year (LPC, unpubl. data).

(Figure 11). The timing of Pb deaths and the presence of associated tackle in the gizzard suggests that a significant proportion of Pb is ingested is of recent introduction into lake systems. Ingestion of sinkers from the reservoir of Pb tackle lying on lake bottoms along with pebbles to aid in digestion might not be as prevalent as was once thought. Therefore, efforts to limit the use



of Pb tackle, if enforced, have the potential to result in a marked decline in Pb deaths in a short period of time (H. Vogel, pers. com.).

Figure 11. Monthly mortality rate of Common Loons from Pb sinkers and jigs in New Hampshire, 1992-2002¹.



¹LPC unpubl. data.

3. Organic Pollutants

Unlike Hg and Pb, organic pollutants are predominantly anthropogenically produced and are recent additions to the natural environment. A period of evolutionary acclimation is missing, thus making these synthetic compounds potentially very damaging. The impacts of organochlorine insecticides (i.e., DDT and its derivatives, such as DDE) are well known in thinning eggshells and causing regionwide population declines in Bald Eagles, Brown Pelicans (*Pelecanus occidentalis*), Peregrine Falcons (*Falco peregrinus*), and Osprey. However, impacts to loon eggshells analyzed in the 1960s and 1970s were minimal and apparently did not cause local reproductive impacts (Vermeer 1973, Gilbertson and Reynolds 1974, Ream 1976, Sutcliffe 1978, Fox et al. 1980, Frank et al. 1983, McIntyre et al. 1993). Geographically comparable studies in Ontario (Frank et al. 1983) and in New Hampshire (Hasteltine et al. 1983; McIntyre et al. 1993) indicate overall declines in DDE, as well as another organic pollutant, polychlorinated biphenyl (PCBs). Few recent examinations of organic pollutants have been made. In the mid 1990s, organochlorine insecticide scans on eggs (DDE, PCBs, dieldrin, heptachloradane, etc) found low levels in the Rangeley Lakes area of Maine (BRI, unpubl. data) and across other parts of New England (M. Pokras, pers. com.). Analysis of other organic pollutants such as polychlorinated dibenzodioxins (PCDDs), polychlorinated dibenzofurans (PCDFs), organophosphorous insecticides (OPs), polycyclic aromatic hydrocarbons (PAHs), and other insecticides and herbicides have rarely been measured in loon tissues.

G. Acid Rain

Atmospheric pollution of sulphur oxides (SO_x) and nitrogen oxides (NO_x) has long-range transport abilities and is deposited as “acid rain” (sulphuric and nitric acid). Acid rain has been



documented for more than a century (Cowling 1982), however, it was not until the mid-1970s that research on levels and effects in North America began in earnest. Federal directives including the U.S. National Acid Precipitation Assessment Program (NAPAP) and the Canadian Long Range Transport of Air Pollutants (LRTAP) Program were instituted in the 1980s and by the mid-1980s reductions of SO₂ and NO_x began. However, even though improvements have been shown in the 1990s there appears to be a large number of lakes that lack the required buffering capacity and show little or no change (Clair et al. 1995). Parts of eastern Canada, including southern Ontario and Quebec and the Canadian Maritimes, and parts of the U.S. including northcentral Wisconsin, western Upper Peninsula of Michigan, and New York are areas of overlap between acid rain impacts and the loon's breeding range.

Reproductive success of piscivorous birds is affected by acid rain because of changes in ecological processes. Increasing acidity negatively impacts invertebrate species richness (McNicol et al. 1995a) and fish species richness and abundance (Matuszek and Beggs 1988). The relationship of acid rain to wildlife is complex though, because lowering pH (1) increases water transparency (which likely contributes to higher foraging efficiency for visual predators (Eriksson 1985) and (2) changes heavy metal concentrations of aluminum (Scheider et al. 1979) and Hg (Winfrey and Rudd 1990) in the lake and its watershed.

Yellow perch, one of the loon's favored prey items (Barr 1996), are generally tolerant at pH levels >5 (although lower tolerances are known in lakes with high organic loads, Burgess et al. 1998b) and therefore provide prey for loons on mildly acidified lakes. However, highly acidic lakes in Ontario (total alkalinity < 40 uequiv./L) were significantly correlated with increased brood mortality (Alvo et al. 1988); a decline in breeding success on highly acidic lakes was also documented by Ashenden (1988). Further and more rigorous efforts by Alvo (1996) documented the relationship of loon reproductive success and lake acidity: (1) fledging success is highly unlikely at a lake pH of 4.0 to 4.3 (regardless of lake size); (2) high brood mortality is consistent on some lakes with a pH of 4.4 to 5.8 (particularly small ones); and (3) acidity-related brood mortality can occur on lakes with 6.3 pH. On fishless lakes, adult loons will commonly forage on a neighboring lake while chicks are fed invertebrates (Alvo et al. 1988, Parker 1988). Invertebrate diets are generally considered energetically insufficient for successful fledging (Alvo et al. 1988). Exceptions of adaptive adult foraging behaviors are known (Parker 1985). Several other investigators have documented lower loon productivity on acidic lakes (McNicol et al. 1987, 1995b; DesGrange 1989; Kerekes et al. 1994). In eastern Canada, an estimated 150,000 lakes had a pH < 6.0 in the mid-1980s (Kelso et al. 1986). Although acid rain emissions have been reduced with associated evidence of improvement in one-third of Canada's lakes (Clair et al. 1995), the remaining magnitude of acidic lakes and new findings by Alvo (1996) on impacts to loons indicate potential continued effects. Doka et al. (2003) predict continued impacts to biota in lake ecosystems of southeastern Canada unless further reduction in sulphate deposition is implemented.

Lastly, acid rain and its associated acidification processes increase net MeHg production by enhancing microhabitat for monomethyl bacteria. Therefore, lakes that become more acidic also have a tendency to increase in MeHg availability to the biota. Meyer et al. (1995) found chicks with blood Hg levels < 0.3 ppm (ww) had lower survival rates on lakes with a pH < 6.3. In



Ontario, fish Hg levels had a negative correlation with lake pH and was linked with reproductive risk to loons on 30% of the study lakes (Scheuhammer and Blancher 1994).

H. Botulism, Aspergillosis, and other diseases

Botulism is a disease caused by the bacteria, *Clostridium botulinum*, in the Great Lakes, and *C. perfringens* in marine environments (McIntyre 1988). These bacteria are categorized into different types based on the characteristics of the neurotoxins that are produced. These neurotoxins have paralytic impacts with diagnostic symptoms of weakness and disorientation that result in an inability to fly or maintain an upright posture. While type C is a relatively common and widespread disease in waterfowl, type E has been linked with multiple loon mortality events in Lake Michigan from 1963 to 1981 (Kaufmann and Fay 1964, Fay 1966, and Brand et al. 1983, Brand et al. 1988). This period was responsible for an estimated 7,400 loon deaths (McIntyre 1988) and may be related to extreme, late-summer to fall lake level declines that facilitate the botulism outbreaks (Fuller and Shear 1995). Alewife (*Alosa pseudoharengus*) and American smelt (*Osmerus mordax*), both introduced species, were common forage fish that carried the botulism disease. Abundance of alewife, in particular, has been linked with botulism-related loon mortality events (Fay 1966, Brand et al. 1988).

