VERMONT COMMON LOON RECOVERY PLAN 15 September 1998 - SEB

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Cover Sheet

Vermont Endangered and Threatened Species Recovery Plan

Species: Common Loon *(Gavia immer)* dated 15 September 1998

Approved by the **Scientific Advisory Group** (SAG) as a recommendation to the Conservation and Education Subcommittee to accept.

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signature: Ian R. Worley date: 11-10-98
ESC Chair

Signature below indicates acceptance of this Endangered and Threatened Species Recovery Plan by the **Agency of Natural Resources** (ANR).

signature: JBKunel date: 11/12/98
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EXECUTIVE SUMMARY

The Common Loon *(Gavia immer)* is a piscivorous diving bird that nests on a diversity of lake types in Vermont and throughout its North American breeding range. The species was placed on the Vermont Endangered Species List in 1987, after several years of monitoring revealed a limited, declining, and vulnerable population. This recovery plan reviews the status and life history of Vermont loons and discusses factors limiting the breeding population. Current research, management and public education efforts are reviewed. A recovery goal of 40 nesting pairs averaged over 5 consecutive years, with sufficient productivity to maintain population stability (average 1.0 fledglings/pair), is recommended to allow consideration of this species for delisting.

Little historical information is available on Vermont's Common Loon population, but it seems likely that the state formerly supported at least 50 nesting loon pairs. A 1977 statewide survey found that the breeding population had significantly declined. Following initiation of an annual loon monitoring and management program in 1978, numbers of breeding pairs peaked at 19 in 1982, then dropped sharply to 8 pairs in 1983. From 1983-1989 Vermont's breeding loon population gradually increased at an average rate of 1 pair per year, stabilized between 1989-1994 at 13-16 breeding pairs, and then experienced a marked increase to 19 breeding pairsin 1995, 21 breeding pairs in 1996, and 25 nesting pairs in 1997. Loon productivity is high in Vermont, relative to neighboring states, averaging 1.01 fledged chicks per nesting pair during the 1978-1997 monitoring period and ranging annually from 0.78 to 1.30. Ongoing conservation efforts, including monitoring, management and public education, have helped to promote recent positive population trends. Current availability of suitable habitat is believed sufficient to support the statewide recovery goal of 40 nesting pairs.

The recovery of Vermont's breeding loon population requires a strategy that combines monitoring, management, research, and education. This plan outlines and prioritizes the specific strategies designed to achieve this recovery goal. Many of these have already been implemented and are ongoing. The cooperation and active participation of a diverse array of interested groups will be necessary to achieve the recovery goals. Management and protection efforts must address both long- and shorter-term conservation issues. Many short-term measures (e.g. annual protection of individual breeding pairs and family groups) will have to be implemented on a site-specific basis and will require a flexible, adaptive strategy. Longer-term measures that safeguard critical habitat from development or that address broad threats to loon population viability (e.g. environmental quality or issues related to human uses of loon lakes) will require a coordinated, statewide approach. The most vital single ingredient to the successful recovery of loons in Vermont will be continued and effective education of all groups whose activities overlap with or potentially impact the species.

VERMONT COMMON LOON RECOVERY PLAN

I. BACKGROUND

Species Description

The Common Loon *(Gavia immer)* is one of 5 species in the single genus of Gaviidae, the only family in the order Gaviiformes. There are no recognized subspecies of *G. immer*. Adults measure about 1 m in length and vary in weight from 2.7 kg to more than 6.3 kg (McIntyre 1988). Males are consistently larger than females, but plumage differences between the sexes are indistinguishable. In breeding plumage, the head and neck are velvety black with a slight greenish gloss. The throat and sides of the neck are marked with a prominent transverse bar of short, vertical white streaks. The bill is black, and the eye is brownish ruby. The upperparts are black with a greenish gloss, heavily spotted with white. The underparts are mainly white, the sides of the breast are streaked black and white, and the flanks are black with small white spots. The tail is short and entirely black; the wings narrow, pointed and mostly black. This plumage is not fully acquired until the third or fourth summer.

The adult winter and immature plumages are similar. In this plumage the forehead, crown and back are grayish-brown, and the chin, throat and foreneck are white. The bill is brownish-gray to pale bluish-gray or horn-colored, and the eye is brown. The upperparts are brownish-gray, the feathers margined with paler gray, and a few black and white feathers are occasionally retained in adults. The underparts are mainly white, with a brownish. streaked appearance on the sides of the breast and flanks. The tail is dark brown, tipped with white.

Distribution in North America

The current North American breeding range of the Common Loon extends from western and central Alaska and northern Canada, south to the northernmost United States, including northern New York, central Massachusetts, and southern New Hampshire in the East. The winter range extends along the entire eastern seaboard, from Newfoundland south to the Gulf of Mexico and the Bahamas, and along the Pacific Coast from the Aleutians south to Baja California and Sonora, Mexico (American Ornithologists' Union 1983). Along the Atlantic Coast, wintering loon concentrations are greatest off the coasts of North Carolina, Virginia, and Maryland. A gradual northward movement of loons occurs during winter. During January and February, peak numbers are found off the coast of South Carolina; by March densities are highest off the coast of New Jersey; and by April loon concentrations reach their maximum off the coasts of Massachusetts and New Hampshire. Historically, the breeding range of the Common Loon included Connecticut, central eastern Pennsylvania, northern Iowa, northern Ohio, and northeastern Indiana and Illinois (American Ornithologists' Union 1983, McIntyre 1988).

Annual Cycle

From November through March, loons winter on coastal waters, as well as larger inland lakes, such as the Great Lakes. In late January and February adults molt the gray winter plumage, replacing it with the black and white breeding plumage. Adult loons also molt wing feathers during late winter, becoming flightless for nearly a month (McIntyre 1988). The timing of this molt may be dictated by loons' need for flight capabilities during the fall while rearing chicks and preparing for migration (Woolfenden 1967). During their flightless period, loons are vulnerable to environmental disturbances such as storms, food limitation, toxic algal blooms, and oil spills (McIntyre and Barr 1997). An oil spill off the Rhode Island coast in January of 1996 was documented to kill at least 65 loons, many of which were flightless and could not escape the spill area (Research Planning, Inc. 1996). Actual mortality was estimated to exceed 400 birds (Sperduto et al. 1997).

In March and April Common Loons migrate northward singly or in small groups to freshwater breeding lakes, arriving during or soon after ice-out. Territories are established immediately, and nesting typically begins 2-4 weeks after arrival (McIntyre 1975). Following the breeding season, flocks of both adults and juveniles begin to congregate on larger staging lakes, prior to migration to the coast. During late summer and early fall, adult loons undergo a second annual molt that produces the grayish winter plumage. Adult birds generally depart Vermont breeding lakes in September or October, while juveniles may remain on natal waters until freeze-up in late November or December. Subadult loons generally remain on nearshore marine waters for 3-4 years before acquiring breeding plumage and sexual maturity.

Food and Feeding Behavior

Adult loons are primarily piscivorous, preferring slow-moving fish, such as yellow perch, minnows, sunfish, smelt, suckers, and bullheads (McIntyre 1988, Blair 1989). Salmonids are taken on lakes that have low populations of other fish species (McIntyre 1988). Loons are opportunistic and will eat frogs, salamanders, leeches, crayfish, amphibians, mollusks, insects, amphipods, and occasionally plant material (McIntyre 1988). During the winter, loon feeding patterns may be correlated with tidal rhythms, and small feeding territories may be defended (McIntyre 1988). Winter prey includes flounder, rock cod, menhaden, sea trout, herring, sculpin and crabs (McIntyre 1988).

During the first 2 weeks after hatching, 65% of a loon chick's diet consists of vegetation and invertebrates, after which these items supply only 4% of total food intake (Alvo and Berrill 1992). Chicks begin catching their own food at 3 weeks, but because capture efficiency at this age is only about 3%, adults continue providing minnows, insects and crayfish until chicks reach 8 weeks of age (McIntyre 1988). A pair of breeding loons and 2 chicks need about 1,050 kg of fish during the 15-week breeding period (McIntyre 1975).

Habitat Needs During the Breeding Season

Common Loons select a diversity of lake types for breeding, ranging from oligotrophic to eutrophic, small to large, shallow to deep, clear to turbid, and remote to heavily developed (McIntyre 1975). Breeding has been documented on lakes as small as 4 ha but most often occurs on lakes of 20 ha or larger (McIntyre 1975). The primary factors in habitat selection appear to be an abundant supply of small fish, water clear enough for efficient foraging, and availability of suitable nest sites. Loons generally need clear visibility to at least 3-4 m, although more turbid ponds are sometimes used if that they provide shallow water areas (< 3 m deep) for locating and capturing prey (McIntyre 1975, 1988). Territories range widely in size from about 5-150 ha and are typically larger on large lakes than on small lakes (McIntyre 1988).

Nest-Site Selection

Loons generally use lakes or ponds that provide small islands or boggy shoreline for nesting, and at least 1 sheltered cove to serve as a nursery area. Although much individual variation exists in loon nest-site selection, general habitat requirements include: protection from wind and wave action, concealment from predators, good visibility by incubating adults, easy access to open water (a moderate slope adjacent to the nest and a deep channel for underwater approaches and exits), and firm substrate (McIntyre 1975, 1983, 1988). Because of Common Loons' poor mobility on land, nests are nearly always built close to the water's edge, generally on small islands, bog mats in swampy areas, or on shorelines that provide adequate substrate (wet grasses or sand) and minimal grade. Loons tend to nest in quiet areas away from human activities, but pairs on developed lakes appear to acclimate to varying degrees to human presence and may nest near cottages and docks (McIntyre 1975, 1988, Rimmer 1992).

Fidelity to Territories and Mates

Both male and female Common Loons are relatively site-faithful, generally returning to the same breeding lake, and often using the same nest site each year. Over the species' eastern North American breeding range, Evers et al. (1996) found a mean adult return rate of 79.5 $\pm$ 7.5% (n = 816 potential returns) to the previous year's territory, with territory switching occurring at a rate of 10-15% per year. Color-marking studies have shown that offspring tend to return to natal waters to breed (Evers 1993, Evers et al. 1996) and may disperse up to 35 miles from their natal lake (Piper et al. 1997a). Immatures typically return at 3-4 years of age, and first-year breeding ranges from age 5-10 years, probably averaging about 7 years (Evers et al. 1996, Evers et al. in prep.). Loons are monogamous during a nesting cycle (Piper et al. 1997b), but pairs are not known to migrate or winter together. Mate-switching does occur at a annual rate of about 20%, usually taking place during the first few weeks after ice-out or following a nest failure (Evers et al. 1996). It thus appears that territorial fidelity is stronger than mate fidelity.

Nesting and Chick Rearing

Both pair members participate in nest construction and maintenance, incubation of eggs, territorial defense, and chick rearing. Loons lay 1 or 2 eggs, very rarely 3, at 1-2-day intervals. Nests are attended by incubating adults 98% of the time and are left unattended only during pair exchanges and during performance of maintenance functions such as preening and stretching. Incubation of the eggs, which typically hatch 1-2 days apart, is 26-31 days. (McIntyre 1975)

In Vermont, nesting usually begins in mid-May , but first nesting attempts have been recorded as late as mid-June. If initial nests fail early in the incubation period (within 10 days), pairs may renest. Reuse of nesting and nursery areas is high and does not appear closely related to nesting success (Strong et al. 1987).

Most loon chicks in Vermont hatch between mid-June and mid-July. Chicks are precocial and leave the nest within several hours of hatching. They are soon moved to nursery areas, which may be located several hundred meters from nest sites and typically consist of a secluded cove or stretch of shoreline, protected from wind and wave action. Chicks are carried on their parents' backs until they reach 3 weeks of age and are aggressively defended by adults underwater and on the surface (McIntyre 1988). Known natural predators of loon chicks include snapping turtles *(Chelydra serpentina)* and larger fish, such as northern pike *(Esox lucius)*. Gulls and Bald Eagles *(Haliaeetus leucocephalus)* have also been reported as predators of loon chicks (McIntyre and Barr 1997). Most juveniles are capable of flight at 11-12 weeks (Barr 1973, McIntyre 1975).

II. HISTORICAL AND CURRENT POPULATION STATUS IN VERMONT

Historical Status

Little historical information is available on Vermont's Common Loon population. While two brief reports (Williams 1794, Thompson 1842) suggested that loons were common in Vermont during the late 18th and early 19th century, reports after 1900 indicated that the population was quite limited (Laughlin 1977). Vermont's statewide loon population appeared to suffer a decline in range and population levels during the 1900s (Rimmer 1993), paralleling similar trends in the neighboring states of New York and New Hampshire (McIntyre 1979, Sutcliffe et al. 1981). The direct and indirect impacts of increased human settlement probably caused these regional declines. Following World War II, lakeshore development increased significantly in Vermont, and waterbodies that had once supported nesting loons, such as Lake Dunmore, Lake Bomoseen, Lake Memphremagog, and Mallet's Bay on Lake Champlain, no longer provided suitable breeding conditions (Laughlin 1977, Metcalf 1979).

In 1977 the Vermont Institute of Natural Science (VINS) conducted a preliminary statewide survey of Common Loons and found that the breeding population had significantly declined (Laughlin 1977). As a result, VINS and the Vermont Department of Fish and Wildlife (VFWD) initiated a loon monitoring and management program in 1978. In 1987 the Common Loon was designated a state endangered species in Vermont, after several years of monitoring revealed a limited and vulnerable population.

Recent Distribution and Population Trends

The statewide loon population, as estimated by an annual July census, has tripled since 1983, the first year of the census. According to the census, there were 39 loons recorded in Vermont in 1983. Between 1986 and 1989, the population stabilized at 59-72 loons, then increased to 127 birds in 1990. Increased numbers of summering immatures and nonbreeding adults were largely responsible for this increase, suggesting higher rates of immigration or recruitment (Rimmer 1988, 1992b, Hall and Rimmer 1990). The population remained relatively stable between 1990 and 1994, ranging from a low of 96 loons in 1993 to a high of 127 birds in 1990 and 1995.

