Survey of Common Loon (*Gavia immer*) Habitats and Nests at UNDERC

BIOS 569: Practicum in Field Biology

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ABSTRACT

The common loon (*Gavia immer*) is not only emblematic of northern wilderness values but also serves as an important bioindicator of aquatic health. Despite extensive research, it is unknown how loons choose nesting lakes. This study aimed to identify and characterize the lakes at UNDERC with a common loon presence. A second objective was to find active nests on these lakes and note their breeding success. To conduct this study, small lakes (< 8 ha) were observed with binoculars, and larger lakes (> 8 ha) were surveyed via canoe. Loons were identified at 11/17 surveyed lakes. The lakes with loons were large with a long, irregular shoreline, clearer water, neutral to slightly basic pH, and islands. Lakes without loons were more acidic, indicating reduced prey abundance and higher organic mercury concentrations. Five nests were located and documented on the property; the nests on Bergner Lake, Plum Lake, and Crampton Lake were successful. The nest on Roach Lake failed due to mammalian predation, and the nest on Tenderfoot Lake failed for unknown reasons. Because common loons return to nests, it is anticipated that this information will encourage minimization of human disturbance of the nests and thus enable greater breeding success for years to come. This survey should also facilitate further studies concerning the breeding population and nest success of the common loon at UNDERC.

INTRODUCTION

The common loon (*Gavia immer*) is one of five loon species worldwide. As its name implies, it is the most common species of loon in North America and the only species that nests in the United States with the exception of Alaska (Hutchinson 2003). Due to its conspicuous presence on northern lakes, the common loon has long been regarded as emblematic of wilderness values. Regardless of its allure, the ecological significance of the common loon as a bioindicator of aquatic health makes study and preservation of its habitat essential. Indeed, the ability to maintain healthy loon populations reflects

favorably on the ability of humans to maintain the integrity of aquatic ecosystems (Evers 2004).

The northern lakes the common loon utilizes for nesting and breeding are threatened by several factors: habitat degradation and loss due to shoreline development; boating activity and use of personal watercraft; and contaminants in breeding lakes, specifically mercury, lead, and pollution from acid rain. Although not currently or formerly listed under the federal Endangered Species Act, the common loon has been granted special status on a state-by-state basis. In 1987, concern over the future of the common loon prompted the Michigan legislature to designate it a State Threatened Species (Kaplan et al. 2002). In Wisconsin, it is a species of Special Concern (Evers 2004).

Much of the research on the common loon has focused on the characteristics of the lakes it occupies during the breeding season, yet it remains unknown how loons choose nesting lakes. Previous research has determined that the optimal lake has a large surface area, clear water, an abundance of small fish, numerous small islands, and a long, irregular shoreline that creates coves ideal for chick nurseries (Evers 2004).

Due to the posterior location of their legs on their bodies, loons are extremely clumsy on land. They seldom take to the air because of the great effort and long runways required to lift their heavy bodies off the water to attain flight. Instead, the domain of the common loon is the water where their extreme

proficiency in swimming and diving has earned them the title of "feathered fish." Therefore, water quality is an important habitat feature for the common loon. As visual predators who sight their food before committing to a dive, clear water is crucial for foraging efficiency. Consequently, secchi disk readings < 1.5 m have been found to alter loon behavior by reducing the efficacy of this survival factor (Evers 2004).

The acidity of the lake is also an important feature to consider because such lakes often have reduced prey abundance. Increased acidity negatively impacts invertebrate and fish species richness (Evers 2004). In addition, acid rain helps convert inorganic mercury in lake bottom sediments to a highly poisonous organic form (Busch 1999). Hence, lakes that become more acidic are also likely to have an increase in the methyl mercury available to the biota (Evers 2004).

To build its nest, the common loon chooses a site close to the water's edge to reduce the distance it has to travel on land. The nest is rarely constructed more than 1 m from the water's edge. The nests are built from a variety of materials using whatever is present at the nest site, typically dead vegetation and mud. Sites close to deep water are considered superior to sites close to shallow water because the risk of egg predation is lessened when adults can slip away from the nests quietly underwater. Small islands on lakes are preferred because they afford a greater protection from predators finding the nest site and a wider range of visibility (Strong 1995).