Recently, another suite of alien species have become established in Lake Erie and are now the forage base link for further loon dieoffs (Roblee 2002). Complex links among (1) water level fluctuations, (2) introduced zebra mussel (*Dreissena polymorpha*) and quagga mussel (*Dreissena bugensis*), and (3) the introduced mollusk-feeding, round goby (*Neogobius melanostomus*) may be responsible for bioconcentrating botulism neurotoxins and increasing availability to piscivorous birds in the fall. During the falls of 2000 through 2003 aerial and shoreline transects conducted by the New York State Department of Environmental Conservation estimate that upwards of 10,000 Common Loons have died from botulism type E on both the U.S. and Canadian side of Lake Erie (K. Roblee, pers. com.). In 2002, the type E strain was found in Lake Ontario and there are concerns that similar mortality events could happen. Because the Common Loon migration through Lake Ontario is significantly much greater than Lake Erie, more serious population-level effects could be forthcoming.

Aspergillosis is a fungal disease of the respiratory tract (Wobeser 1981). *Aspergillus fumigatus* is widely distributed and can produce large numbers of spores within days in warm and moist conditions (such as the lungs of birds). Birds usually become infected by inhaling air containing spores or by ingesting spores while feeding on or near the contaminated sources. Transmission and development of aspergillosis depends on five conditions: (1) the number of spores in the air, (2) the length of the bird's exposure, (3) the age of the bird, (4) the physiological state of the bird and (5) the opportunistic organisms present (Michigan DNR 2002). During the early infection stages, the spores on the walls of the respiratory system and air sacs develop and branch into yellowish nodular masses. Eventually the air passages become blocked and the fungus covers the walls of the bronchi and trachea. Loons are very prone to aspergillosis infection, particularly if their immune system is weakened. This fungal disease is the primary reason why loons do not survive long in captivity. Prevalence of aspergillosis in breeding populations was 2% in Ontario (Frank et al. 1983), and 2% in New England (Miconi et al. 2000). In Minnesota, Ensor et al. (1992) found that 7% of the dead and dying loons sampled indicated severe cases of



aspergillosis. Forrester et al. (1997) documented 7% of a large sample of wintering loons in Florida with aspergillosis; an early component of that database included several cases of *Salmonella* (White et al. 1976). Aspergillosis is usually considered a secondary infection that follows stress from disease, nutritional deficiencies, or other primary reasons that suppress the immune system.

I. Emaciation Syndrome

Birds become emaciated for many reasons that are based on physical injuries and physiological limitations. However, Forrester et al. (1997) surmised that emaciation syndrome is a regular mortality problem for wintering Common Loons and may even be one of the greatest threats to this species. They described an ecological string of events where inclement cold weather and storm-induced turbidity of feeding areas causes stress. During and following such weather events, loons generally need to switch foraging emphasis from fish to crustaceans. Compared to fish, crabs and shrimp have higher salt and parasite loads, which they concluded result in increased physiological stress in loons. Usually, loons are able to withstand such dietary changes, however, during concurrent energetically-demanding physiological changes, such as simultaneous remigial molt, an imbalance may occur. Greater-than-normal physiological stress would result in (1) increased metabolism of fat reserves and catabolism of muscle tissue, (2) remobilization of contaminants stored in both fat (i.e., organochlorines) and muscle (i.e., Hg), and (3) finally, behavioral changes that would impact foraging efficiency. Loons therefore starve and die from emaciation. Sptizer (1995) described a similar scenario for wintering loons along the mid-Atlantic Coast. Emaciation syndrome has also been documented on the breeding grounds and was considered responsible for 12% and 20% of the dead loons collected for studies in Ontario (Frank et al. 1983) and Minnesota (Ensor et al. 1992), respectively. The large die-off of wintering loons documented by Alexander (1991) in the early to mid-1980s in Florida's panhandle is attributed to emaciation syndrome by Forrester et al. (1997). An estimated 13,000 loons died during an epizootic event in late winter of 1983 (Forrester et al. 1997).

X. Monitoring Activities

BioDiversity Research Institute is based in Maine and collaborates with many state and federal agencies and non-governmental organizations across North America. Collaborations are generally research-oriented but many times also include regular, standardized monitoring efforts. Long-term monitoring efforts are primarily in Maine, Massachusetts, and Michigan. This group oversees most of the loon capture, color marking and banding in North America.

The *National Park Service* actively monitors loon distribution and breeding success with an emphasis in Parks with breeding loon populations; these include Acadia (Maine), Glacier (Montana), Isle Royale (Michigan), Voyageurs (Minnesota), and Yellowstone (Wyoming) National Parks.

The *U.S. Fish and Wildlife Service's Office of Migratory Bird Management* monitors breeding and wintering loon populations across North America. Most monitoring activities during the breeding season are based on aerial surveys and are standardized counts conducted over large regions to determine breeding waterfowl populations. During these counts, Common Loons are



also regularly counted. Similar aerial surveys for wintering waterfowl are also conducted with a secondary emphasis on counting loons. National Wildlife Refuges also actively count loons with a special emphasis on breeding populations. Most refuges with breeding loon populations contribute to standardized ground counts, including Kenai (Alaska), Seney (Michigan), and Umbagog (New Hampshire and Maine), or aerial counts including most of the larger Alaskan refuges.

The *Canadian Wildlife Service* also conducts aerial surveys of breeding and wintering loons, often times during waterfowl population counts. Some extra efforts also occur, particularly in National Parks including Kejimikujik (Kerekes et al. 1994) and La Maurice (Kerekes and Masse 2000).

A. Breeding

Canada

Unlike the U.S., Canadian provinces generally lack high resolution monitoring efforts by local governmental agencies or nonprofit groups. One exception is the Canadian Lakes Loon Survey (CLLS). Concern about the effects of acid rain and other human disturbances on loons led to the creation of this organization. The CLLS, an affiliate of Bird Studies Canada (www.bsc-eoc.org) is a long-term project designed to monitor the numbers and breeding success of loons on lakes across Canada.