While Vermont's population has experienced a significant recovery since 1983, its numbers remain well below those in the nearby states of Maine (estimated 1995 population of 2,665 loons in the southern portion of the state, including 250 chicks; J. Camuso, Maine Audubon Society, pers. comm.), New York (estimated 1996 population of 361, including 76 chicks; Rouse, Audubon Society of New York, pers. comm.), and New Hampshire (estimated 1996 population of 538-548 birds, including 88 chicks; K. Taylor, Loon Preservation Committee, pers. comm.). Although historical data are lacking, it seems likely that Vermont has always supported significantly fewer loons than these states. Vermont's small size (less than 1/2 the surface area of Maine and New York) and characteristic physiography (many fewer waterbodies and less complex shoreline configurations than New Hampshire, Maine or New York) combine for an inherently low carrying capacity for loons, relative to these three states.

Breeding loon pairs and nonbreeding adults are distributed primarily in the northeastern region of Vermont (Fig. 1). There are 2 known breeding pairs in the southern half of the state. Lakes that have supported breeding pairs consistently since 1978 include Little Averill Lake, Beaver Pond, East Long Pond, Green River Reservoir, Maidstone Lake, Norton Pond, Somerset Reservoir, Thurman Dix Reservoir and Peacham Pond. Six of these (Beaver Pond, Green River Reservoir, Maidstone Lake, Norton Pond, Peacham Pond, and Thurman Dix Reservoir) accounted for 60% of the total statewide chick production in 1978-1994. Lakes that have been consistently successful since 1990 include Holland Pond, May Pond, and Wolcott Pond. Lakes supporting breeding pairs that have not been consistently successful, but that did hatch chicks in 1995 or 1996, include Hardwood Pond, Kettle Pond, Miles Pond, and Newark Pond. Forest Lake supported its first breeding pair in 1994, with successful nesting in 1994 and 1996. Lake Ninevah supported its first documented breeding pair in 1995 and first successful nesting in 1996. First-ever nesting was confirmed on Coles Pond and Moore Reservoir in 1997.

Peacham Pond is the only lake in Vermont known to have supported 2 successful breeding pairs since 1978, although the north cove territory has been consistently more successful (i.e., fledging chicks). Two pairs occupied Green River Reservoir from 1978-1982, but nesting success was inconsistent. Two pairs were resident on Holland Pond in 1983 and 1990, but no nesting occurred during those seasons. Two adult pairs were observed on Gale Meadows Pond in 1979, but nesting was not documented by either. In 1979 and 1981, Somerset Reservoir supported 2 nesting pairs, but only 1 pair successfully hatched chicks in each year..

Vermont lakes which formerly supported breeding loons, but have not within the last decade, include Caspian Lake, Gale Meadows Pond, Job's Pond, Lowell Lake, Long Pond (Westmore), Martin's Pond, Noyes Pond, Osmore Pond, Turtle Pond, Waterbury Reservoir, and Lake Dunmore (Metcalf 1979, Rimmer and Kaveney 1988).

Surveys of the statewide breeding population have been conducted by VINS and VFWD since 1978. Nineteen years of monitoring have documented an initially stable population of 15-19 known nesting pairs in 1978-1982, a sharp decline to 8 pairs in 1983 and 1984, and a subsequent gradual recovery to 16 pairs in 1992. The breeding population stabilized at 14-16 nesting pairs from 1989-1994, but increased to 19 pairs in 1995, 21 in 1996, and 25 in 1997 (Fig. 1, Table 1). During this same period, the number of territorial pairs occupying Vermont lakes declined from 21 pairs in 1978 to only 12 pairs in 1983, then recovered to 24 pairs in 1993 and 1994, 30 pairs in 1995, 31 in 1996, and 36 in 1997 (Fig. 2, Table 1). The abrupt drop in numbers of breeding and territorial pairs in Vermont in 1983 may have been linked to a large winter die-off along the Gulf Coast of Florida (McIntyre 1988), but this remains speculative, particularly since surrounding states did not experience concurrent declines.

Loon productivity is high in Vermont, relative to neighboring states, averaging 1.01 fledged chicks per nesting pair during the 1978-1997 monitoring period and ranging annually from 0.78 to 1.30. In comparison, New Hampshire loon productivity averaged 0.79 chicks fledged per nesting pair during 1978-1995, ranging from 0.61 to 0.93 (Loon Preservation Committee unpubl. data). Survival of Vermont loon chicks is relatively high, averaging 86% between 1983 and 1996 (Borden et al. 1996). The mean survival rate in New Hampshire from 1983-1995 was 75% (Loon Preservation Committee unpubl. data). This appears to support evidence from elsewhere in North America that loon populations at low densities experience higher productivity than populations at high densities (McIntyre 1988).

Fall Staging in Vermont

Lake Champlain is an important fall staging ground and stop-over site during the fall migration (Rimmer 1992). Data from the *Record of Vermont Birds* (Vermont Institute of Natural Science unpubl. data) show peak concentrations of 361 and 247 Common Loons on northern Lake Champlain in early November of 1987 and late October of 1986, respectively. These probably represent a small percentage of the total loon population using Lake Champlain during peak migration periods. Typically, loons that have inhabited smaller ponds during the breeding season, move to larger lakes and form flocks, or "rafts", prior to initiating migratory flights. Anecdotal reports from Somerset Reservoir, Lake Memphremagog, Lake Seymour, Lake Willoughby, and Peacham Pond suggest that these bodies of water consistently serve as staging areas for loons during spring and fall migrations. Both fall and spring staging sites tend to be traditional, and the availability of specific lakes may be important for successful migrations (McIntyre 1975).

III. LIMITING FACTORS AND THREATS

Intraspecific Competition

Intraspecific competition may limit loon productivity. Interference with courtship and nest building behaviors can delay breeding. Time spent off the nest to defend a territory can cause loss of eggs due to excessive heating or cooling, and leaves them vulnerable to depredation. Nest abandonment may result if the energctic cost of territorial defense is too high. Intraspecific competition can also lead to chick mortality through outright infanticide by extraterritorial loons, or indirectly through exhaustion, starvation or depredation of unattended young. An increase in the incidence of infanticide by extraterritorial loons has been documented in New Hampshire, where the loon population has increased, but habitat availability has diminished (Poirer 1991). Necropsied loons at Tufts University Wildlife Veterinary Clinic between 1988 and 1995 showed death from trauma inflicted during intraspecific conflict (Pokras unpubl. data).

Intraspecific conflict caused 4% of known breeding failures in the Northeast between 1976-1991 and may be an important limiting factor on regional loon productivity (Rimmer 1993). Although documentation of its effects can be difficult, increased intraspecific competition is believed to have contributed to recent nest abandonments (Table 2), chick fatalities, and possibly reduced nesting attempts in Vermont. Severe fighting between adult loons in 1989 likely caused a nest abandonment on Peacham Pond and the death of 2 chicks on Wolcott Pond (Kaveney and Rimmer 1989). Interference competition was believed to cause nest failures on Holland Pond in 1990 (Hall and Rimmer 1990) and East Long Pond in 1991 (Renfrew and Rimmer 1991). At South Pond in 1992, 2 week-old chicks disappeared after their parents were repeatedly observed separated from them, fending off an intruding loon over 3 consecutive days (Renfrew and Rimmer 1992). High chick mortality in 1993 probably resulted at least in part from interference or infanticide by unpaired adults; on Newark Pond, an observed fight between a territorial and unpaired adult may have directly or indirectly led to the subsequent death of a chick there (Renfrew and Rimmer 1993). During the 1994 breeding season, agonistic behavior was observed between resident pairs and unpaired loons at 12 of 23 known territories. Some of these interactions included lengthy chases, intense fights, and loons beaching themselves on shore, possibly from severe exhaustion or as means of temporary escape (Chapman et al. 1994). During 1995, intraspecific conflicts were repeatedly documented on East Long Pond, Norton Pond and Lake Ninevah (Borden et al. 1995). Conflict between breeding birds and extraterritorial adults may have caused the disappearance (i.e., presumed death) of 3 chicks and 3 adults on two Vermont ponds in 1997 (Borden et al. 1997).

One possible explanation for apparent increases in competition on Vermont breeding lakes may be that loon nesting habitat is limited. Numbers of extraterritorial birds on lakes with established pairs appear to have increased more rapidly than on unoccupied lakes. Statewide recolonization has proceeded slowly, and several unoccupied lakes seem to be both physically and biologically suitable for nesting. These observations suggest that current recruitment processes are focused more on gaining access to established breeding territories than on establishing new territories. This may also be related to the tendency of offspring to return to their natal waters when mature .

Disease

Disease is a natural threat to loon population growth, but its effects can be exacerbated by environmental contamination (Ensor et al. 1993). Of 124 New England loon carcasses collected in 1988-1992 and analyzed at Tufts University Wildlife Veterinary Clinic, 19 adults died of systemic bacterial infection and aspergillosis, and 5 chicks died from omphalitis (umbilical infection). Twelve of 24 immature loons died of trauma (by boat or another loon), but most were impaired by aspergillosis and/or heavy parasite infestation prior to trauma (Pokras et al. 1993). Aspergillosis is transferred by airborne spores that destroy air sacs, particularly in stressed birds.

Botulism epidemics have caused widespread loon mortality (Terres 1981, Brand et al. 1983). Massive die-offs caused by botulism and other contagious diseases can exert long-lasting effects on loon populations because of the species' breeding biology. Loons are not sexually mature until 3-4 years of age, produce small clutches, and do not necessarily breed every year.

Predation

Mammalian and avian depredation of loon eggs is a well-documented cause of nest losses in loon populations. Primary egg predators include crows *(Corvus brachyrynchos)*, raccoons *(Procyon lotor)*, skunks *(Mephitis mephitis)*, and gulls (McIntyre 1975, Metcalf 1979, Kaveney and Rimmer 1989, Rimmer 1992). Between 1978 and 1997, egg loss due to depredation was confirmed in 15 Vermont nest failures and suspected in 11 other failures (Table 2). Raccoons were the main predators, although 2 instances of otter depredation were documented. Between 1976 and 1991, 35% of all breeding failures in the Northeast were caused by egg depredation (Rimmer 1993). As human populations have increased, so have populations of opportunistic predators, due in part to increased availability of garbage, as well as human tendencies to feed animals (McIntyre 1988). Depredation rates tend to be higher on lakes with heavier recreational pressure (Titus and VanDruff 1981). Loon chicks are depredated by snapping turtles, pike, muskellunge *(Esox masquinongy)*, walleye *(Stizostedion vitreum)*, red fox *(Vulpes vulpes)*, mink *(Mustela vison)*, skunk, and raptors such as Bald Eagles (Olson and Marshall 1952, McIntyre 1975, 1988). Depredation of adult loons on breeding waters in Vermont has not been reported.

Human Impacts

The direct and indirect effects of human activities threaten loon population viability and growth in a number of ways. Potential sources of human impacts on Vermont loons include habitat loss and degradation from shoreline development, recreational use of lakes, artificially produced water level fluctuations, and environmental contamination.

1. Lakeshore Development and Recreational Use:

Loon nesting failures have been linked to shoreline development, recreational boating activity, intentional or unintentional human disturbance of nest sites, and outright harassment of loons in Vermont (Metcalf 1979, Rimmer 1992), New Hampshire (Ridgely 1975, Sutcliffe 1979), Maine (Lee and Arbuckle 1988), New York (LaBastille 1977, McIntyre 1979, Trivelpiece et al. 1979), and several other states and provinces (e.g., Vermeer 1973, McIntyre 1975, 1988, Ream 1976, Heimberger et al. 1983).

In New Hampshire, a state that has experienced heavy lakeshore development and increased recreational use, a 1979 survey indicated a 53% decline in lake utilization by loons over 50 years (Sutcliffe 1980). While comparable statistics do not exist for Vermont, there is little doubt that loon population declines and cessation of breeding on many lakes after 1900 resulted in large part from increases in shoreline development and recreational activity (Metcalf 1979, Rimmer and Kaveney 1988). The loss and degradation of suitable nesting habitat, both through the direct and indirect effects of human activities, appears to pose the most serious threat to the long-term viability of loon populations in the Northeast (Rimmer 1993).

There is considerable evidence that loons are able to acclimate, with varying degrees of success, to moderate recreational pressures, as long as suitable natural or artificial breeding habitat exists. Factors influencing the impacts of lakeshore development and human use on loon reproductive success include: the timing of specific activities within the nesting cycle, the sensitivity of individual loon pairs to human activity, the degree of loon habituation to human presence, age and breeding experience of individual pairs, the frequency and nature of disturbances, and the availability of alternate suitable habitat on a given lake (McIntyre 1988, Stockwell and Jacobs 1993).

Human disturbance can significantly affect loon nesting success and was documented to cause 15% of known nest losses in the Northeast from 1976-1991 (Rimmer 1993). While intentional human destruction of eggs appears to be rare (but see Rimmer and Kaveney 1988); nest disruptions or breeding failures can result from repeated flushing of incubating adults due to close human approaches, excessive motorboat or personal watercraft wakes, and separation of chicks from parents (McIntyre 1988, Borden et al. 1996). Nest abandonments caused by disturbance may also precipitate increased territorial conflicts, as breeding pairs attempt to find other nest sites. Frequent flushing may also force breeding loons to use suboptimal nest sites, which may be more vulnerable to depredation or human disturbance, or more susceptible to flooding from wave action, than traditional sites. There is also potential for nesting loons to be disturbed by biologists and volunteers who routinely monitor population status and reproductive behavior. In Vermont, VINS and VFWD biologists use telescopes, binoculars, and quiet boats (kayaks and canoes) to minimize intrusions, and distances of 75-100 m (200-300 ft)are maintained from nesting and nursery areas whenever possible.

