THE STATUS AND DISTRIBUTION OF THE COMMON LOON IN WISCONSIN

by

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ABSTRACT

An investigation to determine the status and distribution of the common loon (*Gavia immer*) in Wisconsin was conducted during the summers of 1976 and 1977. Aerial survey methods were 90 percent accurate in assessing loon populations. Audio stimulation was used to attract loons for census purposes. The estimated Wisconsin loon population is 1300 adults and 258 juveniles. Loon distributions were primarily restricted to the northern one-third of Wisconsin. Average size of 195 broods was 1.41 young per brood. Three broods, consisting of three young were observed. Forty percent of the observed adult loons were successful breeders. Loon populations appear stationary in Wisconsin, but continued human disturbance could lead to a future decline. The desertion of three loon nests was linked to human disturbance. Direct human disturbance (harassment and boating activities) is more detrimental to successful breeding than human presence. The number of dwellings per acre of water area of lakes with loon populations was significantly lower ($P<0.05$) than lakes without loons. While loons showed preferences for certain habitat types (large lakes, deep water, and a neutral pH), they do tolerate different types of water areas.

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INTRODUCTION

The common loon is a popular wildlife species because of its interesting habits, calls and unique relationship with the waterways of the undisturbed north (Olson and Marshall 1952). Breckenridge (1949) stated that the loon "expresses the essence of unrestrained wildness and seems to put the stamp of genuineness on a North Country setting like 'Sterling' does on silver".

Concern has been expressed over the decline in loon populations in some areas. The breeding distribution of the common loon is relegated mainly to the northern parts of the Northern Hemisphere, and chiefly North America (Olson and Marshall 1952). Bent (1919) reported loon breeding south to a line running west from New England through northern Ohio, Iowa and northeastern California. Loon populations in Michigan, Minnesota and New Hampshire have declined, with breeding birds found chiefly in less developed sections (Manville 1952, Roberts 1932, McIntyre 1976). Roberts (1932) attributed the early decline of loons in Minnesota to heavy hunting. Spring shooting of loons occurred in Massachusetts from mid-April to the first of June in the early 1900's (Forbush 1912). Pesticides, predators, diseases and human disturbance influences loon productivity in present populations (McIntyre 1975). Management may need to be implemented to maintain current loon populations (McIntyre 1976). Expanded research efforts are needed to provide information for effective loon management.

Little information was available on the status of the common loon in Wisconsin. The Endangered Species Committee within the Wisconsin Department of Natural Resources placed the common loon in a "Status Undetermined" category in 1971. Students, from the University of

Wisconsin - Stevens Point, compiled summer breeding observations of the common loon (Wisdom et al. 1975). A limited study by Kohel (1972), using mail surveys, reported a few loon nesting records and possible migration patterns for Wisconsin loons in 1970. Additional information was needed to determine the current status of loon populations in Wisconsin.

Field surveys were conducted from 15 May through 15 August in 1976 and 1977. Munro (1945) found this period to be the normal occupancy period for loon pairs in British Columbia, Canada. The surveys were restricted to the northern one-third of Wisconsin because of the relatively few reports of nesting loons in the southern two-thirds of the state (Wisdom et al. 1975). Twenty northern Wisconsin counties were surveyed. Surveys were conducted in the northeastern counties in 1976 (Florence, Forest, Lincoln, Langlade, Marinette, Oconto, Oneida and Vilas) and the northwestern counties in 1977 (Ashland, Barron, Bayfield, Burnett, Douglas, Iron, Polk, Price, Rusk, Sawyer, Taylor and Washburn) (Fig. 1).

The objectives of this study were to: (1) determine the breeding status and distribution of the common loon in Wisconsin; (2) determine common loon population trends in Wisconsin; (3) evaluate the use of aerial surveys and audio stimulation as common loon census techniques; (4) determine the effect of human disturbance on loon populations; and (5) determine habitat preferences of the common loon populations.