New England and New York

In **Maine**, there are four major groups that monitor loon numbers. *FPL Energy Maine Hydro* (www.fplenergy.com) works from a proactive standard whereby high resolution productivity information is collected through weekly monitoring efforts. Alongside this is the emphasis to mitigate the impacts of water level fluctuations on their reservoirs through intensive use of artificial nesting islands, in addition to managing river flows to meet the habitat needs of nesting loons. The *Maine Audubon Society* (www.maineaudubon.org) conducts an annual snapshot census on the southern half of Maine and extrapolates population size and trends from this count. This group also publishes fact sheets for the general public and lobbies the state legislature. *Maine Inland Fisheries and Wildlife* (www.state.me.us/ifw) conducts intermittent aerial surveys to estimate breeding loon populations in northern Maine. Coastal populations are accounted for by aerial surveys in the winter. *BioDiversity Research Institute* (www.BRILoon.org) monitors >200 loon territories in the Rangeley Lakes area, and other loon populations across Maine.

In **Massachusetts**, from 1975 through 2000, the *Massachusetts Division of Fisheries and Wildlife Service* (www.state.ma.us/mdc) conducted annual state loon surveys in association with the Department of Conservation and Recreation (MDCR). The MDCR manages and protects the drinking water supply watersheds primarily in Greater Boston, and contracts *BioDiversity Research Institute* (www.BRILoon.org) to monitor loon pairs on those watersheds. Formed in 2002, the *Massachusetts Aquatic Conservation Society* (www.macsloon.org) monitors and surveys for loons not occurring on MDCR reservoirs.



In **New Hampshire**, the *Loon Preservation Committee* (LPC; www.loon.org), a self-funded project of the Audubon Society of New Hampshire, has provided intensive loon monitoring, management and research since 1976. Seasonal staff, whose efforts are supplemented and supported by a vast network of lake volunteers, conduct statewide surveys. The Loon Preservation Committee has set precedents in the use of artificial nesting islands, and conducts collaborative research into Pb, Hg, demographics and human disturbance. The Loon Preservation Committee works with FPL Energy Maine Hydro and the Lake Umbagog National Wildlife Refuge to monitor breeding loons on Lake Umbagog.

In **New York**, the *Adirondack Cooperative Loon Program* (ACLP; www.adkscience.org/loons) conducts research to determine the status and trends of the breeding loon population in the Adirondack Park of New York State, and the effect of Hg contamination and human interactions on this population's reproductive success. ACLP also seeks to minimize anthropogenic impacts on loon populations and other wildlife through public education. Initiated in 2001, the ACLP is a partnership of the Wildlife Conservation Society (www.wcs.org), Natural History Museum of the Adirondacks (www.adknature.org), New York Department of Environmental Conservation (www.dec.state.ny.us), BioDiversity Research Institute (www.BRILoon.org) and the Audubon Society of New York (www.audubonintl.org).

In **Vermont**, the *Vermont Loon Recovery Program* (www.vinsweb.org) is a joint venture of the Vermont Institute of Natural Science and the Nongame and Natural Heritage Program of the Vermont Department of Fish and Wildlife (www.anr.state.vt.us/fw/fwhome). This group conducts a statewide monitoring and management program for Common Loons.

Upper Great Lakes

In **Michigan**, the *Michigan Department of Natural Resources* (www.dnr.state.mi.us) funds Lake Superior State University (www.lssu.edu) to conduct annual surveys to estimate statewide populations. The nonprofit *Michigan Loon Preservation Association* (www.michiganloons.org) uses volunteer observers to also monitor loons in the state and works to conserve and enhance the loon populations through research, habitat protection and restoration, and public awareness and involvement. The nonprofit organization, BioDiversity Research Institute, has been monitoring loon numbers and productivity for many years in collaboration with Isle Royale National Park (www.nps.gov/isro), Hawatha (www.fs.fed.us/r9/forests/hiawatha) and Ottawa (www.fs.fed.us/r9/ottawa) National Forests, and Seney National Wildlife Refuge (<http://midwest.fws.gov/seney/>).

In **Minnesota**, the Minnesota Division of Ecological Services (www.dnr.state.mn.us/ecological_service) oversees statewide monitoring of loons using volunteer observers as part of the Minnesota Loon Monitoring Program (MLMP) (http://www.dnr.state.mn.us/ecological_services/nongame/projects/mlmp_results.html). Since 1994, nearly 1,000 volunteers have annually collected information on breeding loons in six, 100-lake index areas of the state. MLMP provides an early warning system for detecting statistical changes in the largest loon population of the contiguous U.S. The National Park Service monitors breeding loon populations at Voyageurs National Park (www.nps.gov/voya). Federal protection of loons also includes the Chippewa (www.fs.fed.us/r9/chippewa) and Superior



(www.fs.fed.us/r9/superior) National Forests and Tamarack National Wildlife Refuge (<http://midwest.fws.gov/Tamarac>).

In Wisconsin, the *LoonWatch* program of the Sigurd Olson Environmental Institute of Northland College (www.northland.edu/soei/loonwatch.html) works through education, monitoring, and research to protect and restore loon populations and habitats in the state and the greater Lake Superior region. LoonWatch coordinates a volunteer program to monitor the health of loons and their population trends in Wisconsin, presents an annual loon research award, organizes educational programs, distributes informational resources, and collaborates with the Wisconsin Department of Natural Resources Nongame Wildlife Management (www.dnr.state.wi.us/org/land/wildlife) to improve lake management practices. Federal protection of loons includes areas on the Chaquamegon-Nicole National Forest (www.fs.fed.us/r9/cnnf).

Western U.S. and Alaska

In Alaska, the USFWS (<http://alaska.fws.gov/>) monitors breeding loon populations in the Anchorage Bowl, Mat-Su Valley, Kenai Peninsula, and other areas of southcentral Alaska through aerial surveys and a volunteer-based program called the Alaska Loon Watch. The USFWS also oversees statewide monitoring activities through aerial surveys conducted during waterfowl counts. The Anchorage Audubon Society (www.anchorageaudubon.com) assists with loon conservation and monitoring in the Anchorage Bowl and the Mat-Su Valley through education programs such as the LoonCam and Loon Festivals.

In Idaho, the Idaho Fish and Game Department (www.state.id.us/fishgame) works with the U.S. Forest Service Idaho Panhandle National Forest (<http://www.fs.fed.us/outernet/ipnf/>) in monitoring the handful of territorial loon pairs.

In **Montana**, population surveys are conducted by volunteers and biologists, whose efforts are coordinated by the *Montana Common Loon Working Group* (CLWG) and supported by the *Montana Loon Society* (www.montanaloons.org). Individual nesting pairs are monitored at known occupied lakes, and at potential sites identified in the Loon Management Plan. Usually during the third weekend of July, the mid-summer "loon day" is conducted to provide a close estimate of the total population, number of pairs with chicks, total production, and number of unsuccessful pairs. Beginning in 1999, the CLWG coordinated an additional occupancy check at known and potential territories in mid-May. Annual migration counts in spring and fall are being initiated at important migration staging areas (e.g. Canyon Ferry Lake and Pablo Reservoir, etc.). The Flathead National Forest (www.fs.fed.us/r1/flathead) contributes to loon awareness programs and Glacier National Park (www.nps.gov/glac) conducts surveys.