While productivity on lakes where motorized boats are permitted may be lower than on canoe-only lakes (Titus and Van Druff 1981), the relative effects of motorized vs. nonmotorized craft appear to depend on stage of the breeding cycle. Nesting adult loons may be more impacted by slow-moving boats (canoes and fishing boats) that hug the shoreline, while chicks may more affected by fast-moving motorboats because they cannot dive quickly or deeply to avoid collision (McIntyre 1988). Incubating loons are more apt to flush when slow-moving or stationary boats remain for extended periods of time near the nest site (Titus and VanDruff 1981). Some evidence indicates that chicks may be energetically stressed while avoiding boats of any kind (Strong and Bissonette 1985). It has also been observed that nest sites on small lakes may be more affected by canoes than nest sites on large lakes with motorboats. On large lakes, motorboats tend to use open waters and avoid coves where loons typically nest, whereas shoreline and island sites on small lakes are vulnerable to canoes that hug the shoreline and investigate the inlets and swampy areas that loons prefer.

2. Angling-related Threats:

Ingestion of fish hooks, entanglement in monofilament line, and lead poisoning from ingestion of lead sinkers have all been implicated in loon mortality in Vermont (Pokras et al. 1993, Borden et al. 1996) and elsewhere (McNicholl 1988, McIntyre 1988, Pokras et al. 1993, Poppenga et al. 1993). Lead toxicosis causes renal disease, cardiovascular effects, and reproductive problems, and is fatal at low levels (Walsh and Ketelsen 1993). Lead toxicosis from ingested fishing sinkers has been determined to be the leading cause of death in breeding adult loons in New England (Pokras and Chafel 1992). From 1987-1995, 212 dead Common Loons were collected from New England waters and necropsied at Tufts University Wildlife Veterinary Clinic (Pokras 1995). Forty-eight of these had ingested lead objects, of which 80% were related to fishing, 8% were shotgun pellets, and 12% unidentifiable. Liver lead levels were consistent with lead poisoning, and ingestion of lead objects accounted for 56.3% (45 of 80) of the mortalities among adult loons necropsied. The lead objects were primarily sinkers and jig heads, which the loons had probably ingested while obtaining pebbles from lake bottom sediments as an aid in digestion and buoyancy regulation for diving (Pokras 1995). Of 14 Vermont loon carcasses examined between 1989 and 1997, 8 died from lead poisoning (M. Pokras, unpubl. data).

Loons throughout the Great Lakes area have also been shown to have high concentrations of lead in their livers (Locke et al. 1982). Between 1976 and 1991, 227 loon carcasses collected from 18 states were analyzed by the National Wildlife Research Center in Wisconsin. Fourteen loons (6%) died from lead poisoning due to ingestion of lead sinkers. Eleven of these (79%) had sinkers in their gastrointestinal tract (Franson and Cliplef 1993). Of 54 Common Loon carcasses analyzed from Michigan waters, 17 (13%) died from lead toxicosis, with sinkers or jigheads found in the gizzards (Poppenga et al. 1993). In Minnesota, 17% of loon deaths were caused by lead toxicosis (Ensor et al. 1993).

In March of 1994, the Environmental Protection Agency (EPA) proposed a ban on the production, distribution and use of lead sinkers less than 1 inch in any dimension, citing reports that 64% of adult loon mortality in New Hampshire and 44% of adult loon deaths in Maine had been caused by lead sinker ingestion. The use of lead shot has already been banned throughout the United States. Lead sinkers were banned in Great Britain in 1987 (North American Loon Fund, pers. comm.) because of documented effects on Mute Swan *(Cygnus olor)* populations. The EPA has since dropped consideration of its proposed lead sinker ban, on the grounds that the problem impacts only the Northeast section of the country. In 1996, VFWD developed a sign warning anglers of the dangers of monofilament line and lead sinkers to loons and waterfowl. This sign was posted at boat accesses statewide. A list of companies that produce non-lead sinkers was also distributed to lake-users statewide. Concerns remain about loon mortality due to lead poisoning.

3. Water Level Fluctuations:

Lakes and ponds experience natural water level fluctuations due to spring thaw, excess rain, drought conditions, and beaver dams. During periods of normal rainfall, loons can adapt to most natural fluctuations through nest-site selection, nest maintenance, timing of nest initiation, renesting, and nest-site tenacity (Vermeer 1973, McNicholl 1988), water level fluctuations resulting from human-made dams can cause nest failures and can reduce the suitability of a lake for breeding loons. In Vermont, hydroelectric companies control water levels on 12 of 23 lakes that supported breeding loon pairs in 1995 and 1996.

Significant and/or frequent water level fluctuations threaten loon nesting success in a number of ways. Rising water can flood nests or exacerbate the effects of wave action. Low water levels can facilitate depredation of island nests by enabling shoreline mammalian predators to more easily reach island nest sites. When lake levels are drawn down, loons must expend more time and energy getting to the nest during incubation exchanges. Eggs are left unattended for longer periods, increasing their vulnerability to depredation or exposure. If a nest is stranded too far from the water, a loon pair may abandon it. Water drawdowns also create more visible paths from a nest to the water, increasing conspicuousness to predators. Newly-hatched chicks are more vulnerable to predators and susceptible to fatigue, the farther a nest is from the water's edge (Fair 1979). Water level fluctuations also tend to increase water turbidity. If water level fluctuations occur repeatedly (between years or within a single season), debris can accumulate on the changing shoreline, making traditional nest sites inaccessible to loons (Strong and Bissonette 1987).

Nesting onset may be delayed if water levels are maintained at artificially high levels during spring. Delayed nesting can affect chick survival, as late-hatched chicks may not be fully fledged or adequately prepared for migration prior to ice formation on their natal pond. Furthermore, renesting attempts are less likely if initial nesting is delayed. When historical nest sites are submerged, loons may be forced to select less optimal sites or may forego nesting altogether (Fair 1979, Sutcliffe 1980, Strong 1985).

Water level fluctuations caused 24% of Common Loon nest failures in the Northeast between 1976 and 1991 (Rimmer 1993). Several additional studies have documented the role of artificial water level fluctuations in the decline of loon populations in the northeastern and central portions of the United States, due to nesting inhibition, flooding, nest abandonment from water drawdowns, and depredation of unattended nests (McIntyre 1975, 1988, Sawyer 1979, Barr 1979, Fair 1979, Metcalf 1979, Wood 1979, Ewert 1988). Forty-three percent of Vermont loon nest failures with known causes from 1978-1997 were due to flooding or stranding (Table 2).

4. Environmental Contaminants

a. Organochlorines

Organochlorines and their residues have been detected in loon eggs and carcasses. Pesticides (PCB and chlorinated hydrocarbons, DDT, DDE, dieldrin) interfere with calcium metabolism, which reduces the reproductive capacity of adults. Loon eggs with higher levels of DDE residues tend to have thinner shells than eggs with lower residue levels, which may permit invasion by bacteria (McIntyre 1975, Ridgely 1975, Sutcliffe 1978), but which has not been shown to cause shell breakage. Embryos in the last few days before hatching and chicks in the first few days after hatching are vulnerable to death, resulting from elevated residues in yolk lipids and in chicks' fat reserves (Ridgely 1975).

Fetal development is also affected by PCBs (polychlorinated biphenyls). In Vermont, PCB levels in selected fish species are above the level considered safe for human consumption in 4 out of 6 bodies of water tested, being highest in Lake Champlain and the Hoosic River (Walsh and Ketelsen 1993). Dioxins can cause decreased testosterone levels in male loons and cancer in both sexes (Walsh and Ketelsen 1993). While there has been no documentation of lowered productivity in loons as a result of elevated pesticide loads (Barr 1979, Sutcliffe 1978), no specific investigations have been conducted in Vermont.

b. Acid Precipitation:

Acid precipitation may reduce the quality of loon nesting lakes. Acid precipitation causes changes in the abundance, composition, and distribution of biota (Barr 1986, Ashenden 1988), and increases the solubility and mobility of highly toxic metals, such as cadmium, aluminum, and lead (Mitchell 1989). Lake acidification accelerates the release of mercury from sediments into the water column, facilitating its uptake through the aquatic food chain. Acidification reduces the concentration in prey of essential elements, such as selenium and calcium, needed for egg production and growth of chicks. These elements are also needed to reduce the toxicity of heavy metals (Pokras et al. 1993).

Studies of lake acidity and loon breeding success indicate that brood production is higher on lakes with low acidity (pH < 6.3) (McNicol et al. 1987, Alvo et al. 1988) and that greater brood mortality occurs on acidic lakes with reduced prey bases (Parker 1988, Blair 1989). Acidification and reduced water quality may also affect the suitability of breeding lakes to loons, by altering concentrations of elements such as dissolved organic carbon, phosphorous, iron, aluminum, nitrate, manganese, and ammonia. While loons may derive short-term benefits from acidification through increased water clarity and improved foraging opportunities (Mitchell 1989), longer-term reductions in prey diversity and quality due to lake acidification have been documented as a cause of loon population declines in eastern North America (Alvo 1986, Parker 1986, McNicol et al. 1987, Alvo et al. 1988, Blair 1989). The effects of acid precipitation on Vermont's loon population have not been investigated.

c. Mercury

Methylmercury poisoning has been implicated as the most widespread, irreversible, and deadly threat to loons (McIntyre 1988). It is known to cause decreased productivity and increased mortality (Stroud and Lange 1983, Alexander 1985, Ensor et al. 1993, Pokras et al. 1993). While mercury is a naturally occurring element in aquatic ecosystems, atmospherically deposited levels have increased 3-4 times in North America during the postindustrial era (Evers et al. in press). In New England, trash incineration is a major source of mercury emissions (Walsh and Ketelsen 1993).

Loons are considered to be at risk from elevated mercury levels because they are long-lived birds at the top of the aquatic food chain, where biomagnification and bioaccumulation are highest (Stroud and Lange 1983, Evers et al. in press). Mercury effects the central nervous system, peripheral nervous system, kidneys, and red blood cells. It causes weakness, weight loss, muscle atrophy, and paralysis of gastrointestinal muscles, which interferes with food consumption (Pokras et al. 1993). Mercury toxicity impairs motor coordination, affecting loons' diving and feeding abilities (speed and maneuverability). Emaciation is considered to be a clinical symptom of elevated mercury levels in the liver (Ensor et al. 1993, Pokras et al. 1993). During the winter of 1983 a massive die-off of loons occurred in the Gulf of Mexico, with about 7,500 carcasses recovered. Necropsies revealed high levels of mercury, concurrent with fluke infestation and emaciation (Alexander 1985).

While loons may be able to eliminate 90% of their methylmercury burden through feather molting (Pokras et al. in press), several studies have implicated mercury in causing reduced reproductive success (Barr 1979, 1986, Frank et al. 1983, Okoniewski and Stone 1986, Ensor et al. 1993, Meyer et al. 1993). Mercury affects reproductive behavior by reducing territorial defense and tenacity to the nest site (Barr 1986). It can block egg production, lead to malformed embryos, and cause increased mortality of chicks (Barr 1979). Mercury also causes visual impairment, which affects fishing and territorial defense. Because mercury toxicosis reduces nest site tenacity, conditions of low water levels or high intraspecific competition and aggression may increase the probability of nest abandonment (Blair 1989). Recent studies have found significantly elevated blood mercury levels in loons nesting on low pH lakes in Wisconsin (Meyer et al. 1995). While no specific information exists on mercury concentrations in Vermont loons, adults sampled from New Hampshire and Maine showed the highest feather mercury levels of any populations sampled in North America (Evers et al. in press)

IV. MONITORING AND MANAGEMENT

The Common Loon monitoring and management project in Vermont is a cooperative effort between VINS, VFWD's Nongame and Natural Heritage Program, the Green Mountain National Forest, the Vermont Department of Forests, Parks and Recreation, several Vermont hydroelectric companies, VFWD game wardens and district biologists, The Nature Conservancy (TNC), and a network of volunteers. The project recognizes public education as a management tool that is essential and complementary to conservation of loon habitat and active protection of nesting pairs.

Current loon management practices in Vermont include:

1) stabilization of water levels during the nesting period through cooperation with hydroelectric companies;
2) placement of artificial nesting platforms (rafts) in appropriate waters;
3) placement of warning sign buoys in the water to discourage human intrusion of nest and nursery sites;
4) placement of informational signs at access areas on lakes occupied by territorial loons;
5) public education regarding loon population status and conservation needs;
6) monitoring of loon behavior and reproductive status and success, including coordination of an annual loon watch (census) day.
7) enforcement of laws protecting loons by VFWD game wardens.

These management practices are described below, with recommendations for future implementation:

1. Water Level Stabilization

Although impounded waters pose a challenge to loon nesting success, human-made reservoirs, if carefully controlled, do provide excellent habitat for loon nesting and chick rearing (McIntyre 1988). An optimal water level for loon nesting should be determined prior to the breeding season. The target water level, once achieved, then needs to be stabilized within a specified range (generally ± 2 in) throughout the nesting period. The key to stabilizing water at optimal levels for breeding loons is communication between hydroelectric companies and the agency responsible for loon monitoring. Success of management efforts on Lake Umbagog in New Hampshire improved dramatically after a target water level regime was established, with the number of loon nests fledging chicks increasing from 6 to 12 per year (Fair and Poirier 1993).

In Vermont, cooperative efforts to stabilize water levels were initiated in the late 1980s and have led to verbal agreements on 6 of 11 loon lakes managed by hydroelectric companies (East Long Pond, Green River Reservoir, Moore Reservoir, Norton Pond, Peacham Pond, and Somerset Reservoir) . Voluntary compliance with specified target water levels is solicited through an annual written appeal from VFWD to each hydroelectric company or other group responsible for water control structures. Although accurate statistics are not available, nesting success has improved on these 6 lakes since 1990, and most nest failures have resulted from causes other than flooding or stranding. Verbal agreements have not yet been established, but are being explored, on 5 other lakes managed by hydroelectric companies (Little Averill Lake, Marshfield Reservoir, Miles Pond, Seymour Lake, and Thurman Dix Reservoir). Two of these lakes have experienced recent nest losses due to water level fluctuations.

Each spring, specific protocols are followed to establish communication between VFWD/VINS and each cooperating hydroelectric company that manages a lake or reservoir supporting breeding loons. These protocols include:

1) designating key individuals to represent both VFWD/VINS and the hydroelectric company, in order to streamline communication;
2) implement a protocol for regular communication during the nesting season, including responses to emergency events;
3) providing formal written communication in advance of each loon breeding season from VFWD to the hydroelectric companies specifying these protocols. This annual letter summarizes recent loon nesting history on each impoundment, specifies an optimum water level range, requests that levels be maintained within this range from 1 May to 1 August, and provides phone numbers of primary VFWD and VINS contacts.