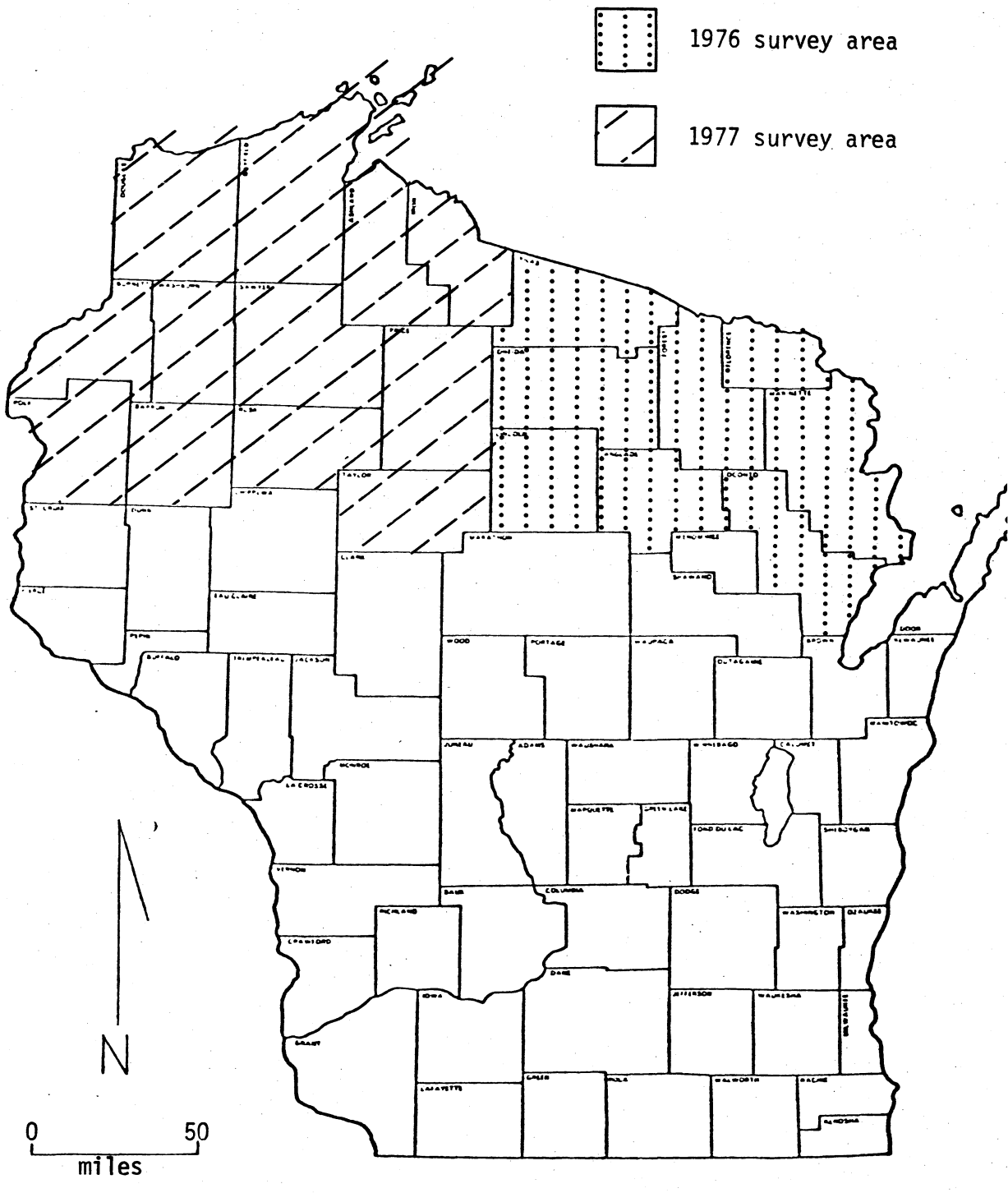

Fig. 1. Field survey area for common loon study in Wisconsin, 1976-1977.

METHODS

Historical data on the common loon in Wisconsin were located. These included the Wisconsin Society for Ornithology (W.S.O.) field notes, Wisconsin Breeding Bird Surveys (B.B.S.), Cornell Nest Records (C.N.R.), Wisconsin Department of Natural Resources (D.N.R.) observations and banding records from the Bird Banding Laboratory, Laurel, Maryland. These records were pertinent because loon pairs use the same lakes year after year (Bent 1919, Munro 1945). Data from a loon survey conducted in 1976 in the Nicolet National Forest by the United States Forest Service (U.S.F.S.) were also obtained. A survey of the Crex Meadows Wildlife Area in 1976 provided information on loon populations in that area (Lombard 1976, unpublished data, University of Wisconsin Center, Rice Lake, Wisconsin).