In Nevada, the Nevada Fish and Game Department (www.ndow.org) collaborates with the Boise State University-Raptor Research Center to monitor the migration of loons at Walker Lake and nearby lakes.

In **Washington**, the nonprofit *Loon Lake Loon Association* (www.loons.org) was formed around concerns of struggling breeding Common Loon populations in the Pacific Northwest. This group



coordinates volunteer loon survey efforts with the Washington Department of Fish and Game (www.wa.gov/wdfw), U.S. Forest Service's Okanogan and Colville National Forests (www.fs.fed.us/r6/oka), and the Confederated Tribes of the Colville Reservation (www.colville-tribal.com).

In Wyoming, the National Park Service monitors breeding loon activity in *Yellowstone National Park* (www.nps.gov/yell/home) while those pairs outside the Park are monitored by the *Wyoming Game and Fish Department* (www.gf.state.wy.us). The states' efforts began in 1989 and include the tracking of migration activities at important staging areas.

B. Winter

The *National Audubon Society* (www.audubon.org) organizes a long-term monitoring program called the Christmas Bird Count. The data collected by volunteer participants provide a snapshot of early winter bird populations across North America. More than 50,000 observers participate each year, from 14 December to 5 January in the census of early-winter bird populations. The results provide trends of early-winter bird populations.

Each January, the *U.S. Fish and Wildlife Service, Office of Migratory Bird Management* (www.migratorybirds.fws.gov) conducts annual, mid-winter aerial surveys for waterfowl. Ancillary survey information includes data on loon distribution and density. In many areas the U.S. Fish and Wildlife Service collaborates with the *Canadian Wildlife Service* (www.cws-scf.ec.gc.ca) and state and provincial wildlife management agencies. This is a nationwide effort that provides standardized information on population trends. Because of the emphasis on waterfowl, little data analysis has been conducted.

C. Migration

Cape May, New Jersey: The New Jersey Audubon Society (www.njaudubon.org) conducts seabird migration monitoring on Cape May (Avalon Sea Watch). Fall migration counts from 1993 to 1998 documented a range of 3,231 to 5,026 Common Loons. Peak counts range from late October and early November.

Cayuga Lake, New York: As part of efforts sponsored by Cornell Lab of Ornithology (www.birds.cornell.edu), standardized fall migration counts are conducted on Cayuga Lake, New York. Efforts have documented more than 8,000 Common Loons peaking in late October and early November (Evans et al. 1994). This count has related major migratory movements with northwesterly winds. There are two documented pulses in the migration; one near daybreak lasting 45 minutes and, after a 30-minute gap in observations, a second and larger pulse consisting of high altitude migrants. These overland migrants use high altitudes (Kerlinger 1982), probably en route to Chesapeake Bay.

Hamilton Beach, New York: Along southern Lake Ontario, Braddock Bay Raptor Research Center (www.bbbo.org) sponsors a standardized count on the fall loon migration (Sherony et al. 2000). Ewald and Sherony (2000) summarized results for the Common Loon migration. Fall migration from 1993 to 1999 ranged from 3,934 to 16,846 Common Loons (average = 7,588 +/- 4,527). Peak migration ranges from 16 October to 14 November. They speculated that this



migration cohort is different than the one using the Cayuga Lake corridor to Chesapeake Bay; it has a more westerly direction and likely moves south across western Pennsylvania (similar to the Red-throated Loon, Sherony et al. 2000).

Southern California locations: The southern Pacific Coast migration of loons was quantified for the fall and spring flights near Pt. Magu by Long (1998). Few Common Loon migrants were counted (<600 in the fall and <200 in the spring; fall migration began in early November while spring migration began in mid March). Standardized counts were not conducted. Compared to Common Loons, far more Red-throated (80% of the 3,758 fall loon migration) and Pacific Loons (86% of the 5,872 spring loon migration) were documented at Pt. Magu.

Whitefish Point, Michigan: On the southeastern end of Lake Superior, Whitefish Point Bird Observatory (www.wpbo.org) conducts standardized annual counts of spring (since 1984) and fall (since 1989) migration. It is well established that the timing of peak spring migration is in the early morning hours of the first week of May (Ewert 1982). This cohort of loons uses northern Lake Huron as a staging area and the Sault St. Marie River as a migration corridor (Sanders 1993). The magnitude of spring migration is greater than fall migration. Spring migration from 1984 to 1995 ranged from 3,840 to 10,278 (average = 6,815 +/- 2,285) and fall migration from 1989 to 1995 ranged from 2,115 to 5,085 (average = 3,200 +/- 993) (Evers et al. 1996). Actual total migration through the Sault St. Marie River corridor may be three times the counts at Whitefish Point (Sanders 1993). Annual variations documented at Whitefish Point could be related to weather-dependent migration alteration and/or actual population changes.

XI. Management Activities

A. Hydrological regime

In New England, reservoirs that have undergone FERC relicensing in the past decade have increasing scrutiny by area stakeholders. Subsequent settlement agreements for reservoirs with breeding loons have resulted in stringent management mandates to ensure loon sustainability. Two primary hydrological regimes are used to manage reservoir water levels for optimum loon productivity. For reservoirs that have the hydrological flexibility for maintaining relatively steady water levels, loon nests are most successful when water levels do not increase more than six inches or decrease more than 12 inches during any 28-day period within the peak nesting season (Fair 1979). A FERC license and an agreement by Central Maine Power Company (now owned by FPL Energy Maine Hydro) set this precedent on Lake Umbagog (a National Wildlife Refuge on the border of Maine and New Hampshire) (J. Fair, pers. com.). Management of stable water levels for many reservoirs is more difficult, particularly when (1) reservoirs are interconnected, (2) there are downstream-user requirements, and (3) peaking facilities are operating. In these cases, storage reservoirs that usually have slow drawdowns through the summer require rafts for loon nesting success (Figure 12). Precedent-setting loon management plans in Maine by FPL Energy Maine Hydro employ a reservoir-wide artificial nest platform (rafts) program. Rafts are placed and weekly monitored at every loon territory, except those where island configuration or floating bog mats make natural nesting possible (DeSorbo and Evers 2001; Savoy et al. 2001a,b; Yates et al. 2002b). On peaking reservoirs, with daily



fluctuating water levels of around a meter, rafts are also required and are integral parts of loon management monitoring programs (Clarke 2002, 2003).

Figure 12. A storage reservoir in Maine in late summer showing shoreline responses to drawdowns¹.



¹This type of system requires artificial nesting islands to mitigate impacts of water level management regime shifts.