The VINS biologist contacts each designated hydroelectric company or other group representative when appropriate, including:

1) prior to the nesting season, as a means to establish preliminary annual communication;
2) as soon as nest building begins;
3) as soon as laying of the first egg occurs, or when incubation is first confirmed;
4) as soon as nesting ends (nest fails or chick[s] hatch).

An automatic water level gauge was installed on Norton Pond prior to the 1997 breeding season. This gauge signals when water levels have risen above or fallen below specified optimal levels (with a 2-in margin of error in both directions). An alarm rings in the residence of the VINS loon biologist, with back-up calls to two representatives from VINS and VFWD. One of these individuals then calls a lake resident to verify the threat to the loon nest, and then, if warranted, the hydroelectric company is called. Water level gauges should expedite communication during potentially threatening situations and ensure prompt action to avoid nest loss from flooding or stranding. These gauges should also reduce the potential for human error in monitoring water levels subjectively or through the use of a temporary device (e.g., stream gauges).

2. Artificial Nesting Platforms

Artificial nesting platforms (rafts) have been placed on Vermont lakes where historical nest sites have experienced egg depredation or on lakes subject to chronic water level fluctuations. Platforms have also occasionally been placed on Vermont lakes that lack natural islands or that have shoreline which is not suitable for loon nesting due to development or human disturbance.

Artificial nesting platforms can be an important tool for reducing mammalian depredation of nests. Platforms provide an alternative to shoreline nest-sites, locating loon nests farther from potential mammalian predators. Platforms can also be located in deeper water, allowing for less conspicuous underwater approaches by adults during nest exchanges. However, platform nests are sometimes more conspicuous than shoreline nests, increasing their risk of detection. Avian depredation of eggs can be discouraged by constructing a vegetative, roof-like covering over the platform.

Artificial nesting platforms can mitigate the effects of fluctuating water levels, provided that loons use them. Platforms alone are unlikely to attract loons to an unoccupied body of water (McIntyre and Mathisen 1977), but they do serve to enhance habitat by imitating loons' preferred island nesting substrate. In one Minnesota study, nesting success increased by 59% following the addition of platforms to breeding lakes (McIntyre and Mathisen 1977). However, platform placement should be carefully considered because less visible nests tend to experience higher hatching success than more conspicuous nests (Titus and VanDruff 1981). Platform nests tend to be more visible than shoreline nests or hummock nests located in swampy areas. Loons nesting on platforms, therefore, tend to be more vulnerable to disturbance than loons nesting on natural sites. Regular vigilance and monitoring by lake residents can significantly improve the success of platform nests that are susceptible to disturbance. Some evidence suggests that construction of bog mat islands on lakes that are subject to fluctuating water levels may benefit loons more than the placement of nesting platforms (Reiser 1988). The bog mats become a permanent and natural part of the habitat, do not have to be removed at the end of each season, are less conspicuous than platforms, and will rise and fall with fluctuating lake levels.

Prior to platform placement on Aziscohos Lake in Maine, an average of 2 chicks fledged from 2 nests per year. After platforms were placed on the lake, chicks fledged from an average of 8 nests per year, with 5 of the 8 platforms being used annually by loons (Fair and Poirier 1993). Between 1981 and 1987, platform use in Maine ranged from 25-50% (Lee and Arbuckle 1987). In New Hampshire, platform use was 50% in 1987, with 22% of the chicks hatching from platforms (McCoy 1988).

Artificial nesting platforms have been used on 18 different Vermont lakes since 1979 to enhance loon breeding success (Appendix A). They have been used successfully, although not annually, on 8 lakes. Between 1979 and 1986, up to 6 platforms were placed by VINS and VFWD each year on various occupied loon lakes, or on lakes believed to have potential for supporting breeding loons. Only one instance of platform nesting was recorded during those 8 years, on East Long Pond in 1981, when the eggs were abandoned for unknown reasons. Between 1987 and 1997, up to 12 platforms were placed on loon lakes. Probably as a result of more careful placement, the use of platforms was consistently higher in 1987-1997 than in 1979-1986, averaging 25% and 16%, respectively.

It is important to note that placement of a platform on a lake does not guarantee that nesting will occur. Loons sometimes select natural sites over platforms, even when previous nests at a natural island or shoreline site have failed. Maintaining stable water levels within a specified optimum range during nesting will continue to be essential to enhance breeding success of Vermont loons, even on lakes where platforms are used.

Guidelines for Placement of Artificial Nesting Platforms

Placement of artificial nesting platforms should be carefully considered on a lake-by-lake basis. Platforms are most appropriate on lakes with the following characteristics:

1) natural island sites: a) do not exist; b) are not available (e.g., used for campsites or cottages); or c) are not suitable (e.g., inappropriate substrate, steep incline; debris accumulation, presence of predators);
2) chronic water level fluctuations cause nest failures;
3) mammalian predators cause nest failures, especially of shoreline nests;
4) undeveloped shoreline suitable for loon nesting is lacking;
5) platforms can be routinely monitored for human disturbance;
6) protected bays or coves are available with vegetation to sculpt nest bowls and provide cover;
7) protected coves are available near platform site, for use as nursery areas

3. Warning Sign Buoys

It has been well documented that warning sign buoys help to deter boat traffic and reduce human disturbance of loon nest sites. Prior to placement of floating signs in Montana, human-related disturbance of nest sites (boats and shoreline activity) accounted for 59% of flushes, with fishing boats, canoes, kayaks, and rowboats causing most disturbances (Kelly 1993). Loons were kept off their nests an average of 24 minutes per flush. The number of successful nests (defined both in terms of number of chicks hatched and number of 2-chick broods) increased significantly after warning sign buoys were placed (Kelly 1993).

In 1987, VINS and VFWD, in cooperation with TNC, placed warning sign buoys at the entrances to nesting or nursery coves and around nesting islands that were determined to be especially vulnerable to human disturbance. These signs, used on 4 breeding lakes in 1987, appeared to significantly limit disturbance to the nesting loons (Rimmer and Kaveney 1987). In recent years, up to 30 buoys have been placed on as many as 9 breeding lakes. Decisions to use sign buoys are made on a site-by-site basis each year, carefully weighing factors such as the risk of drawing attention to a nest and whether or not volunteers are available to monitor human use around signed areas. Buoys are typically placed at distances of 200-300 ft from loon nests (generally the distance at which an incubating loon is observed to become agitated, i.e. adopt "crouching" behavior, plus 25%). These distances avoid subjecting incubating loons to unnecessary stress, while minimizing restriction of lake use by boaters and anglers. Warning sign buoys have also been used to inform boaters of loon nursery areas. Because loons tend to select coves as nursery areas, floating signs can be placed at the entrance of nursery coves to inform lake users that a loon family may be present.

4. Informational Signs

Stationary signs are also posted at all lake access areas where breeding and non-breeding loon pairs have been observed on a regular basis. These signs inform lake users of the adverse impacts of human disturbance on loon reproductive success, and warn that harassment of loons is an illegal act punishable by state and federal laws. After chicks have hatched, signs warning boaters of the presence of loon chicks are placed at lake access areas. Signs are also posted at these areas warning anglers of the harmful effects of discarded monofilament line and lead sinkers on waterfowl.

5. Annual Monitoring

Monitoring and protection of Common Loons in Vermont has been carried out by VINS and VFWD annually since 1978, with the exception of 1980. Monitoring efforts include regular visits (approximately once per week) by a VINS or VFWD biologist to lakes and ponds occupied by territorial pairs, less frequent surveys of other lakes where loons have been reported or historically observed, and opportunistic visits to lakes that are believed to be potentially suitable for loon occupancy. Monitoring responsibilities include locating territorial and breeding pairs, documenting nesting chronology and nest-site locations, recording numbers of chicks hatched and surviving through August, and identifying potential nesting habitat on lakes not known to support breeding pairs. Water levels, loon behaviors, boating and other human activity, weather conditions, and observations of other wildlife are also recorded. Nests are located by observing territorial pairs, checking historical nest sites, and, if necessary, carefully searching the perimeter of lakes and ponds. Caution is taken not to disturb incubating loons. Observations are conducted with binoculars from a canoe, kayak, or small motorboat, and occasionally from shore. Vermont State Park staff, VFWD game wardens, and local volunteers assist with monitoring on some breeding lakes.

Volunteers have provided invaluable assistance by monitoring breeding pairs and reporting loon observations. As of 1995, campowners regularly monitored loon activity on more than half of the lakes supporting a territorial pair, and they often report or prevent human disturbances to nests or loon families. Some volunteers also assist VINS or VFWD biologists with buoy and platform placement, and educate lake-users about the presence of these structures and the need to avoid them. Volunteer monitoring of lakes only sporadically occupied by loons is usually more casual and intermittent, but often provides useful information for the loon biologist.

To estimate the mid-summer loon population in Vermont, a statewide loon survey (Loon Watch Day) has been conducted annually since 1983. On the third Saturday in July each year, volunteer observers survey assigned lakes, ponds, and reservoirs from 0800 to 0900. A core of lakes is prioritized for coverage based on known current and historical use by loons. Each observer records the number of adult, immature (subadult), and juvenile loons counted on a standardized data form, which is returned to VINS. The information is compiled to provide an annual index of Vermont's loon population. Vermont's Loon Watch Day is synchronized with similar surveys in New Hampshire and Maine.

6. Law Enforcement

VFWD game wardens have played an increasingly important role in loon protection. The VINS biologist establishes written contact each spring with all wardens in districts with recent loon nesting. This letter informs wardens of the previous breeding season's results and requests their assistance, especially in investigating cases of harassment or other disturbance. Wardens have been instrumental in reporting loon nesting or other significant events (e.g. grounding, stranding, injury, death). State police dispatch numbers are listed on posted informational signs to aid reporting of incidents to local wardens. Some legal citations have been issued in recent years, and the increased presence of wardens has visibly enhanced statewide protection efforts.

V. EDUCATION

Public education about loons and their conservation needs is vital to long-term stabilization of Vermont's loon population, and to protection of its habitat. Currently, the following methods are used to provide educational opportunities for the public:

1) Common Loon slide lectures, and VFWD's endangered species slide program that includes the Common Loon, are presented to audiences at Vermont State Parks, Audubon chapters, schools, libraries, lake associations, and other interested organizations;
2) periodic radio features are presented. Radio features in 1995 and 1996 included an announcement of the annual Loon Watch and ongoing "Nature Notes" on Vermont Public Radio;
3) periodic articles and press releases featuring Vermont loons are sent to newspapers and periodicals by VFWD and VINS. These range in content from features on loon biology and statewide conservation efforts by VINS and VFWD, to articles highlighting volunteer involvement in the project, to announcements of events like Loon Watch Day, to press releases regarding the issue of lead poisoning from sinkers;
4) access area signs and informational posters are widely distributed;
5) concerted efforts are made by the VINS biologist, VFWD staff, and volunteers to informally educate the public through regular personal contacts. These include informing lakeshore residents and boaters about loon conservation needs, maintaining established contacts on lakes regularly occupied by loons, and attempting to enlist new participants in the statewide volunteer network;
6) VINS and VFWD annually distribute information about Vermont loons to all project volunteers and other interested parties, and respond to all requests for such information. Available information includes a VFWD fact sheet, the annual VINS/VFWD monitoring report and 1-page project summary, plans for constructing nesting platforms, and copies of newsletter or other relevant articles.

VI. STRATEGIES FOR RECOVERY OF COMMON LOONS IN VERMONT

Recovery Plan Goals: The overall goal of this recovery plan is to establish a stable breeding population of Common Loons in Vermont and to attain population levels that will justify removing the species from the Vermont Endangered and Threatened Species List. There are 2 specific recovery goals:

Goal 1) A minimum statewide breeding population of 30 nesting pairs averaged over 5 consecutive years, with sufficient productivity to maintain population stability (average 1.0 fledglings/pair), to allow consideration of this species for downlisting from endangered to threatened status;

Goal 2) A minimum statewide breeding population of 40 nesting pairs averaged over 5 consecutive years, with sufficient productivity to maintain population stability (average 1.0 fledglings/pair), to allow consideration of this species for delisting from threatened status. Loons should be established either in a minimum of 2 geographically discrete areas of the state separated by at least 40 air miles, with a minimum of 5 nesting pairs in each area, or over a broad, continuous statewide distribution.

Justification for Recovery Plan Goals: The recovery plan goals are based on several factors:

1) Although few historic population data exist, it seems likely that Vermont formerly supported at least 50 nesting loon pairs. This figure is based on an examination of known recent and historic breeding records, and a subjective determination of the state's current carrying capacity. Including Lake Champlain, which probably once supported multiple breeding loon pairs, at least 45 Vermont water bodies are known to have supported loon nesting since 1900. Owing to the paucity of published records prior to 1977, there were likely additional breeding lakes and ponds that were never documented.

2) In addition to the 25 Vermont water bodies that supported 26 breeding loon pairs in 1995-1997, 13 lakes were occupied by territorial pairs in 1 or all years. At least 2 reservoirs (Green River and Somerset) which historically supported 2 nesting loon pairs, but are currently occupied only by a single breeding pair, still appear to contain adequate habitat to support 2 pairs. Several lakes and ponds (e.g., Berlin, Gale Meadows, Jobs, Pigeon, Turtle) with a history of loon occupancy or nesting, but which have not supported recent breeding, appear to provide suitable loon habitat. Several other lakes and ponds (e.g., Caspian, Joe's, Martin's, Nichol's, Noyes, Osmore, Waterbury) that were sporadically occupied or used for breeding by loons appear to have marginal potential for future nesting, but might be improved with concerted management and public education efforts. Thus, a total of at least 40 Vermont water bodies appear capable of supporting nesting loons.

3) Because an individual loon pair may not nest every year (J. Fair, pers. comm.), target breeding population levels should be averaged over 5 consecutive years for downlisting to be considered. A 5-year average would allow for small annual fluctuations in population levels, yet would be sensitive to larger, potentially problematic changes, such as a steep 1-year decline.