There are few natural predators of the adult common loon because they are only vulnerable when they are on land. Bald eagles (*Haliaeetus leucocephalus*) have been known to attack incubating loons. However, eagles can only lift one-third of their body weight, and adult loons normally exceed this limit. Therefore, overt predation on adults by eagles is likely a rare event (Evers 2004). Although adults are attentive to their nests, incubating loons may be displaced by a human, eagle, or other disturbance, leaving their eggs susceptible to predation. The raccoon (*Procyon lotor*) is the mammalian predator with the greatest documented impact on eggs. Mink (*Mustela vision*), fisher (*Martes pennati*), and striped skunk (*Mephitis mephitis*) incidentally feed on loon eggs. River otter (*Lontra canadensis*), canids, and other large predators opportunistically take eggs. Avian predators also feed opportunistically and are attracted to unattended nests. Eggs with holes and contents not completely emptied indicate avian predation (Evers 2004).

The primary objective of this survey was to identify the lakes where the common loon is present at the University of Notre Dame Environmental Research Center (UNDERC) and to characterize the habitat of those lakes, specifically topographical features, surrounding vegetation, water clarity, and water acidity. The pH of each lake was used to qualitatively indicate the relative prey abundance of the lake as well as the potential methyl mercury content. An acidic pH indicated reduced prey abundance as well as a higher methyl mercury

concentration in the lake (Evers 2004). It was predicted that loons would choose larger lakes with clearer water and neutral to slightly acidic conditions for nesting. A second objective was to locate nests, observe nesting activity, and note breeding success on the UNDERC lakes with a common loon presence. Data gathered regarding common loon nests on this property will hopefully be used to minimize human disturbance at these sites and facilitate greater breeding success in the future.

MATERIALS AND METHODS

Habitat Selection:

All lakes on the UNDERC property > 2 ha (N = 17) were chosen for this survey according to methods established by previous surveys (Kaplan et al. 2002; Figure 1).

Species Survey:

The method used to identify loons on each lake varied depending on the size of the lake. If the lake was relatively small (< 8 ha) and could be seen in its entirety from the water's edge or dock (if present), binoculars were used to look for loons on the lake. If this was not possible, a canoe was used to explore the perimeter of the lake (because adult loons forage in shallow areas within 50 to 150 m from the shoreline) as well as any islands (Evers 2004). Care was taken not to disturb the loons because they were nesting. If the common loon was not

initially located at a particular site, the lake was revisited, time permitting. On lakes where the common loon was found to be present, the loons were observed further to determine how the loons were using the lake and to attempt to locate any nests.

Habitat Characterization:

Several methods were utilized to characterize the 17 lakes selected for the survey. First, each lake's general shape and size was evaluated visually and with the assistance of topographical maps (Guide to UNDERC, 1993) and available DOQQ maps in GIS format. Any islands were noted, and the vegetation characterizing each lake, both edge and surrounding, was also generally described. A secchi disk was used to measure the water clarity, and a probe measured the pH of each lake. To minimize bias from temperature or rainfall, all water chemistry measurements were taken within a 24-hour period.

Nest Characterization:

Following hatching or nest failure, any nests found were examined and documented. The surrounding site of each nest was described as well as the natural "construction materials" used. The presence or absence of eggshells and their relative age was also noted. Measurements taken include the width of the nest, the distance from the rim of the nest to the water's edge, and the water depth 1 m from the water's edge in front of the nest. The success of each nest was also

noted, as well as any hypotheses as to why it might have failed as indicated by the state of the nest.

Statistical Analysis:

The characteristics of the lake habitats with a loon presence were compared to those of the sites without loons through a series of *t*-tests. The habitat features that were statistically analyzed included surface area of the lake, length of the shoreline, pH, secchi depth, and number of islands. A chi-square test was also performed to determine whether lakes with islands were statistically preferred habitats of the common loon.