B. Artificial nest platforms and avian guards

Use of artificial nest platforms or rafts by nesting loons is a well-established management tool (Mathisen 1969; McIntyre 1977b; Fair 1993, DeSorbo and Evers 2001). Proper construction is important to maximize use by loons and for longevity. Rafts are generally constructed from cedar logs (with galvanized bolts or nails) and plastic mesh fencing (attached using 1-1/2 inch galvanized fencing staples) (Figure 12) (Fair 1993). Rafts need to be lined with material such as sphagnum moss, grasses, and other vegetation. Loons occupying rafts will typically add nesting material gathered from the immediate vicinity of the nesting site, but it is important to have a natural base. Rafts require regular monitoring to insure proper placement, buoyancy and sufficient nesting materials throughout the season. Rafts should be removed from the water soon after nesting has ceased (to dry and increase the longevity of the raft). Placing rafts on a nearby shore is typical.

Raft positioning and location is determined by (1) knowledge of wind and wave action patterns relative to each territory, (2) knowledge of loon territorial boundaries and proximity to other territories, (3) knowledge of previous traditional and non-traditional nest site locations, and (4)



knowledge of boat traffic and human activity patterns relative to the specific territory (this is particularly important relative to the orientation of the avian guard).

Avian guards are effective in (1) reducing egg exposure to avian predators, (2) lessening raft visibility by recreationists, and (3) increasing the probability that incubating loons remain on the nest during close approaches by recreationists and potential predators. Avian guards therefore reduce flushing events and related disturbances to nesting loons. Fair (1993) found nesting success increased on territories when employing avian guards on territories with regular avian predation of raft nests. Avian guards are made of metal fencing and camouflage mesh (Figure 13). Burlap camouflage mesh is a useful surrogate and is adequate for single-season use. Camouflage mesh material should be removed at the end of the season to avoid further degradation.

Figure 13. An artificial nesting island (or raft) designed for nesting by Common Loons¹.



¹Note avian guard and amount of vegetation in the nest pocket.

C. Signs, buoys, and roping

Recreational activities likely play a role in loon hatching and fledging success (see Human Disturbance). In response to this pressure, the use of ropes and floating signs to cordon-off high-risk territories can be effective especially where enforcement of exclosures is possible. On highly developed lakes in New Hampshire, territories with the benefit of signs and floatlines surpassed the hatching success of territories without such restrictions (Taylor and Vogel 2002). Use of voluntary exclosures should be based on site-specific nest failure history and an understanding of typical lake use patterns. Kelly (1991) recommends floating 3-6 signs, approximately 137 m from the nest site for optimal buffering capacity. Exclosures should be



removed immediately following hatch, or when the adults have moved young to another location. This will maximize public acceptance and compliance. Although signs and floatlines can serve to draw attention to a nest site they can also effectively create a buffer that minimizes human impacts to nesting pairs.

XII. Current protection of populations

A. Current protective status

The Common Loon has various levels of protection at the state and federal level. It is given general protection by the U.S. Migratory Bird Treaty Act of 1918. It was formerly designated a species of special management concern by the USFWS in Regions 1, 3, 4, 5, 6, and 7 (USFWS 1995) but is no longer on the national list of Birds of Conservation Concern (USFWS 2002). In the northwestern U.S., the Bureau of Land Management considers it a sensitive species for region 1 and the U.S. Forest Service (USFS) a species of special status. In Canada, the Migratory Bird Convention Act of 1994 protects the Common Loon from purposeful, non-subsistence related take. It is red listed in Europe.

Table 10. Special protection status for Common Loon breeding populations.

State/Province	State/Province	The Nature Conservancy ¹
Idaho	Special Concern	S2 (imperiled)
Massachusetts	Special Concern	S1 (critically imperiled)
Michigan	Threatened	S3 (vulnerable)
Montana	Special Concern	S2 (imperiled)
New Hampshire	Threatened	S3 (vulnerable)
Vermont	Endangered	S2 (imperiled)
Washington	State Sensitive	S2 (imperiled)
Wisconsin	Special Concern	S3 (vulnerable)
Wyoming	Special Concern	S2 (imperiled)

¹Global rank is G5 (Very common; demonstrably secure under present conditions). State ranks are only listed for those states with an official protection status.

Lead fishing sinkers and jigs \leq one ounce regularly kill Common Loons across North America. Their impacts on Mute Swans (*Cygnus olor*) and other wildlife spurred a 1987 ban in Great Britain. In Canada, the use of Pb fishing sinkers and jigs in national parks and national wildlife preserves has been banned since 1997. In the United States, three states have passed legislation on the use and sale of Pb fishing tackle. New Hampshire passed a ban, effective January of 2000, on the use of Pb sinkers \leq one ounce (28g) and Pb jigs smaller than one inch (2.54cm) along its longest axis. In Maine and New York, legislation banning the sale of Pb sinkers \leq half ounce was passed in 2002 (although the New York bill will not go into effect until 2004). That same year, the U.S. Fish & Wildlife Service banned the use of Pb tackle at Red Rock Lakes National Wildlife Refuge, Montana; National Elk Refuge, Wyoming; and Seney National Wildlife Refuge, Michigan, with future bans discussed for all refuges with breeding loons and trumpeter swans.

Comment: The NY bill was passed in 2002, but won't take effect until 2004.

Other Pb bans are being considered in Massachusetts, Michigan, Minnesota, and Vermont. A bill prohibiting both the sale and use of Pb sinkers was introduced in the Minnesota Senate in



January of 2003. Massachusetts and Vermont have begun limited outreach efforts to encourage anglers to voluntarily switch to non-toxic tackle.

B. Existing protected habitat

Common Loon breeding populations occur in a wide range of federal, tribal and state protected areas. Populations are monitored in many of the larger protected areas. Protected loon breeding habitats in U.S. National Parks include lakes in Acadia, Glacier, Isle Royale, Voyageurs, and Yellowstone. Important National Wildlife Refuges include Lake Umbagog and Seney in the contiguous U.S. and many of the Alaskan National Wildlife Refuges south of the Brooks Range (e.g., Kenai). Important National Forests include Chequamegon-Nicolet (Wisconsin), Chippewa (Minnesota), Flathead (Montana), Hiawatha (Michigan), Ottawa (Michigan), and Superior (Minnesota). Major state areas include Adirondack Park of New York State.

Major Canadian National and Provincial Parks are: Manitoba (Atikaki); Northwest Territories (Nahanni); Nova Scotia (Kejimikujik); Ontario (Algonquin and Quetico); Quebec (La Maurice and La Verendrye); and Saskatchewan (Prince Albert).

Common Loon wintering populations are in areas protected by National Oceanic and Atmospheric Administration and National Marine Fisheries Service programs, including Apalachicola National Estuarine Reserve.