4) Although no published information exists on minimum productivity levels needed for self-sustaining Common Loon populations, Vermont's loon population growth during the 13-year period from 1984-1997 was accompanied by an average annual productivity rate of 1.01 fledglings/nesting pair (range 0.75- 1.3). During a period of relatively stable population levels from 1988-1994, over which the total number of nesting pairs increased only from 12-14, annual productivity averaged 0.98 fledglings/nesting pair. Thus an average productivity of 1.0 fledglings/nesting pair seems necessary to ensure stability of Vermont's loon population. We recommend that this level, in conjunction with the specified target breeding population goals over 5 consecutive years, be met in order to consider the species' downlisting on the Vermont Endangered Species List.

5) Common Loons currently breed in 2 discrete areas of Vermont: the Northeast Kingdom south to Barre/Berlin (23 nesting pairs in 1997) and southern Vermont between Somerset and Mt. Holly (2 pairs in 1997). The nearest two lakes in each area (Berlin Pond and Lake Ninevah, respectively) are separated by about 50 air miles. The existence of self-sustaining loon populations in each area could be important in buffering potential effects of a region-specific traumatic event (e.g., disease, severe weather, environmental contamination) that might cause widespread mortality or breeding failure. We further believe that sufficient suitable habitat exists in south-central and southern Vermont to support ≥ 5 nesting loon pairs. We thus recommend either occupancy of two geographically distinct areas of the state by a minimum of 5 nesting pairs for 5 consecutive years or a broad, continuous statewide breeding distribution before delisting is considered.

Recommended Actions to Achieve Recovery Goals: The recovery of Vermont's breeding loon population requires a strategy that combines monitoring, management, research, and education. The cooperation and active participation of a diverse array of interested groups will be necessary to achieve the recovery goals. Management and protection efforts must address both long- and shorter-term conservation issues. Many short-term measures (e.g. annual protection of individual breeding pairs and family groups) will have to be implemented on a site-specific basis and will require a flexible, adaptive strategy. Longer-term measures that safeguard critical habitat from development or that address broad threats to loon population viability (e.g. environmental quality or issues related to human uses of loon lakes) will require a coordinated, statewide approach. The most vital single ingredient to the successful recovery of loons in Vermont will be continued and effective education of all groups whose activities overlap with or potentially impact the species.

The actions recommended below are separated into those deemed to be of high priority that should be achievable in the short-term (1-5 years), given existing constraints of funding and available human resources, and those that we believe to be desirable but that may not be realistically achievable within 5 years.

1. Monitoring

Continued annual monitoring of the statewide breeding population will be necessary to determine population levels and trends, including: 1) locations of all nesting and territorial pairs; 2) locations of nest sites, in order to determine specific needs for protection; 3) hatching and fledging success; 4) total number of fledglings; 5) productivity; and 6) identification of factors limiting reproductive success. This information will form the basis for evaluating the extent to which recovery goals have been met.

Short-term, high priority actions:

a) Continue to dedicate a full-time seasonal Loon Biologist who will be responsible for coordinating statewide field monitoring, compiling field data, and producing an annual report on the population status of Vermont loons (see Appendix B for position description).
b) Reallocate existing VFWD staff to further incorporate district biologists in monitoring and management efforts; provide field training as appropriate.
c) Further develop network of volunteers and cooperators to take on greater share of routine monitoring at selected sites and to conduct searches at prospective loon breeding lakes.
d) Improve coordination of volunteers, improve standardization of data collection among volunteer loon monitors, maintain a computerized volunteer data base. Investigate possibility of creating a position (paid or volunteer) of Loon Volunteer Coordinator.
e) Continue to coordinate Vermont Loon Watch Day on third Saturday in July. Examine value of data as a mid-summer loon population index.

Longer-term, medium priority actions:

a) Develop a computerized data base of all breeding population parameters collected since 1978 and incorporate in future analyses and reports of population trends and reproductive statistics.

2. Management

Short-term management activities will continue to focus on enhancing loon nesting success and productivity. Most will be implemented on a site-specific, annual basis. Longer-term goals include measures to secure protection of loon habitat in Vermont.

Short-term, high priority actions:

a) Continue efforts to stabilize water levels through cooperative agreements with hydroelectric companies; work in coordination with VFWD fisheries biologists to ensure protection of all aquatic organisms.
b) Annually evaluate water level management regimes on all impounded lakes and reassess site-specific protocols (i.e. optimum water levels for loon nesting, emergency response protocols).
c) Urge the Vermont Endangered Species Committee to advise the Secretary of the Agency of Natural Resources (ANR) and the Commissioner of VFWD to develop effective legal means to restrict human access to areas around loon nests;
d) Continue to use artificial nesting platforms as necessary; maintain and upgrade existing platforms as needed; maintain and update an inventory of platforms for tracking purposes.
e) Continue to use warning sign buoys as needed; upgrade sign language and design as necessary; maintain and update an inventory of number and locations of buoys.
f) Continue to post informational signs at VFWD and other access areas; replace and update signs periodically as needed.
g) On heavily-used lakes or lakes with loon nests that are especially vulnerable to human disturbance, recruit volunteers and project cooperators to patrol nesting or nursery areas, particularly during periods where heavy human traffic may interfere with loon breeding activities (e.g., July 4th weekend).
h) VINS/VFWD biologists who monitor specific lakes should make regular contact with local game wardens to coordinate site-specific management; training and orientation should be provided as appropriate. Wardens should be encouraged to aggressively and proactively protect loons. Immediate contact should be made if any law enforcement violations are witnessed or reported.

i) Urge the Vermont Endangered Species Committee to work cooperatively with ANR, especially VFWD, to reduce the threat of lead sinkers to loons.

Longer-term, medium priority actions:

a) As opportunities arise, explore options for habitat acquisition or long-term protection through conservation easements, creation of buffer zones, zoning ordinances, or through formal cooperative management agreements with landowners and regulatory agencies.
b) Review impacts of boat and other human traffic on individual lakes and develop site-specific recommendations for means to reduce human disturbance on loon nests or family groups.
c) Develop an information sheet and set of management protocols/options for each loon breeding lake. These should include: 1) a detailed map of each lake with known nest sites and nursery areas delineated; 2) a list of key contacts (e.g., volunteers, local game warden, district VFWD biologist, hydroelectric company representative) with phone numbers; 3) a brief history of loon occupancy and breeding status on the lake; 4) a list of identified management issues and loon management needs; 5) a list of management activities that have been used (e.g., platforms, sign buoys, water level gauges, agreements with hydroelectric companies); and a summary of protocols to be followed in specific situations. These information sheets should be distributed to all concerned parties and updated annually. This task could be accomplished by an intern or as an undergraduate thesis project.
d) Explore means to reduce nest predation levels, if appropriate and feasible. This could include investigating predator fencing around nests or modifying platform designs;
e) Explore means to enhance habitat (e.g., substrate modification, creation of bog mats or islands) if deemed feasible and necessary to promote successful nesting on specific lakes.

3. Research

Although a solid base of information exists on the distribution and population status of Vermont loons since 1978 (see Appendix C for 1978-1997 lake-specific nesting chronology), many questions remain about the ecology, demography, and projected long-term viability of the statewide breeding population. These include: 1) factors affecting the carrying capacity of Vermont lakes for loons, 2) patterns of occupancy and recruitment, 3) age structure and turnover of the breeding population, 4) extent and effects of intraspecific competition, 5) impacts of human disturbance on breeding pairs and family groups, 6) impacts of environmental contaminants on the breeding population, and 7) the effectiveness of current management techniques. Some data addressing these questions have been opportunistically collected, but little focused research has been conducted. While we believe that the endangered status of Vermont's loon population precludes most types of potentially invasive research on demographics and population ecology, carefully selected studies could provide information that will help promote the recovery of a stable, self-sustaining population. However, given existing constraints of funding and available staff, we recommend implementation of the research outlined below only if adequate resources become available and if such research can be conducted without impinging on high priority monitoring, management, and education efforts.

Specific recommended research activities include:

a) Develop a data base to characterize all lakes used by nesting loons since 1978, as well as those where non-breeding pairs or individuals have been regularly observed since 1987 (i.e., the most recent 10 years). This should include data on: 1) physiography (e.g. surface area, perimeter, maximum and mean depth, number of natural islands), 2) turbidity, 3) acidity, 4) concentrations of environmental contaminants (e.g. mercury, selenium, PCBs, etc. if such data available), 5) extent and types of shoreline development (e.g. number of permanent and seasonal dwellings, 6) extent and types of human recreational use (if data available), 6) information on fish prey base, if data available (e.g. angling catch, stocking volume and frequency). These and other data might enable an assessment of lake parameters that are important for loon occupancy and/or successful breeding, and might help prioritize certain lakes for protection or enhancement of loon nesting. This could be carried out by an intern or as an undergraduate senior thesis project.

b) Conduct a thorough assessment of lake occupancy patterns and habitat suitability. Incorporating data on lake characteristics (above), this analysis should compare: 1) lakes regularly occupied, sporadically occupied, and chronically unoccupied by loons; 2) lakes that consistently support successful loon breeding, lakes on which successful breeding is sporadic, and occupied lakes that are either not used for breeding or on which breeding is unsuccessful; and 3) lakes with high productivity versus those with low productivity. The goal of this analysis would be to develop a set of objective, measurable criteria that provide an assessment of lake suitability for loons. This might help to prioritize or direct management efforts by identifying those lakes most important to active or potential breeding pairs, as well as identifying limiting factors that might be modified to enhance habitat conditions for potential future nesting. This would also enable a more quantitative assessment of Vermont's carrying capacity for breeding loons than is currently possible and could help refine recovery goals. Such a project could be combined with development of the above data base and might be suitable as a graduate research topic.
c) Investigation of the impacts of human activities on breeding pairs and family groups. Although human disturbance is frequently cited as a threat to breeding loons, few quantitative data exist by which to establish management guidelines. A carefully designed study conducted at various stages of the breeding cycle, involving standardized field observations, could be used to develop specific recommendations to better manage human activities near loon breeding sites. Such a study could incorporate volunteers and might constitute a graduate thesis project or undergraduate internship.
d) Assessment of the extent and impacts of environmental contaminants in Vermont loons. Currently, VINS and VFWD cooperate with several groups (e.g., Loon Preservation Committee, Tufts University Wildlife Veterinary Clinic, BioDiversity, Inc.) who are investigating this. Such cooperation should be continued and expanded, if appropriate. Any future studies that might incorporate the use of live loons must be carefully reviewed for their value and risk to loons in Vermont.
e) Evaluation of the effectiveness of current management tools (e.g., warning sign buoys, artificial nesting platforms, automatic water level gauges, access area signage). Information on both loon and human responses to these tools under various circumstances could help guide improvements in their usage. Such an evaluation might include a survey of lake user attitudes towards loons.

4. Education

Enhanced public awareness of loon conservation needs will be essential to achieve the recovery goals. Although important gains have been made in educating lake users, resource managers, and the general public, increased efforts are needed to augment existing educational activities. Volunteers will play a key role in building appreciation of loons and support for loon conservation among the general public.

Short-term, high priority actions:

a) Continue educational efforts described in Section V (above), including expanded offerings of public slide lectures and promotion of such programs at state parks, summer camps, private campgrounds, municipal libraries, Audubon Society chapter meetings, and lake association meetings.
b) Improve educational materials by incorporating specific information about avoidance of human disturbance to breeding loons, responsible use of recreational watercraft, and recommended means to limit fishing gear impacts to loons.
c) Continue to produce and disseminate annual monitoring reports, 1-page project summaries, and VFWD fact sheets (periodically updated as necessary).
d) Increase efforts to educate lake users and the general public about the dangers of lead sinkers and lead poisoning, and the availability of alternatives to lead. Information on this issue should be published in the VFWD Law Digest.

Longer-term, medium priority actions:

a) Produce regular articles and press releases in conjunction with VFWD from April-September in local newspapers, including appeals for volunteers.
b) Develop permanent interpretative displays at state parks or other public facilities close to loon breeding lakes; encourage cooperation with Vermont Forests, Parks and Recreation Department to accomplish this.

c) Develop an annual spring "kick-off" informational packet on loon population status and conservation needs in Vermont, with an appeal for volunteers. Publicize through radio, television, newspapers, and other media. This would require a paid Volunteer Coordinator or a committed volunteer.
e) Provide a mid-summer update, just before Loon Watch Day, using the above media. This would also require coordination by paid staff or a dedicated volunteer.
f) Organize an end-of-summer "festival", promoted through the above media, as a means to thank volunteers, provide information on results from the breeding season, and further educate the public. This could be combined with other wildlife-oriented public events and would require extensive volunteer coordination.
h) Develop new promotional materials to increase public awareness and generate funds for monitoring and management, such as an "adopt-a-loon pair" program, special posters or bumper stickers for loon volunteers to display, T-shirts for volunteers, etc.
j) Develop a program on loon biology and conservation to incorporate into public school curricula.