RESULTS

Eleven of the 17 lakes visited in this survey had a common loon presence on their waters (Table 1). The largest lake with loons was Tenderfoot Lake (surface area = 194.24 ha; shoreline length = 9447 m); the smallest was Ward Lake (surface area = 2.74 ha; shoreline length = 613 m). The average surface area of lakes with a common loon presence was 45.60 ha and the average shoreline length was 3625 m. Six lakes did not have loons (Table 1). The largest lake without loons was Long Lake (surface area = 7.87 ha; shoreline length = 2127 m); the smallest was Peter Lake (surface area = 2.52 ha; shoreline length = 702 m). The average surface area of lakes without a common loon presence was 4.84 ha and the average shoreline length was 1049 m. Lakes with loons had significantly

larger surface area ($t = 2.382$; p = 0.038) and shoreline length ($t = 2.836$; p = 0.016).

The pH of the 17 lakes surveyed ranged from 6.1 to 8.2 (Table 1). Of the 11 lakes with a common loon presence, the average pH was 7.55. The six lakes without loons were significantly more acidic (average pH = 6.74; $t = 2.576$; p = 0.031).

The secchi depth of all 17 lakes was greater than 1.5 m (Table 1). However, the difference in secchi depth between lakes with and without loons was not statistically significant ($t = 0.617$; p = 0.552). The average secchi depth for lakes with loons was 3.67 m. The average secchi depth for lakes without a loon presence was 3.29 m, only slightly lower than the clarity measure for lakes with loons.

The presence or absence of islands was not statistically significant between lakes that served as loon habitats and those that did not ($X^2 = 0.726$; p = 0.394) although a trend is evident. Thirty-six percent of the lakes with a common loon presence also had islands compared to 16% of the lakes without loons (Table 1). The difference in the number of islands between the two groups was also not statistically significant ($t = 1.506$; p = 0.154). The vegetation surrounding the lakes did not show any obvious trends; lakes with and without a loon presence alike shared grass, shrub, marsh, and mixed edges as well as conifer, hardwood, and mixed surrounding forests (Table 1).

Pairs of loons were observed at least once on nine of the 11 lakes with a common loon presence (Table 2). However, from these nine pairs, only five nests were found and documented (Table 3; Appendix 1). All five nests were located on islands or marshy hummocks away from the shore (Table 2; Figure 2) and surrounded by shrubs or tall grasses. The nests were constructed from mud and whatever vegetative substrate was available on the island or around the nest, such as dried grass, twigs, leaves, bark, and pine needles. The average width of the nests was 56 cm, the average distance from the rim of the nest to the water's edge was 30 cm, and the average water depth 1 m from the water's edge was 18 cm. Eggshells were found in or near four of the nests, but only three successfully yielded chicks. The loon pair re-nested on Roach Lake, but this nest was not located.

DISCUSSION

As predicted, the common loon preferred to breed and nest on larger lakes with clearer water and long, irregular shorelines. However, single loons were also found on smaller, circular bodies of water such as Kickapoo Lake and Ward Lake. These loons may have been floater loons (single loons without a mate) looking for a place to rest and feed, or they could have been a member of a pair that had gone to a different lake from its nesting lake to forage. In Wisconsin and Michigan, all loon pairs on lakes < 24 ha use at least one other lake during breeding season as

part of a multiple-lake territory (Evers 2004). Breeding pairs observed on Bergner Lake, Inkpot Lake, and Moccasin Lake may therefore have been using different lakes than their nesting lakes for feeding. All 11 lakes with a common loon presence possessed an "aquatic runway" long enough for take-offs and landings because the same number of loons was not always observed on each lake. In addition, the secchi depths for all 17 lakes were > 1.5 m. Hence, the water clarity of all lakes surveyed should not have affected foraging efficiency.