C. Collaborative Conservation Groups

Wetlands International Diver/Loon Specialist Group (DLSG): This is an association of professionals from all parts of the world interested in divers/loons. It forms part of the waterbird network of Wetlands International and The World Conservation Union's (IUCN) Species Survival Commission (IUCN-SSC). DLSG aims to (1) provide an international network of experts on the world's divers/loons, (2) stimulate, coordinate and promote diver/loon research and information, and (3) provide research information and advice to Wetlands International/IUCN-SSC and others in support of promoting the conservation management and wise use of divers/loons and their habitats. The DLSG is open to individuals or institutes who are actively involved or interested in any aspect of the biology or management of divers/loons and their habitat. A newsletter, links to reports, and translations of Russian literature are available at the web site www.briloon.org/diver.htm. Joe Kerekes is the coordinator. A directory of members and their research interests is available at www.briloon.org/Directory.doc.

Alaska Loon and Grebe Working Group: This focus group of biologists and managers from federal and state agencies and various nonprofit groups was formed in 1997. Through annual meetings goals have been created and include: (1) facilitate exchange of information among biologists, managers, and the public, (2) identify conservation and management issues faced by Alaska's loons and grebes, (3) review and identify gaps in knowledge of loon and grebe distribution, status and ecology, and (4) facilitate collaborative projects among agencies and others. A directory of members and their research interests is available (www.r7.fws.gov/mbm/loons).



Montana Common Loon Working Group: This group was formed in 1999 and includes members and staff from the Montana Loon Society, Montana Department of Natural Resources, Montana Fish, Wildlife & Parks, Department of Natural Resource Conservation, Plum Creek Timber Company, U.S. Forest Service, Avista Corporation, American Bird Conservancy and other interested agencies and persons. Coordination of surveys, nest site management and public outreach efforts are facilitated by the CLWG. They include:

- Coordinate the construction and use of floating signs and nest structures;
- Coordinate annual surveys of occupancy (May) and production (July) at known, historic and potential territories (nesting lakes);
- Serve as a clearinghouse for the compilation and use of population data;
- Develop and disseminate public outreach materials;
- Facilitate public contacts throughout the nesting season on high conflict lakes;
- Provide information to managers, planners, developers and landowners regarding potential conflicts on lakes used for nesting.

North American Loon Fund (NALF): This nonprofit organization is an umbrella group for loon conservation organizations across North America. NALF hosted a fund for research grants for many years and was also responsible for publishing a series of research-oriented proceedings: (1) in 1979, Scott Sutcliffe edited “The Common Loon: Proceedings of the Second North American Conference on Common Loon Research and Management,” (2) in 1988, Paul Strong edited “Papers from the 1987 Conference on Loon Research and Management,” (3) in 1992, Linda Morse, Sally Stockwell, and Mark Pokras co-edited “The Loon and its Ecosystem: Status, Management, and Environmental Concerns,” and (4) in 2000, Judy McIntyre and David Evers co-edited “Loons: Old History and New Findings.” Papers from the last proceeding were peer-reviewed and are included in BioAbstracts. Information on NALF is available at www.loonfund.org.

Northeast Loon Study Working Group (NELSWG): NELSWG was formed in 1994 to combat the increasingly apparent impacts of Hg on loons in New England and eastern Canada. Since then, members have met biannually or annually and have effectively linked with state and federal policy makers. Members include representatives from the U.S. Fish and Wildlife Service, U.S. Environmental Protection Agency, Canadian Wildlife Service, state wildlife and conservation departments from New England and New York, provincial wildlife departments from some of the eastern Canadian provinces, universities, non-profit organizations from each state and Canada, and private industry. A directory of members and meeting minutes is available at www.BRILoon.org/NELSWG. Many members are described under section 10 (Monitoring Activities). NELSWG members not listed are primarily laboratories and include the Wildlife Clinic of Tufts University School of Veterinary Medicine (www.tufts.edu/vet/loons/), University of Pennsylvania Animal Health Diagnostic Laboratory, Texas A&M Trace Element Research Laboratory, and Buffalo State University.



XIII. Conservation Plan

The primary goal of this conservation plan is to maintain the distribution and density of current breeding populations. A secondary goal is to recover breeding populations in areas historically occupied. To reach these goals the following objectives are presented with their associated strategies for action. Current threats are many throughout the loon's life cycle and even though overall populations are robust, the Common Loon's life history strategy includes low annual productivity and poor dispersal ability and therefore demands careful attention by landscape managers and policy makers. This document provides the basis for the following Conservation Plan.

The threats to loons vary dramatically by geographic region and season. Therefore, the governing U.S. Fish and Wildlife Service and Canadian Wildlife Service offices should use the following outline of this Conservation Plan to prioritize efforts within the five overall categories of monitoring, research, education and information, management, and policy. A Joint Steering Committee is recommended to best integrate this Plan across federally-designated regions. Envisioned is a network of regionally-customized plans that prioritize actions based on the following 14 objectives and strategies.

A. Monitoring

Objective 1. Improve and network monitoring efforts at spatial and temporal levels appropriate for each area's abundance and associated threats¹.

¹Standardized information should be collected for the number of territorial pairs and number of chicks >6 weeks of age.

Strategy 1.1. Continue statewide, high-resolution monitoring of breeding populations in the contiguous U.S.

- 1.1.1. Focus efforts on states that have inadequate statewide population estimates: Maine, Michigan, New York and North Dakota.
- 1.1.2 Continue to improve and refine efforts in other states as needed.
- 1.1.3. Integrate the georeferenced information into a centralized and standard web-based database.

Strategy 1.2. Establish aerial surveys using a standardized, random sampling scheme by ecozone (or a smaller ecological unit) to statistically estimate breeding population levels in mid-summer across Alaska, Canada, Greenland, and Iceland. Canada contains 94% of the Common Loon's breeding population and few loon-specific surveys are conducted.

- 1.2.1. Design aerial surveys with a network of key agencies: U.S. Fish and Wildlife Service (USFWS), U.S. Geological Survey – Biological Research Division (USGS-BRD), and Canadian Wildlife Service (CWS).



- 1.2.2. Prioritize aerial surveys for areas of greatest abundance. Focus surveys on breeding populations that overwinter on the Atlantic Coast (representing Ontario and Quebec), on the Gulf Coast (representing the Upper Great Lakes northwest to Manitoba), and on the Pacific Coast (representing British Columbia).

Strategy 1.3. Establish migration stations that have spatial and temporal relevance for long-term tracking of migrant loon populations.

- 1.3.1. Design a network of migration stations using standardized protocols. Network should include existing stations with the addition of others through a consensus of key agencies (USFWS, USGS, CWS) and those non-profit organizations currently involved with regular waterbird migration monitoring programs (e.g., Bird Studies Canada, Braddock Bay Bird Observatory, Cornell Lab of Ornithology, Manomet Center for Conservation Sciences, Whitefish Point Bird Observatory, and Point Reyes Bird Observatory).
- 1.3.2. Prioritize choice of migration stations to maximize coverage of the major migration corridors. Monitoring efforts need an ability to detect statistical differences in population trends for spring and fall migrants along the Pacific, Atlantic, and Gulf Coasts.