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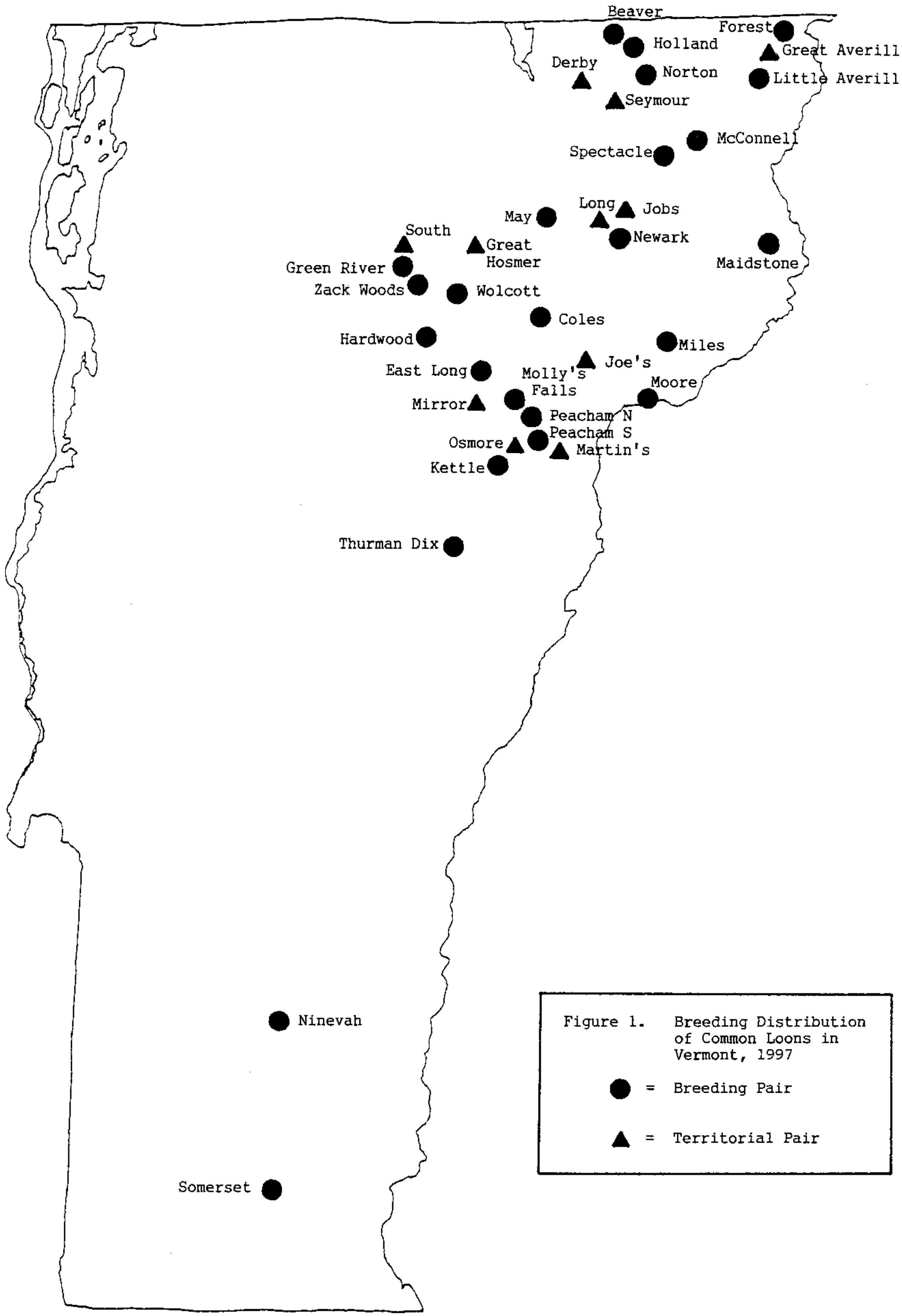

Figure 1. Breeding Distribution of Common Loons in Vermont, 1997

Figure 2. Common Loon Population Levels in Vermont, 1978-1997.

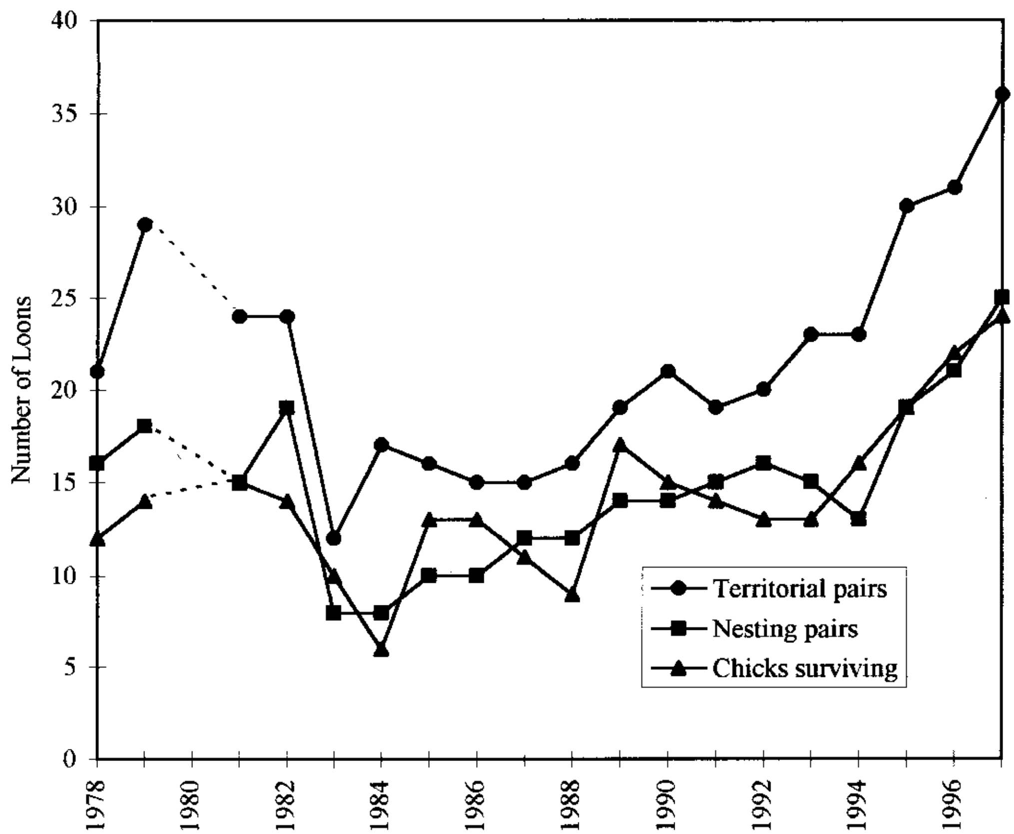

Table 1. Population and reproductive statistics of Common Loons in Vermont, 1979-1997.

YEAR	79	80	81	82	83	84	85	86a	87	88	89	90	91	92b	93	94	95	96	97
Territorial pairs	29	---	24	24	12	17	16	15	15	16	19	21	19	20	23	23	30	31	36
Nesting pairs	18	---	15	19	8	8	10	10	12	12	14	14	15	16	15	14	19	21	25
Successful pairs	12	---	11	12	6	6	8	9	9	7	10	9	10	10	11	13	15	14	20
Immatures	8	---	11	6	7	1	0	5	15	9	9	33	18	23	11	14	10	9	3
Chicks hatched	---	---	---	---	11	7	---	16	12	11	19	18	16	15	18	20	21	25	31
Chicks hatched per nesting pair	---	---	---	---	1.38	.88	---	1.60	1.00	.92	1.36	1.29	1.07	.94	1.2	1.43	1.10	1.19	1.24
Chicks surviving through August	14	---	15	14	10	6	13	13	11	9	17	15	14	13	13	17	19	22	24
Chicks surviving per nesting pair	.78	---	1	.74	1.25	.75	1.30	1.30	.92	.75	1.21	1.07	.93	.81	.87	1.21	1.00	1.04	.96
% chick survival	---	---	---	---	.91	.86	---	.81	.92	.82	.89	.83	.88	.87	.72	.85	.90	.88	.77
Lakes with nesting pairs	17	---	14	19	7	8	10	10	11	11	13	13	14	15	14	14	18	21	24

a Data do not include 2 pairs each with 2 chicks found on Lake Champlain
b Data do not include 1 pair with 2 chicks found on Lake Champlain

Survey data from 1980 are incomplete

Table 2 Primary causes for Common Loon nest failure in Vermont, 1978-1997.

Year	Depred.	Flooded	Stranded	Aband.	Human dist.	Intrasp. Conflict.	Unknown	Failures/ Nests[a]
1978	1						7	8/14
1979							5	5/15
1980	1						3	4/11
1981	2						3	5/18
1982	3	4						7/18
1983		2					2	4/9
1984							2	2/8
1985							2	2/10
1986							4	4/12
1987							5	5/9
1988							5	5/14
1989	1	1		1				3/14
1990	1	2	1	1				5/12
1991		1	1			1	3	6/16
1992	1		1	2	1		1	6/17
1993	1	1		2				4/14
1994		1					2	3/16
1995	1	1	1				1	4/19
1996	2	1		3			2	8/23
1997	1	3		2				6/26
Totals	15	17	4	11	1	1	47	96/295

[a] Includes renests

Appendix A. Platform use through 1997 on Vermont lakes (First date indicates first year of placement)

Great Averill Lake
reason for placement: water level fluctuations
1984-1993 -- not used
1994 -- new platform; loon pair investigated; platform dislodged, not used
1995-1997-- platform not used
(no documented nesting attempts on lake since 1982)

Little Averill Lake
reason for placement: water level fluctuations
1984-1993 -- not used; pair nested on natural sites with mixed results
1994 -- used successfully as renest site
1995-1997 -- used successfully

Berlin Pond
reason for placement: water level fluctuations
1990 -- not used; pair nested successfully on natural site

East Long Pond
reason for placement: depredation, water level fluctuations
1981 -- used successfully
1982-1997 -- pair nested successfully on natural sites

Forest Lake
reason for placement: depredation
1996-1997 -- used successfully

Green River Reservoir
reason for placement: water level fluctuations
1982-1993 -- not used; pair nested on natural sites with mixed results
1994 -- new platform, not used; pair did not nest
1995 -- not used; nest failed on natural site
1996-1997 -- pair nested successfully on natural site

Holland Pond
reason for placement: depredation, water level fluctuations
1984 -- not used; pair did not nest
1985-1997 -- pair used natural sites successfully; platform placed in 1997 after nest failure, not used

Joe's Pond
reason for placement: water level fluctuations, habitat enhancement
1996-1997 -- not used, pair did not nest

Kettle Pond
reason for placement: depredation, human disturbance
1981-1991 -- not used; only 1 successful nest on natural site
1992 -- used, but nest depredated
1993 -- used successfully
1994 -- not used; pair did not nest
1995 -- used successfully
1996 -- used, but platform dislodged and eggs abandoned
1997 – used successfully

May Pond
reason for placement: depredation
1990-1992 -- used successfully
1993 -- platform dislodged; successful nest on natural site where platform had been
1994-1997 -- pair used natural site successfully, platform not placedin 1995-1997

Miles Pond
reason for placement: water level fluctuations
1995 -- not used; pair nested successfully on natural site
1996-1997 -- not used; nest and renest (1996 only) failed on natural site

Marshfield Reservoir
reason for placement: water level fluctuations
1978, 1979, 1982 -- pair nested successfully on natural sites
1995 -- pair used natural site; nest flooded
1996 -- new platform, not used
1997 – used successfully

Norton Pond
reason for placement: water level fluctuations, habitat enhancement
1996-1997 -- not used, pair did not nest (note: there are 2 territorial pairs on Norton Pond, one of which nested successfully on a natural site in both years. The second pair did not nest)

Silver Lake (Brandon)
reason for placement: water level fluctuations, habitat enhancement (no natural islands)
1995 -- new platform, not used
1996 -- not used
(no nesting has been recorded on this pond since monitoring began in 1978)

Somerset Reservoir
reason for placement: water level fluctuations
1989-1994 -- not used; nesting occurred on natural sites with mixed results
1995 -- not used; pair nested successfully on natural site
1996 – platform lost, not replaced; pair nested on natural island site; chick hatched but lost

South Pond
reason for placement: habitat enhancement, water level fluctuations
1992 -- new platform, used successfully; only documented nesting ever recorded on pond
1993-1997 -- not used; inconsistent occupancy of pond by loons

Spectacle Pond
reason for placement: water level fluctuations
1994 -- new platform, not used; pair did not nest
1995-1996 -- not used; pair did not nest
1997 – used successfully

Thurman Dix Reservoir
reason for placement: severe drawdown of water for dam repairs
1995 -- new platform, not used; pair did not nest
1996 -- not used; egg abandoned on natural island site
1997 – not used; pair nested successfully on natural island site

Appendix B. Guidelines for the VINS Loon Biologist

These guidelines are intended to define the responsibilities of a seasonal VINS Loon Biologist. The success of each project requires that procedures outlined below be carefully followed. Communication is the key. Each project involves a diverse array of cooperators at different levels -- VINS and the Nongame and Natural Heritage Program (NNHP) of the Vermont Fish and Wildlife Department (VFWD) are the principal players, but other participants include the Green Mountain National Forest, the U.S. Fish and Wildlife Service, The Nature Conservancy, the Vermont Dept. of Forests and Parks, various power companies and landowners, lake associations, a host of volunteers, and the general public. It is critical to know who to contact in which circumstances, and to actively maintain close communication at all levels of the project.

The VINS Director of Research is the overall director of VINS' research program and will supervise the Loon Biologist. He/she must be kept informed about all aspects of the project. This will necessitate frequent and regular communication. The VINS Director or Research is responsible for the performance of the Loon Biologist, and it is important that there be no hesitation in seeking guidance when necessary.

The Loon Biologist is also expected to maintain a close working relationship with the NNHP Project Coordinator. This person and the VINS Director of Research work closely together in a formal partnership to administer the project. Some of the NNHP Project Coordinator's primary roles will be to coordinate activities (e.g., posting of nesting sites or nursery coves) with landowners and other interested parties, and to deal with regulatory issues (e.g., water level management). The NNHP Project Coordinator may suggest actions for the Loon Biologist to take, and the Loon Biologist will be expected to keep in close contact, via both written weekly reports and frequent oral communication.

The VINS Director of Research and NNHP Project Coordinator will work closely with the Loon Biologist and keep each other informed. The Director and Coordinator will try to cover each other's responsibilities if either one is unable to be contacted. Often, it will be necessary for the Loon Biologist to contact both about a specific situation.

Early in the field season the Loon Biologist should make phone contact with each local game warden whose district includes a nesting or territorial site that will be monitored. The Biologist should introduce him/herself and inform the warden of the status of each site and of planned monitoring activities there. Whenever an activity other than routine monitoring (e.g., loon platform or buoy placement) is planned, the warden should be contacted first. Game wardens often receive calls from the concerned public and need to know if the actions being reported are attributable to expected monitoring activities or other, possibly illegal, actions. Violations of Fish & Wildlife Law, whether witnessed by or reported to the Loon Biologist, must be communicated to the local warden as soon as possible. The warden district map and phone directory should be kept accessible at all times. If immediate, direct contact with a warden is necessary but not possible, the state police dispatch number should be called. This number is listed in the Fish & Wildlife Law Digest. The warden on duty will then be contacted by radio.