For both foraging and nesting, the common loon preferred lakes with neutral to slightly basic pH conditions. The six lakes without loons were more acidic, indicating reduced prey abundance. However, none of the lakes surveyed were acidic enough to totally eliminate prey from their waters. Yellow perch, one of the loon's favored preys, are generally tolerant at pH levels > 5 and therefore provide food for loons on mildly acidified lakes (Evers 2004). In addition, the more acidic lakes most likely had higher organic mercury concentrations compared to the neutral or slightly basic lakes. Mercury content is an issue of particular concern at UNDERC since north-central Wisconsin and the western Upper Peninsula of Michigan have been identified as mercury "hotspots" (Evers 2004). Loons afflicted with mercury poisoning may not be able to fly, become disoriented, lose weight, and may abandon their nests and chicks (Busch 1999). Highly acidic lakes, and hence higher methyl mercury concentrations, have been significantly correlated with higher brood mortality (Evers 2004).

Lakes with islands were also favored loon habitats. Only one lake with an island, Nansen Lake, did not attract common loons to its waters. This is not surprising because Nansen is a smaller lake with a shorter, regular coastline (Table 1). At UNDERC, islands were the preferred nesting site for loons. Four of the five documented nests were built on islands, and the fifth was built on a small hummock surrounded by water, thus resembling an island. In sharp contrast, a recent survey conducted in British Columbia found that 43% of common loon nests are onshore, 35% are on islands, and 12% are built on bare ground with no nest materials (Busch 1999). A preference for islands at UNDERC may indicate a healthier mammalian population because islands offer protection from terrestrial predators. A survey in Minnesota found that loon nests built on islands were twice as safe from predators as those on shore (Busch 1999).

The condition of a nest may often suggest why it failed. The first nest on Roach Lake most likely failed due to mammalian predation. The eggshells were found in relatively large pieces, removing the possibility that they hatched successfully. They were also found inland from the nest, indicating that they had been carried a distance before they were consumed. This eliminates avian predation. Although the nest was constructed on an island, it is relatively close to shore and thus it is possible that a predator swam to the island and destroyed the nest (Keren Tischler, personal communication).

The reason for the nest failure on Tenderfoot Lake is more ambiguous. Tenderfoot Lake has a public boat launch and is therefore accessible to fishermen and recreational users in addition to researchers. On more than one occasion, boats were seen passing extremely close to the marsh island where the nest was found. It is possible that this human disturbance caused the incubating loon to flush the nest, leaving it open to avian predation. Also, if the eggs are exposed for long periods of time, or repeatedly uncovered, they can become chilled and fail to hatch (Schoch 2002). Bald eagles are also known to nest on Tenderfoot Lake, and their presence may also be responsible for flushing the incubating loon. The incubating loon could have possibly knocked the eggs off the nest when it flushed, thus explaining the lack of eggshells on the nest. On the other hand, the lack of eggshells may imply that no eggs were laid at all.

The three nests from Bergner Lake, Plum Lake, and Crampton Lake share characteristics that may have contributed to their success. All three nests were not built on the water's edge, but rather 0.32 m, 0.60 m, and 0.60 m away respectively. This distance prevented the nests from being flooded when the water level of the lake fluctuated (Evers 2004). Flooding is another reason why the Tenderfoot Lake or Roach Lake nests could have failed because they were not elevated but rather flush with the level of the lake.

Common loon nests tend to be used year after year. Either the same nest is used multiple years in a row (Busch 1999), or the new nest is built in close

proximity to the previous nest (Strong 1995). Hence, the loon nest locations documented in this study will be applicable to the UNDERC lakes for several years to come. It is anticipated that this information will encourage minimization of human disturbance of the loon nests and thus enable greater breeding success in the future. This survey should also facilitate further studies concerning the breeding population and nest success of the common loon at UNDERC.

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TABLES

Table 1: Characteristics of 17 lakes included in common loon survey.