Strategy 1.4. Using Christmas Bird Count data, federal winter aerial surveys, and other information, identify major winter concentrations.

- 1.4.1. Design a ranking system of wintering loon concentrations through a network of key agencies (USFWS, USGS, CWS, and National Oceanic and Atmospheric Administration (NOAA)).
- 1.4.2. Prioritize areas of loon concentration for regular, high-resolution monitoring efforts along the Pacific, Atlantic, and Gulf Coasts. Emphasis needs to include (1) known important concentrations in southwestern British Columbia, North Carolina, and Long Island Sound and (2) concentrations representing unique areas such as freshwater winter sites on reservoirs in Tennessee and Alabama, and (3) concentrations representing isolated population cohorts such as in the Gulf of California.

B. Research

Objective 2. Identify potential sink populations in the breeding range based on the Plan's population model².

²Areas identified as potential population sinks have a rate of fledged young per territorial pair less than λ (0.48) over a six consecutive year time period.

Strategy 2.1. Investigate potential population-level impacts.



- 2.1.1. Emphasize loon populations impacted by landscape-level, multiple stressors (i.e., acidic lakes, MeHg availability, botulism outbreaks in Lake Erie and Ontario, and marine oil spills). High priority area is eastern Ontario and western Quebec.
- 2.1.2. Emphasize loon populations impacted from known localized stressors (stressor is indicated in parentheses).
 1. Southern Nova Scotia (Hg)
 2. Northern Maine (Hg and lake water level fluctuations)
 3. Southeastern (Hg) and southern (Pb) New Hampshire
 4. Adirondack Mountains (high elevation acidic lakes and Hg)
 4. Upper Peninsula of Michigan (commercial netting on Great Lakes)
 5. North-central Wisconsin (Hg)
 6. Northernmost Minnesota (lake water level fluctuations)
 7. Northcentral Saskatchewan (Hg, from staging lakes)

Strategy 2.2. Investigate potential local-level impacts.

- 2.2.1. Emphasize publicly-owned areas with breeding populations prone to human disturbance and recreation
 1. National Wildlife Refuges,
 2. National Parks (U.S. and Canada)
 3. Provincial Parks, and
 4. National Forests.
 5. State Parks and Forests
- 2.2.2. Emphasize areas impacted by acid rain.
- 2.2.3. Emphasize areas impacted by other contaminants including Hg, Pb and persistent bioaccumulative toxins.

Objective 3. Develop geographic linkages between breeding and wintering populations³.

³This is particularly important for compensation of loons lost during marine oil spill events.

Strategy 3.1. Use satellite transmitters and newly developed implant techniques to track long-distance movements. Given transmitters are expensive, prioritize.

- 3.1.1. Wintering concentrations most at risk to anthropogenic stressors (e.g., high-use petroleum shipping corridors and seaports where marine oil spills will likely occur).
- 3.1.2. Major migration corridors (e.g., areas on the Great Lakes prone to botulism outbreaks).
- 3.1.3. State-listed breeding populations (e.g., Michigan, New Hampshire, and Vermont).



Strategy 3.2. Use less expensive means to link winter, migration, and breeding areas with (1) morphometric and wing-loading measurements, (2) band recoveries, and (3) isotope tracing methods.

Strategy 3.3. Use newly developed microsatellite techniques to genotype breeding populations. Recent published evidence shows genetic differences among breeding populations. A genetic profile of North American breeding populations will provide science-based compensation options following marine oil spills and other mortality events related to anthropogenic sources.

Objective 4. Develop a web-based information center that facilitates networking among field biologists, lab scientists, and museum curators⁴.

⁴There needs to be a repository network and a disposition protocol for loon carcasses and tissues.

Strategy 4.1. Standardize carcass retrieval and submission, necropsy procedures, and tissue bank development.

Strategy 4.2. Network museum reference collections and establish connections with institutions and individuals that possess carcasses.

Strategy 4.3. Establish a federal protocol for the disposition and processing of loon carcasses and loons injured during large mortality events.

Objective 5. Use the Common Loon as an indicator of mercury risk to piscivorous wildlife populations⁵.

⁵ A dual objective is served by tracking Hg exposure in loons and using loons as a standard national and international indicator.

Strategy 5.1. Develop a standard long-term monitoring program across North America using loon blood and egg Hg levels to establish spatial and temporal context. Such efforts should concurrently measure overall loon productivity.

5.1.1. Conduct this program on U.S. Department of Interior properties.

1. National Parks of significance include Acadia, Glacier, Isle Royale, Voyageurs and Yellowstone.

2. National Wildlife Refuges of significance include Kenai, Seney, and Umbagog.

5.1.2. Conduct this program on U.S. Department of Agriculture properties.

1. National Forests of significance include Chequamegon-Nicolet, Chippewa, Flathead, Hiawatha, Okonogan, Ottawa, and Superior.

5.1.3. Conduct this program on Canada's National and Provincial Parks of significance including Algonquin, Kejimikujik, La Maurice, Prince Albert, and Quetico.



5.1.4. Conduct this program on Tribal lands.

Strategy 5.2. Use the recently developed wildlife criterion value (WCV) as a basis for the long-term monitoring program and as a foundation to evaluate Hg risk to other piscivores.

C. Education and Information

Objective 6. Develop a web-based information center to increase awareness of loon conservation needs and integrate standardize geo-referenced databases.

Strategy 6.1. Network with North American loon conservation programs to develop databases that compile geo-referenced locations of territorial pairs, their reproductive success, and other information into a cooperative system..

Objective 7. Promote responsible recreational fishing practices.

Strategy 7.1. Regulate the use, sale, and possession of Pb objects on lakes and rivers.

Strategy 7.2. Continue and expand Pb-exchange and outreach programs in the U.S. and Canada.

Strategy 7.3. Expand current moratoriums on Pb usage across all federally protected areas.

Strategy 7.4. Promote responsible disposal of discarded monofilament line and more persistent retrieval of lost tackle.

Strategy 7.5. Enhance fishing regulations to include forfeiture of license and/or automatic disqualification during fishing tournaments if loon sanctuaries and enclosures are disregarded.

Objective 8. Promote changes in commercial fishing techniques.

Strategy 8.1. Use “loon excluder” nets that have a larger ceiling mesh size for trap nets in the Great Lakes and subsidize conversion.

Strategy 8.2. Evaluate scope and impact of loon take by commercial and subsistence fisheries in Alaska, Canada, and Greenland.

Strategy 8.3. Develop regulations in U.S. coastal waters that minimize bycatch of wintering loons (e.g., mid-Atlantic).

D. Management:

Objective 9. Protect loon breeding habitat at a landscape level to minimize further degradation or fragmentation of suitable habitat.



Strategy 9.1. Integrate territory ranking layer, including digitized nest and brood sites, into existing state and federal natural resource inventory databases (see Objective 4.) for use by resource managers.