The NNHP Project Coordinator will send a letter of contact to known landowners and owners of water control structures at the beginning of each field season. The Loon Biologist may subsequently need to contact landowners and owners of water control structures to address field monitoring and management issues. People often want to know who the biologists are and to develop a working dialogue (e.g., Power Company contacts usually like to meet the Loon Biologist). If there is doubt about who should be contacted and in what situations, either the VINS Director of Research or the NNHP Project Coordinator should be consulted.

The Loon Biologist is the on-the-ground coordinator of field activities and is responsible for all field aspects of the project. A crucial role will be to provide guidance to volunteers, VFWD biologists, and others assisting on the project. This is especially critical for those individuals who are responsible for monitoring specific sites. The Loon Biologist must make early season contacts with these individuals and work out a mutually agreed upon scheme for monitoring. It will be the responsibility of the Biologist to track the progress of each site-specific monitor, to ensure that they are kept "in the loop", and to collect their monitoring data at season's end.

If a management problem (e.g., rapidly dropping or rising water level) arises, either a predetermined, site-specific response protocol should be followed, or the VINS Director of Research and NNHP Coordinator should both be contacted immediately. If neither option is possible, there will be a list of alternate contacts (with phone numbers) for each specific situation. The Loon Biologists should keep this list accessible at all times. Examples of such alternate contacts include:

- water level changes .... local power company and local lakeshore resident(s)
- human disturbance .... VFWD warden, Kim Speckman (USFWS Special Agent), Clay Grove (if on GMNF)

For reasons of both safety and timely communication, it is important that the whereabouts of the Loon Biologist is known as accurately as possible. It will be necessary to check in with the VINS front desk at least 2-3 times per week and to inform them of schedules so that messages can be relayed efficiently. The Biologist will be issued a first aid kit which should be carried in the field at all times.

An inventory of needed project materials and equipment will be available at the beginning of the field season. The Biologist will be required to provide a similar document for the following field season to avoid last-minute scrambling for needed items such as signs and buoys.

An annual project report and 2-page fact sheet should be completed by September 30 of each year. The Loon Biologist will be the principal author, and the VINS Director Of Research and NNHP Coordinator will contribute as co-authors. Summary data should be collected from site monitors no later than August 1, and subsequent updates should be obtained as needed. A first draft should be ready for review by August 15. Formats of reports should follow that used in 1997. Annual reports are to be primarily factual reporting of the year's events -- speculation should be limited and clearly justified.

The Loon Biologist is the most visible spokesperson for loon conservation in Vermont. He/she will need to make a concerted effort to inform and enlighten the public through personal contacts, presentations of slide lectures, posting of informational signs, contribution to press releases, and other means. Good PR is important to VINS, NNHP, and all organizations involved in these projects. If an exciting or newsworthy event takes place during a project, the Loon Biologist should check with the VINS Director of Research and NNHP Coordinator to determine whether a report of that event should go out to newspapers and other public information sources. Education is an extremely important part of the Loon Biologist's job.

In all public outreach activities the partnership of VINS and NNHP should be emphasized, and the project's connection with the Nongame Wildlife Fund highlighted. NNHP is part of the Vermont Fish and Wildlife Department and should be recognized as such. Contributions of other organizations (e.g., GMNF, USFWS) and individuals should also be acknowledged. The VINS Director of Research or the NNHP Coordinator should be consulted if clarification is needed about the specific roles of various contributors.

Tasks and duties specific to the loon project will be reviewed prior to the beginning of field work each season. The Biologist should not hesitate to seek guidance on any aspect of the project (e.g., priorities, expectations, protocols) at any point during the season. At the conclusion of field work, the Loon Biologist and VINS Director of Research will meet to evaluate the project's strengths, weaknesses, and overall success, and to discuss recommendations for future efforts. Formal evaluation forms will be used for this, and these will be kept on file at VINS.

In addition to these guidelines, the Loon Biologist should reference Attachment A of the VFWD contract for the project, which is the Specifications of Work to be Performed. A copy of this will be provided to the Biologist at the beginning of the field season.

Appendix C. A Chronology of Loon Nesting Data on Vermont Lakes: 1978 - 1997

The following is a summary of loon nesting behavior on all the lakes, ponds and reservoirs in Vermont that have had at least one confirmed nest since 1978. These bodies of water have been selected for documentation because they once had or currently appear to have characteristics that make them attractive to breeding loons.

Explanation of Terminology/format:

The following information is included when known:

1) existence of nest
2) location of nest
3) nest failure and cause
4) renesting attempts and outcome
5) existence and use of artificial nesting platform ("platform")
6) number of eggs
7) number of chicks hatched
8) reason for egg/chick mortality
9) number of chicks surviving through August (if mortality is not noted, the assumption is that the chick[s] survived)
10) water fluctuations
11) presence of extraterritorial loons ("e.t.")
12) relationship between territorial and extraterritorial loons ("conflict")
13) use of warning sign buoys ("buoys") to discourage human intrusion

Note: some data are not presented below for one of two reasons:

1) field data were not recorded by or reported to VINS that year
2) conflicting data existed and subjective interpretation was not attempted

Beaver Pond *(Holland)*

81 - 1 chick/island nest
82 - 1 chick
84 - nest failure
85 - 1 chick
86 - 2 chicks
87 - 2 chicks
88 - 1 chick
89 - 2 chicks/island nest
90 - 2 chicks/island nest/1 chick survived/e.t. after hatch - conflict
91 - 1 chick
92 - 2 chicks
93 - 1 chick/island nest/e.t. after hatch
94 - 1 chick
95 - 2 chicks/island nest
96 - 2 chicks/island nest
97 - nest failure - flooding/same spot on island/2 eggs

Berlin Pond *(Berlin)*

89 - 2 juveniles
90 - 2 chicks/platform not used - site not known/e.t
91 - nest failure/north swamp - 2 eggs disappeared
92 - 2 chicks/91 nest site
93 - 1 adult
94 - pair/e.t. inconsistent

95 - pair/e.t. consistent
96 - 1-3 loons inconsistent

Caspian Pond *(Greensboro)*
81 - 1 adult, 1 juvenile
82 - nest failure - raccoon depredation
92 - no loons
93 - 3 adults inconsistent
96 - pair consistent
97 - 1-3 adults

Coles Pond *(Walden)*
90-93 - no loons
94 - pair in spring, then only 1 adult
95 - pair (Although this pond shows no record of nesting, it has excellent habitat and an anecdotal history suggesting possible nest attempts in 94 and 95. This pond is also located in an area of successfully nesting loons, suggesting that offspring from those sites may return to nest near natal waters).
96 - pair inconsistent
97 - 2 chicks/small island west of large island in north cove/one chick lost in first week, 2nd lost in e.t. conflict/buoys

East Long Pond *(Woodbury)*
78 - 2 chicks
79 - nest failure
80 - 1 chick
81 - 1 chick/platform/2 pairs on pond
82 - 1 chick/platform not used - site not recorded
83 - nest hatched chicks - number not recorded/platform not used - site not recorded
84 - nest: fail/platform not used
85 - 2 chicks
86 - 1 chick/e.t.
87 - nest failure
88 - pair/e.t.
89 - 2 chicks/nest on south side of small island in north end/e.t. pair in early spring
90 - 1 chick/89 nest/e.t. pair in south end/chick destroyed in conflict
92 - nest and renest failure - nest on north side of 89 nest island - 1 egg - human disturbance and e.t. conflict/renest - shell fragments found in water
93 - nest failure - no eggs found - otter tracks behind nest/92 nest
94 - 2 chicks/92 nest site/buoys
95 - 2 chicks/92 nest site/chicks destroyed in e.t. conflict/buoys
96 - 2 chicks/nest on east tip of small north island (92 nest island) - 1 chick survived/e.t. loons late summer/buoys
97 - 2 chicks/96 nest site/chicks and breeding male destroyed in e.t. conflict/buoys

Forest Lake *(Averill)*
81-82 - no loons
83 - pair inconsistent
89-90 - no loons
91 - 1-2 adults
92 - no loons
93 - pair
94 - 1 chick/nest at head of southwest channel
95 - nest failure - raccoon depredation/94 nest/buoys

96 - 2 chicks/platform nest/buoys
97 - 2 chicks/platform nest/buoys

Gale Meadows Pond *(Winhall)*
78 - no loons
79 - 2 pairs
80 - nest failure
81 - nest failure
83 - no loons
90 - no loons
91 - 1 adult
92 - pair inconsistent
93 - pair inconsistent
94 - 1 adult inconsistent
95 - no loons/water level very low - Great Blue Heron rookery, Canada Goose population
96 - 1 immature loon in spring
97 - no loons

Great Averill Lake *(Averill)*
78 - nest failure
79 - 1 chick
80 - pair
81 - pair
82 - nest failure - flooded
83 - pair
84 - pair/platform put in
89 - no loons
90 - pair/high water levels
91 - 2 pairs inconsistent (one pair may have been from Little Averill because they abandoned their nest)
92 - pair/e.t.
93 - 1-2 adults seen early spring only
94 - pair/investigated platform/platform dislodged
95 - 1-2 adults inconsistent/94 platform pulled ashore - new one put in
96 - pair consistent/platform on water
97 - pair/platform on water

Green River Reservoir *(Hyde Park)*
78 - 2 pairs - 2 chicks from one nest/one nest failed
79 - 2 pairs - one nest failure
80 - 2 pairs - 1 chick from one nest/one nest failed
81 - 2 pairs - 2 chicks from one nest
82 - 2 chicks/platform put in - not used
83 - nest hatched chicks - number not recorded/platform not used
84 - 1 chick
85 - nest failure
86 - 2 chicks
87 - 2 chicks
88 - 1 chick
89 - 2 chicks/nest on small island at south (access) end/buoys/heavy boat use
90 - 2 chicks/89 nest/buoys/heavy boat use/water level fluctuations
91 - 2 chicks from renest/89 nest/initial nest flooded
92 - 2 chicks/nest on small island in northwest end/1 egg/e.t. conflict
93 - 2 chicks/89 nest/e.t.

94 - pair seen with nesting material near 89 nest/water level fluctuations/platform put in at north end
95 - nest: fail/nest on north side of large central island in north end - 2 undeveloped eggs abandoned - 1 found in water, 1 in nest had hole in top/water drawn down during nesting/heavy boat use but loons were "stickers" (not flushed)
96 - 1 chick/95 nest/1 egg/nest flooded day after hatch/1 e.t. loon/buoys
97 - 1 chick/nest island of 95, but on west tip. not north side/buoys/1 e.t. loon/1 egg

Hardwood Pond *(Elmore)*
84 - pair
85 - 1 chick
86 - 1 chick
87 - 1 chick
88 - 1 chick
89 - pair/island submerged (probable nest site of 85-88)
90 - pair/island submerged
91 - no loons
92 - no loons
93 - pair
94 - pair
95 - 1 chick/island nest - steep grade and debris on runway
96 - 2 chicks/island nest
97 - 2 chicks/island nest

Holland Pond *(Holland)*
78 - nest failure
79 - pair
80 - pair
81 - pair
82 - nest failure - raccoon depredation/e.t.
83 - 2 pairs
84 - pair/platform put in
85 - pair
86 - no loons
87 - no loons
88 - pair
89 - 2 chicks/nest in central part of marsh in south end/e.t. in early spring
90 - 3-4 adults/89 nest submerged
91 - 1 chick/89 nest
92 - 2 chicks/89 nest
93 - nest site submerged
94 - 1 chick/nest in northeast cove by channel to Turtle Pond - 2 eggs - 1 half - opened egg abandoned/e.t./buoys
95 - 2 chicks/89 nest/e.t./buoys
96 - 1 chick/nest at head of inlet at southwest corner/1 egg/e.t. loons/buoys
97 - nest failure - flooding/95 nest/e.t. loons/buoys/platform placed just off nest site after fail/2 eggs

Job's Pond *(Newark)*
78 - nest failure
79 - 1 chick
80-89 - no loons
90 - pair inconsistent
91 - 1-2 adults inconsistent
92 - pair inconsistent

93-94 - no loons
95 - pair inconsistent
96 - no loons
97 - pair/e.t. loons/platform placed

Joe's Pond *(Danville)*
81 - no loons
94 - pair/e.t./heavy boat use - water - ski route in north cove (only potential nesting habitat)
95 - pair/territory in north cove - same issues as 94
96 - pair consistent as 95/platform on water in west cove
97 - pair/platform on water

Kettle Pond *(Groton)*
78 - nest failure - raccoon depredation
79 - 1 chick
80 - nest failure - raccoon depredation
81 - nest failure/platform put in - not used
82 - no loons
83 - no loons
89 - no loons
90 - 1 adult inconsistent
91 - pair
92 - nest failure/platform used in west end cove
93 - 2 chicks/platform/1 chick survived
94 - pair
95 - 2 chicks/platform/trails behind nest closed off, cove roped off/buoys
96 - nest failure - platform dislodged and nest abandoned/2 eggs/trails closed,cove roped off/buoys
97 - 1 chick/platform/trails behind nest closed off, cove roped off/buoys/2 eggs

Little Averill Lake *(Averill)*
78 - 2 chicks
79 - nest failure
80 - 2 chicks
81 - 2 chicks
82 - nest failure - flooded
83 - 2 pairs/1 nest failure - egg shells found
84 - 1 chick/platform not used - site not recorded
85 - nest failure
86 - 2 chicks
87 - 1 chick/renest
88 - nest failure
89 - 2 chicks from renest/nest located to right of inlet at north end - 2 abandoned eggs/renest at head of inlet - water level fluctuations
90 - pair/e.t./nest site submerged
91 - nest failure - abandoned/nest in channel/e.t. conflicts/low water level
92 - nest failure - 1 fully developed abandoned egg, 1 partly eaten chick in nest/91 nest
93 - 2 pairs/water level fluctuations
94 - 1 chick from renest/nest located on shore/renest on platform in north cove/water level fluctuations/e.t./buoys
95 - 1 chick/platform/1 egg/water level dropped steadily during nesting/e.t. after hatch/buoys
96 - 2 chicks/platform/e.t. loons - conflicts/buoys
97 - 1 chick/platform/buoys/2 eggs