Name of lake	Presence of loons	Surface area (ha)	Length of shoreline (m)	pH	Secchi depth (m)	Number of islands	Edge Vegetation	Surrounding Vegetation
Bay	yes	67.30	7693	6.9	4.20	0	grass	conifer/hardwood
Bergner	yes	17.85	2083	6.3	4.30	0	shrubs/grass	conifer
Brown	yes	32.87	2828	8.1	2.98	0	grass	conifer/hardwood
Crampton	yes	29.00	3437	7.1	5.08	1	shrubs/grass	conifer
Gilbert	no	4.03	950	-	-	0	marsh/grass	conifer
Inkpot	yes	6.61	1046	7.5	2.78	0	marsh/grass	conifer/hardwood
Kickapoo	yes	7.87	1306	7.8	2.35	0	marsh/grass	conifer
Long	no	7.87	2127	6.1	3.25	0	shrubs	conifer
Moccasin	yes	6.67	1237	8.0	2.00	0	shrubs/grass	conifer
Morris	no	5.93	1026	7.2	2.09	0	shrubs/grass	conifer/hardwood
Nansen	no	4.04	632	7.4	-	1	marsh/grass	conifer
Peter	no	2.52	702	6.3	4.12	0	shrubs	conifer/hardwood
Plum	yes	91.43	5649	7.8	6.89	2	none	conifer/hardwood
Raspberry	no	4.63	859	6.7	3.70	0	shrubs	conifer/hardwood
Roach	yes	45.07	4538	7.1	4.07	2	shrubs/grass	hardwood
Tenderfoot	yes	194.24	9447	8.2	3.49	3	shrubs/grass	conifer/hardwood
Ward	yes	2.74	613	8.2	2.25	0	shrubs/grass	conifer

Table 2: Description of activity observed on lakes with a common loon presence.

Name of lake	Maximum number of adult loons observed on lake at one time	Possible use of lake	Location of nest
Bay	1 pair (2 loons)	breeding/nesting	no nest
Bergner	1 pair (2 loons)	breeding/nesting	west shore across from dock beneath dead spruce tree on marshy hummock
Brown	1 pair (2 loons)	breeding/nesting	no nest
Crampton	1 pair (2 loons)	breeding/nesting	northeast corner of island tucked into shrubs
Inkpot	1 pair (2 loons)	breeding/nesting	no nest
Kickapoo	1 loon	foraging	N/A
Moccasin	1 pair (2 loons)	breeding/nesting	no nest
Plum	1 pair (2 loons)	breeding nesting	northwest corner of northern island beneath dead, tilting conifer
Roach	1 pair (2 loons)	breeding/nesting	north shore of northern island next to a large rock
Tenderfoot	1 pair (2 loons) 1 single floater	breeding/nesting for pair foraging for floater	larger, southern marsh island in middle of lake
Ward	1 loon	foraging	N/A

Table 3: Characteristics and measurements of documented loon nests at UNDERC.

Name of lake	Width of nest (cm)	Water depth (cm)	Distance to water's edge (cm)	Site description	Construction materials	Presence of eggshells	Success of nest
Bergner	50	12	32	surrounded by water, not solid ground, shrub on each side of nest	twigs, mud, and dried grass	small pieces fresh from this year	1 chick
Crampton	45	37	60	surrounded by shrubs and sphagnum moss	twigs, mud, dried grass, and leaves from shrubs	small pieces fresh from this year	2 chicks
Plum	41	15	60	surrounded by tall grass	mud and dried grass	small pieces fresh from this year	1 chick
Roach	55	8	0	surrounded by shrubs, large rock to left of nest	bark, pine needles, mud, and dried grass	large pieces found inland on island	0 chicks
Tenderfoot	90	18	0	surrounded by water and tall grass, not solid ground	twigs, mud, and dried grass	none	0 chicks