Strategy 9.2. Create a graduated mitigation policy for shoreline projects impacting loon habitat that enforces strict conservation of high quality habitat and allows for responsible development practices on lower quality habitat. Points of consideration include:

9.2.1. Creation of undeveloped buffer areas of 500 feet around known nest and brood sites. Protection of all islands <5 ha in size on lakes supporting loon pairs.

9.2.2. Cluster development on shorelines, leaving areas of undeveloped tracts.

Strategy 9.3. Establish partnerships between developers and conservation organizations to incorporate low impact uses and practices in the deed restrictions of shoreline subdivisions.

9.3.1. Limiting amount of motorized craft allowable on a waterfront property, including the exclusion of all jet-propelled watercraft.

9.3.2. Limiting horsepower or enforcing headway speed in sensitive areas.

9.3.3. Include the cost of increased monitoring effort in subdivision fees, lake association fees, or other local fees.

9.3.4. Restrict construction activities, particularly those involving barges, from occurring during the nesting season.

Objective 10. Implement a territory ranking system to help prioritize conservation efforts.

Strategy 10.1. Incorporate ranking system to prioritize efforts to balance time, funding, and energy allotments. Overall productivity (fledged young per territorial pair) provides the best evaluation technique for areas occupied by loons. Protection of these high quality territories should be the highest priority. Productivity ranking categories have been developed for context (Evers et al. 2002b).

10.1.1. Use for management strategies at federal, state, and local levels.

10.1.2. Use as a compensation tool for Natural Resource Damage Assessments.

10.1.3. Use for prioritizing land protection.

Objective 11. Protect loon breeding habitat at a local level to sustain area populations¹¹.

¹¹ Because of high public value on loons localized efforts are expected.

Strategy 11.1. Enforce site-specific and appropriate restrictions for recreational activities during the critical parts of the breeding season (e.g., during nest initiation, incubation, and the first five



weeks post-hatch). This is particularly relevant in public recreational areas such as National, Provincial, and State Parks, National and State Forests, and similar areas. These would include activities that include:

- 11.1.1. Rapid localized movement and loud noise such as power boating, personal watercraft, water skiing and floatplanes.
- 11.1.2. Non-motorized craft such as sailing, windsurfing, rowing and canoeing.
- 11.1.3. Prolonged periods of time in a localized area such as certain angling practices (i.e. bass fishing) and rafting by boats.
- 11.1.4. Spread of exotic invasive species such as Eurasian Water Milfoil.
- 11.1.5. Use of chemicals such as 2-4-D used to eradicate invasive species.

Strategy 11.2. Create site-specific sanctuaries for nesting and nursery areas.

Strategy 11.3. Establish partnerships between lake associations and conservation organizations to design protective measures at a lake level.

Strategy 11.4. Establish partnerships between shoreline property owners and conservation organizations to encourage voluntary participation, such as providing observational data, deployment and maintenance of protective signs, and assistance in monitoring of enclosures and refuges.

Objective 12. Develop a standard process for the Federal Energy Regulatory Commission to dictate mitigation and/or other management tools that assist resource managers.

Strategy 12.1. Enlist U.S. Fish and Wildlife Service offices to use a standard procedure for evaluating breeding loon populations and potential impact of hydrological management regimes on nesting success.

Strategy 12.2. Develop a standard procedure to evaluate impacts, including a standard field monitoring strategy that includes identification of territorial pairs, nesting attempts, chicks hatched, and chicks fledged. Weekly surveys are required for high confidence in the determination of these four parameters.

Strategy 12.3. Develop standard mitigation guidelines. For example, unless storage reservoir water levels can be held relatively steady (i.e., <6 inch increase and <12 inch drawdown), rafts need to be used. All peaking reservoirs (i.e., those reservoirs attached to electrical power facilities that daily use water surges) require rafts.

Strategy 12.4. Develop a standard monitoring strategy for the responsible party to use as a way to determine the success of mitigation efforts for enhancing loon breeding habitat. Part of this strategy should require frequent evaluations by the associated U.S. Fish and Wildlife Office.



Strategy 12.4. Construct a U.S. Fish and Wildlife Service initiative to interact with appropriate Canadian agencies to establish national or provincial regulatory oversight of hydro projects.

E. Policy

Objective 13. Connect efforts and information within this document with relevant plans¹³.

¹³The following list of ongoing plans and efforts is not necessarily inclusive of all plans.

Strategy 13.1. North American Bird Conservation Initiative including national and regional waterbird plans

Strategy 13.2. U.S. Environmental Protection Agency' National Health & Environmental Research Laboratory's Wildlife Risk Assessment Program.

Strategy 13.3. United Nations Environment Program's Global Hg Assessment.

Objective 14. Investigate, document, and summarize relevant data to assist science-based legislation and policy¹⁴.

¹⁴The following issues are viewed as those needing the most immediate attention to resolve impacts between loons and anthropogenic activities.

Strategy 14.1. Regulate anthropogenic air emissions and water effluents of Hg into the environment.

14.1.1. Develop U.S. and Canadian legislation to unify current patchwork approach.

14.1.2. Use developing risk assessments for the Common Loon as a basis for assessing ecological health related to Hg.

14.1.3. Use the Common Loon as a national and international indicator for monitoring MeHg bioavailability.

Strategy 14.2. Regulate the use, sale, and possession of Pb objects in lakes and rivers.

14.2.1. Develop U.S. and Canadian legislation to unify current patchwork approach.

14.2.2. Emphasize regulation of Pb sinkers and jigs less than one ounce and one inch in length (at its longest axis) that are designed for fishing.

14.2.3. Promote non-toxic alternatives including steel, ceramics, bismuth, natural granite, tungsten, and recycled glass. Steel most closely matches Pb in performance. Zinc is toxic and is not a viable alternative.

Strategy 14.3. Improve prevention of tanker oil spills.



14.3.1. Further strengthen the Natural Resource Damage Assessment process for protecting natural resource injury. Fair compensation packages that negatively exceed economic cost-benefit ratios will provide economic incentives for improving tanker construction.

14.3.2. Identify highly sensitive ecological areas and assess space and time limits by oil tankers.

Strategy 14.4. Minimize commercial and tribal fisheries bycatch on the ocean, Great Lakes, and other large waterbodies.

14.4.1. Develop U.S. and Canadian legislation to unify an approach for minimizing bycatch.

14.4.2. Implement “loon excluder” devices for certain fishing practices (such as those using trap nets).

14.4.3. Identify overlap of areas with high densities of loons with commercial-tribal fishing interests. Develop plans for minimizing bycatch.

Strategy 14.5. Standardize requirements by the Federal Energy Regulatory Commission.

14.5.1. Use established protocols for compensating loss of loon breeding habitat across the U.S.

14.5.2. Work collectively with Canadian agency counterparts and the International Joint Committee.



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