Long Pond *(Westmore)*
81 - nest failure - raccoon depredation/2 eggs
82 - 1 chick
83 - no loons
87-93 - no loons
96 - 1-3 loons
97 - pair - copulation and nest building, sitting with no eggs/buoys

Maidstone Lake *(Maidstone)*
78 - pair
79 - pair
80 - 3 adults
81 - 1 chick/house island nest/1 egg
82 - 2 chicks/southwest island nest/e.t. found dead
83 - 2 chicks/82 nest
84 - 1 chick
85 - 2 chicks
86 - 1 chick
87 - 1 chick/82 nest/2 eggs
88 - 2 chicks
89 - nest failure - depredation/nest on backside of southwest island/2 eggs/e.t
90 - 1 chick/81 nest (house island)/ 2 eggs - remaining egg was fully developed but loon was flushed/e.t. after hatch conflict
91 - 2 chicks/site not known - not house island
92 - 1 chick/82 nest/2 eggs - second chick pipped but was abandoned/buoys
93 - 2 chicks/82 nest/e.t. in early spring/buoys
94 - 2 chicks/81 nest (house island)/e.t./buoys
95 - 1 chick/site not known - not house island or southwest island
96 - 1 chick/nest on southwest island, northwest side of island/2 eggs/e.t. loons/buoys
97 - 1 chick/renest/96 site/first nest failure - flooding/nest on west side, south end of island/buoys

Martin's Pond *(Peacham)*
78 - no loons
79 - 2 chicks
80 - no loons
81 - 1 chick/shoreline nest
82 - 1 chick/2 eggs
83-86 - no loons
87 - 1 adult
88-90 - no loons
94 - 1 juvenile
96 - 1 loon
97 - 1-3 loons

May Pond *(Barton)*
85 - no loons
86 - 3 adults
87 - nest failure
88 - nest failure
89 - no loons
90 - 2 chicks/platform - southeast cove
91 - 1 chick/platform/2 eggs - second egg undeveloped
92 - 1 chick/platform

93 - 2 chicks/platform not used - dislodged/nest on hummock where platform had been
94 - 1 chick/93 nest/e.t conflict/buoys
95 - 1 chick/93 nest/buoys
96 - 1 chick/93 nest/buoys/1 egg
97 - 2 chicks/93 nest/buoys

McConnell Pond *(Brighton)*
80 - pair
86 - 1 chick
87 - no loons
88 - 1 adult
89 - 1 chick
90 - nest failure - flooded/nest in north shore inlet/1 egg
91 - 2 chicks/90 nest/1 chick survived
92 - nest failure - abandoned/2 eggs
93 - pair inconsistent
94 - 2 chicks
95 - pair/e.t.
96 - nest failure - flooded
97 - 2 chicks/platform nest

Lake Memphremagog *(Newport)*
82 - 1 chick/nest in John River
89-95 - up to 10 loons seen each season - some subadults
96 - up to 10 reported at south end - some subadults

Miles Pond *(Concord)*
78 - nest failure
79 - 1 chick
80 - pair
81 - pair
82-86 - no loons
87 - pair
88 - 1 adult
89-90 - no loons
91 - 1 adult
92 - no loons
93 - 1 adult
94 - nest failure - flooded/nest on small island midway down pond/1 egg/water level rose
95 - 1 chick/94 nest/platform put in/water level stable/human intrusion on family
96 - nest - fail: flooded/renest - fail: otter depredation/platform not used/94 nest site/1 egg each nest
97 - nest - fail: abandoned/nest in east swamp

Molly's Falls Pond *(Marshfield)*
78 - 1 chick
79 - 1 chick
80 - no loons
81 - pair
82 - 1 chick/platform not used
83 - pair
84 - no loons
90 - 1 adult
91 - pair/e.t.

92 - pair/platform pulled ashore
93 - 2 adults (not a pair)
95 - nest failure - flooded/nest on boulder field at "elbow" of lake
96 - pair consistent/platform on water
97 - 2 chicks/platform

Moore Reservoir *(Concord)*
97 - 2 chicks/disappeared - Bald Eagle in nest cove all summer/buoys

Newark Pond *(Newark)*
78 - 1 adult
79 - pair
80-84 - no loons
85 - pair
86 - nest failure
87 - nest failure/island nest
88 - nest failure
89 - 1-2 adults inconsistent
90 - 2 chicks/87 nest/1 chick survived
91 - 1 chick/87 nest
92 - pair/e.t./water level low
93 - 1 chick/87 nest/e.t./buoys
94 - pair/water level high/heavy boat use
95 - 2 chicks/87 nest - southern tip
96 - nest failure - abandoned/1 egg/e.t. loons - conflicts/ 87 nest
97 - nest failure - abandoned/e.t. loons

Nichol's Pond *(Woodbury)*
78 - no loons
79 - no loons
80 - 2 pairs inconsistent
81 - pair
87 - 1 adult
88 - no loons
90 - no loons
92 - 1 adult
93 - pair inconsistent
94 - pair in spring, then only 1
95 - pair inconsistent
96 - loon caught in monofilament line - disappeared

Lake Ninevah *(Mt. Holly)*
90 - 2 subadults
93 - no loons
95 - nest failure/island nest - eastern tip/1 undeveloped egg abandoned beyond due date/e.t. conflict/buoys
96 - 2 chicks/95 nest/buoys/e.t. loons
97 - 1 chick/nest in small island in swamp/2 eggs/buoys

Norton Pond *(Norton)*
78 - nest failure
79 - 1 chick
80 - 1 chick from renest
81 - 2 chicks from renest/nest on small island on west shore, midway up pond

82 - 1 chick/2 eggs
83 - 2 chicks/81 nest
84 - 2 chicks
85 - 2 chicks/e.t.
86 - 2 chicks/e.t.
87 - 1 chick from renest/1 egg
88 - 2 chicks
89 - 1 chick/81 nest/2 eggs/e.t.
90 - nest failure - otter depredation/water level rose during nesting
91 - pair/copulation and nest - building observed/water level low and drawn down
92 - pair/water level high
93 - 1 chick from renest/nest on east side of 81 nest island - flooded/renest on west side (historic site)/ chick did not survive
94 - 1 chick/81 nest/nest almost flooded/buoys
95 - 1 chick/81 nest/2 eggs - 1 undeveloped and abandoned/buoys
96 - 2 chicks/81 nest/1 chick survived/e.t. loon pair/buoys
97 - nest failure - otter predation/81 nest/2 eggs/buoys

Noyes Pond *(Groton)*
78 - no loons
79 - nest failure
80 - no loons
81 - pair
82 - no loons
83 - 1 adult
90 - 1-2 loons
93 - no loons
94 - 1 adult inconsistent
95 - pair inconsistent - 1 adult consistent
96 - 1 loon
97 - pair

Osmore Pond *(Peacham)*
78 - 1 adult
79 - pair
80 - 1 chick
81-83 - no loons
90 - 1 adult
91-92 - no loons
93 - 1 adult
94 - 1 adult
96 - 1-3 loons
97 - pair

Peacham Pond *(Groton)*
North Cove Pair:
78 - 2 chicks
79 - 1 chick
80 - 1 chick
81 - 2 chicks
82 - 1 chick/2 eggs/e.t.
83 - nest failure - flooded/2 eggs
84 - 1 chick

85 - 1 chick
86 - nest failure/e.t.
87 - 1 chick
88 - 1 chick/island nest in south cove/2 eggs/chick did not survive
89 - nest failure/nest abandoned - 1 egg found in water/waterlevel fluctuations/e.t. conflict
90 - 2 chicks/88 nest/e.t.
91 - 2 chicks/88 nest
92 - 1 chick/88 island nest, but nested farther up due to high water level/1 egg not developed/e.t.
93 - nest failure/88 nest/1 partly developed egg found in water/e.t.
94 - 1 chick/88 nest/buoys
95 - 1 chick/88 nest/2 eggs - 1 undeveloped found in water/water level stable/e.t. conflict/buoys
96 - nest failure - abandoned/e.t. loons/1 egg/buoys
97 - 2 chicks/88 nest/1 disappeared in tenth week/buoys

South Cove Pair
78 - nest failure
79-85 - pair not seen
86 - nest failure - 2 eggs - 1 found in water, 1 found in brush behind nest/renest - 1 egg - outcome not reported/e.t.
87 - 1 chick
88 - nest failure - 2 eggs/renest failure
89 - 1 chick/nest in marsh/e.t. conflict
90 - nest failure - abandoned/nest in marsh/e.t.
91 - nest failure/nest on right side of marsh/renest failure - 1 abandoned egg/e.t. conflict
92 - 1 chick/91 nest/2 eggs - partly developed found outside of nest
93 - 2 chicks/nest on left side of marsh/1 chick survived/e.t. conflict
94 - pair/nesting material in beak/e.t. conflict
95 - 1 chick/nest on right side of marsh/1 egg/water level stable/e.t.
96 - pair consistent/1 e.t. loon hanging with pair all summer/no nest attempt/high water
97 - 2 chicks/nest in marsh/e.t. loons

Pigeon Pond *(Groton)*
89 - no loons
90 - 1 adult
95 - pair
96 - pair consistent
97 - pair

Seymour Lake *(Morgan)*
78 - pair
79 - 1 chick
80 - 1 subadult
81 - 2 chicks
82 - nest failure - raccoon depredation
83 - no loons
89-95 - pair inconsistent/e.t.
96 - nest failure - depredation/renest - 2 chicks/nest in river channel between Seymour and Echo Lakes/accesses to river roped off and signs used on trails
97 - pair/e.t. loon

Somerset Reservoir *(Searsburg)*
78 - 1 chick
79 - 2 chicks from 1 nest/second pair nested and failed

81 - 1 chick/second pair nested and failed
82 - nest failure - flooded/e.t.
83 - nest failure
84 - pair
85 - 2 chicks
86 - 3 adults
87 - pair
88 - 1 chick
89 - 2 chicks/nest on north island in northwest cove/platform not used/e.t.
90 - nest failure - 1 egg developed but abandoned, second egg just fragments/water level low/nest on island at south end of northwest cove
91 - 1 chick/water level fluctuations
92 - nest failure - stranded/90 nest/water level fluctuations/1 egg partly developed but deformed: no upper mandible, brain case incomplete/e.t. conflict
93 - 1 chick/89 nest/1 egg/e.t.
94 - 1 chick/89 nest/2 eggs - 1 abandoned/water level drawn down during nesting/e.t. conflict
95 - 1 chick/89 nest/1 egg/water level stable/e.t.
96 - 1 chick/did not survive/nest on south side of west island in northwest cove/1 - 3 Bald Eagles on reservoir all summer/1 egg
97 - 1 chick/96 nest/2 eggs/e.t. loons

South Pond *(Eden)*
78 - no loons
79 - pair
80-90 - no loons
92 - 2 chicks/platform nest/chicks disappeared/e.t. conflict
93 - 1 adult inconsistent
94 - 1 - 2 adults
95 - 3 loons
96 - loons inconsistent
97 - nest failure - reasons unknown/island nest/2 eggs/buoy

Spectacle Pond *(Brighton)*
82 - pair
83 - nest failure - 2 eggs abandoned/island nest
85 - no loons
86 - 3 adults
90 - no loons
91 - pair in spring, then only 1 adult
92 - pair inconsistent
93 - 1 chick/island nest/e.t. after hatch
94 - pair/nest island submerged/platform not used
95 - pair inconsistent/platform from 94 gone, new one put in
96 - pair consistent/platform on water/pair seen on and off it/copulation seen on island/territorial defense observed regularly in response to e.t. loons
97 - 1 chick/platform/2 eggs/buoys/e.t. loon

Thurman Dix Reservoir *(Orange)*
78 - no loons
79 - 1 juvenile
80 - 1 chick
81 - 1 chick
82 - 1 chick/2 eggs/e.t.

83 - 2 chicks
84 - 1 chick/small island nest
85 - 2 chicks
86 - 2 chicks
87 - 1 chick from renest/84 nest/1 egg
88 - 1 chick/84 nest
89 - 1 chick/84 nest
90 - 2 chicks/84 nest
91 - 2 chicks/84 nest/e.t. after hatch
92 - nest failure - 2 undeveloped eggs abandoned/84 nest/e.t.
93 - nest failure - stranded/2 eggs - 1 found in water, 1 shell fragments (depredation?)/e.t. conflict
94 - 1 chick/84 nest
95 - pair/water level way down due to dam repair/platform put in
96 - nest: fail - abandoned after egg overdue/1 egg
97 - 1 chick/nest built very tall mud nest on top of submerged nest island/1 egg

Turtle Pond *(Holland)*
81 - nest failure - depredation
82 - nest failure - flooded
83-95 - single loon inconsistent
96 - loon inconsistent

Waterbury Reservoir *(Waterbury)*
78 - pair
79 - nest failure
80 - nest failure
81 - 1 chick
95 - loon inconsistent

Wolcott Pond *(Wolcott)*
87 - no loons
88 - pair
89 - 2 chicks/found dead in north cove to left of beaver lodge/e.t. conflict
90 - 2 chicks
91 - nest failure - no eggs found/site not known
92 - 1 chick from renest/89 nest/first nest depredated/second nest - 1 egg
93 - 2 chicks/89 nest/1 chick survived
94 - 2 chicks/e.t. conflict
95 - 2 chicks/site not found - not historic site
96 - 2 chicks/site back in central part of historic nest cove/past nests also found there
97 - 2 chicks/96 nest

Zack Woods Pond *(Hyde Park)*
87 - no loons
88 - pair
89-90 - no loons
91 - 1 adult
92 - 1 adult
93 - pair until June
94 - pair/e.t. conflict
95 - 1-2 adults inconsistent/1 adult dead from lead sinkers
96 - 2 chicks/tip of central island
97 - 1 chick/nest on small grassy island in cove/buoys/2 eggs