FIGURES

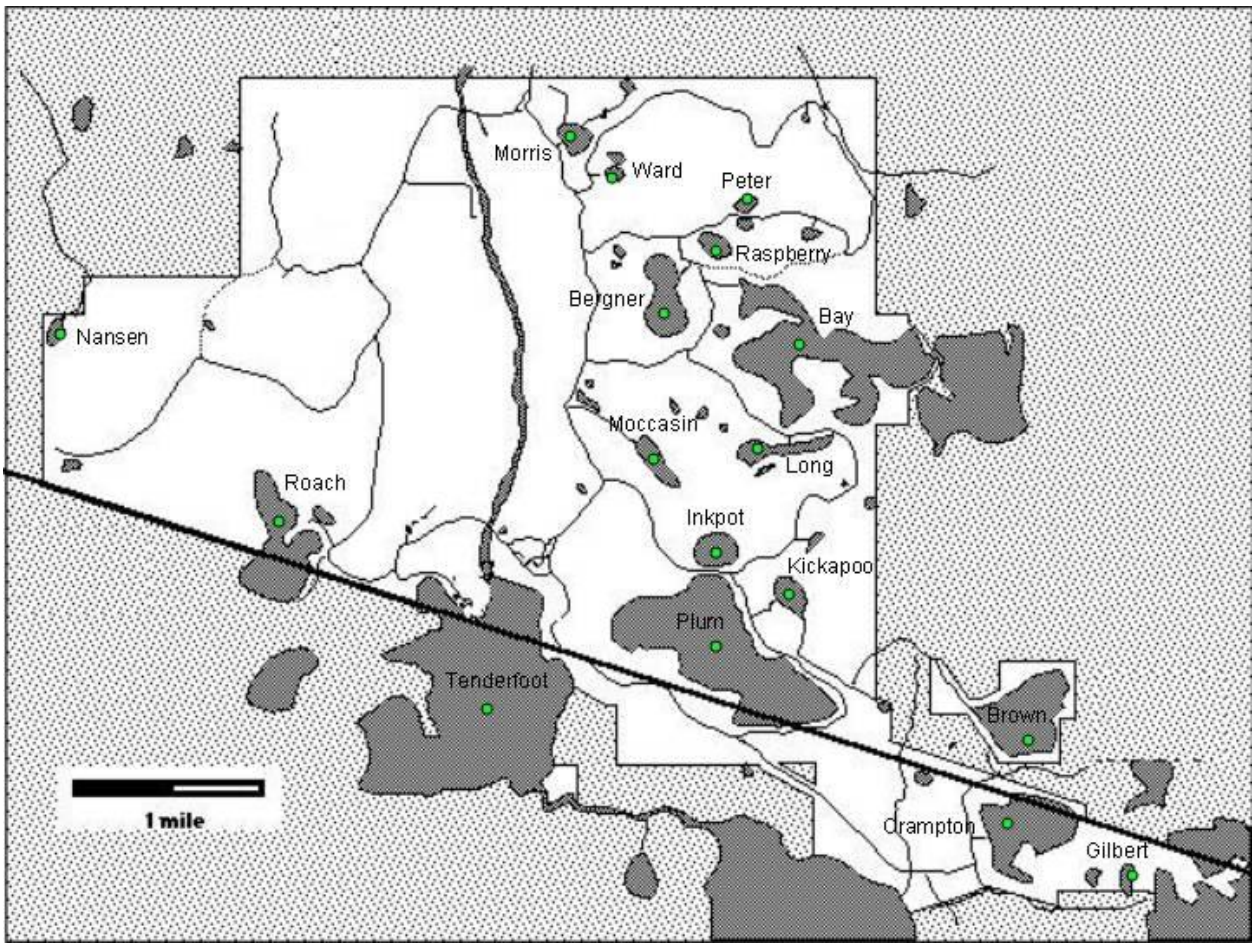

Figure 1: Map of UNDERC property. Lakes included in this survey are marked with a green dot and labeled.

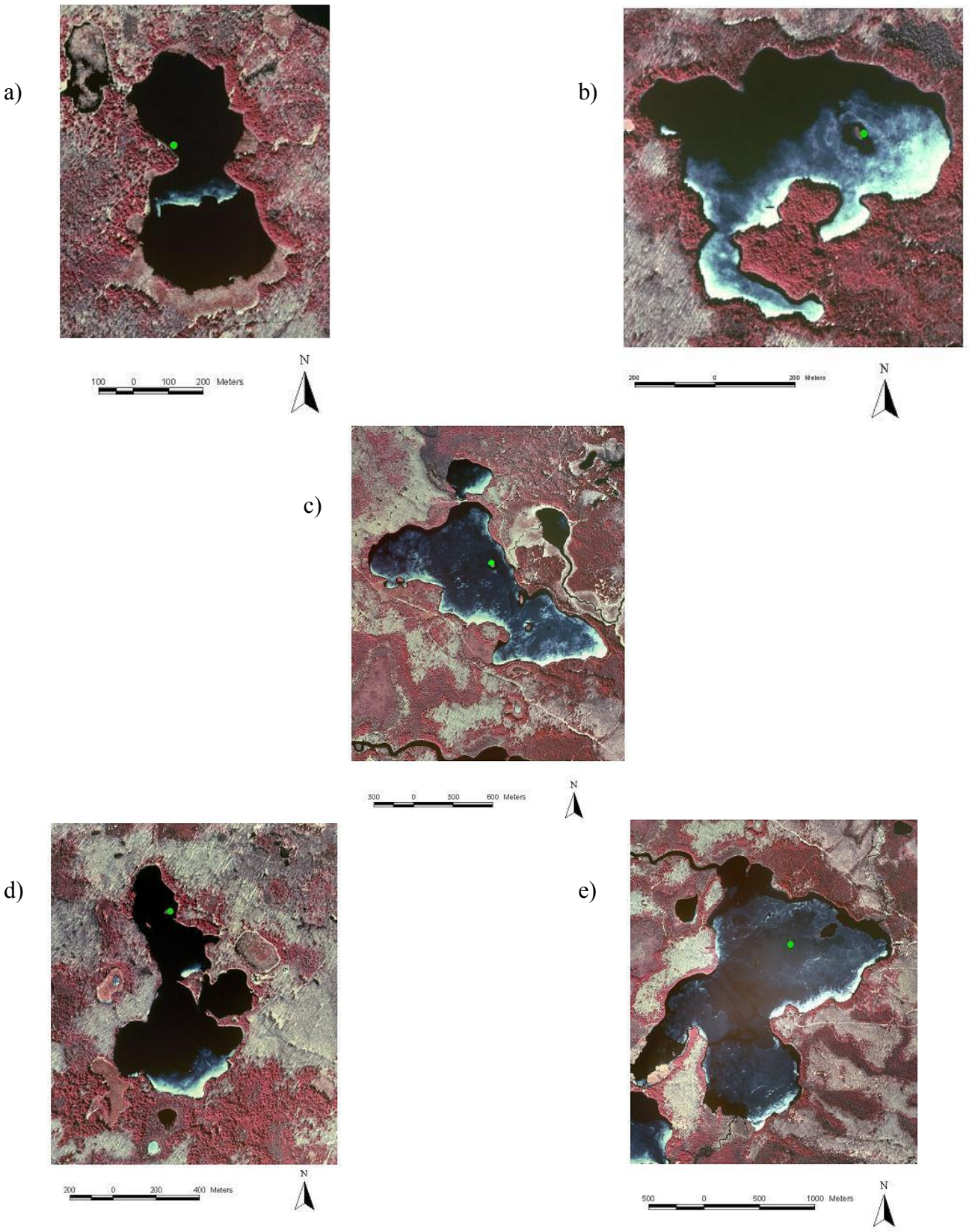

Figure 2: Nest locations on a) Bergner Lake, b) Crampton Lake, c) Plum Lake, d) Roach Lake, and e) Tenderfoot Lake. Nests are indicated on each lake by green dots.

APPENDICES

a)

b)

c)

d)

e)

Appendix 1: Pictures of active loon nests on a) Bergner Lake, b) Crampton Lake, c) Plum Lake, d) Roach Lake, and e) Tenderfoot Lake. For each pair, the picture on the left shows the nest location from a distance. The picture on the right is a close-up of the nest.