Mail questionnaires, seeking information on loon distributions (Appendix A), were distributed in 1976 and 1977 to D.N.R. and U.S.F.S. personnel throughout the state. Questionnaires were sent to W.S.O. members and were also distributed at their annual conferences. Postpaid, return envelopes were provided for replies. A news release,requesting information from the general public (Appendix B), was distributed to all newspapers in Wisconsin. Local radio stations in northern Wisconsin broadcasted a request for information throughout the summer months of 1976 and 1977. Residents of northern Wisconsin lakes were personally interviewed. All lakes, larger than 30 acres, were surveyed from the ground or air. Sjolander and Agren (1972) and McIntyre (1975) reported that lakes smaller than 30 acres were seldom occupied by loons. Observations were still requested from lakes of all sizes. A sample of lakes, smaller than 30 acres, was surveyed from

the ground. Wisconsin Lake Survey Reports were used to determine lake size and location. Most lakes were surveyed only once.

Censuses were conducted from vantage points adjacent to the lakes with 7x binoculars and a 20x spotting scope. A 10-minute observation was conducted at each vantage point. Lakes with many bays or islands, which could not be accurately censused from the shoreline, were surveyed from a canoe. Nests were found by walking shorelines of small lakes and islands. Nest searches on large water areas were conducted by canoeing within 20 feet of the shoreline. Olson and Marshall (1952) found that loons nest close to the water's edge.

Loon observations were conducted from ½-hour before sunrise till ½-hour after sunset. Surveys were not conducted when winds were greater than 15 mph.

A tape recording of the tremalo call of a loon (Olson and Marshall 1952) was broadcast with a Panasonic portable tape recorder and 6 inch oval amplifier to elicit responses. Calls were broadcast for 10-seconds, with 10 - 20 second listening intervals between calls. The calling-listening periods were continued for 5 minutes or until loons were observed. Bent (1919) stated that loons will even answer calls made by humans. Responses to audio stimulation were noted and recorded.

Aerial surveys were conducted during July and August in 1977 on large (greater than 1000 acres) and inaccessible water areas that could not be efficiently surveyed from the ground. Lake Superior was surveyed from the air within 0.5-mile of the Wisconsin shoreline with fixed winged aircraft, flying at an altitude of 300 feet. Aerial surveys were flown only when winds were less than 5 mph. Transects were flown at 0.25-mile intervals on the large water areas. When a loon was sighted, the area was circled for 3 minutes to detect other

submerged loons. Palmer (1949) reported the duration of loon dives to be 8.5-60 seconds.

Ninety lakes in Burnett and Washburn counties were surveyed from the air and the ground to determine aerial census accuracy. These surveys were conducted within a 3 day period.

Population trends were determined from surveys conducted for 2 consecutive years (1976 and 1977) on a 236-lake study area (Fig. 2).

The number of dwellings, resorts, public access sites, and boats was recorded for each water area to assess the human disturbance factor. Only dwellings and resorts directly adjacent to the shoreline were included in the survey; docked boats were not included. Wisconsin Surface Water Resources Bulletins provided human development information for lakes that were surveyed from the air. Loon reactions to human disturbance were also recorded.

Habitat characteristics for water areas in 17 of the 20 counties in the field survey area were obtained from Wisconsin Surface Water Resource Bulletins; data on water areas in Lincoln, Price and Washburn counties were not available. Six physical (acreage, water depth, length of shoreline, shoreline development factor, length of public frontage and percent of shoreline composed of wetlands) and four chemical (pH, alkalinity, specific conductance and water color) factors from each water area were analyzed to determine loon habitat preferences. A Seechi disc was used to determine water color (Ruttner 1952).

Data are presented using the English numerical system because all lake information and past records were reported in the English system.

All human disturbance and lake characteristic data were summarized and mean, variance, and standard deviation were calculated. Data were evaluated by t-test with paired samples (Steel and Torrie 1960). The minimum level of significance accepted was $P<0.05$.

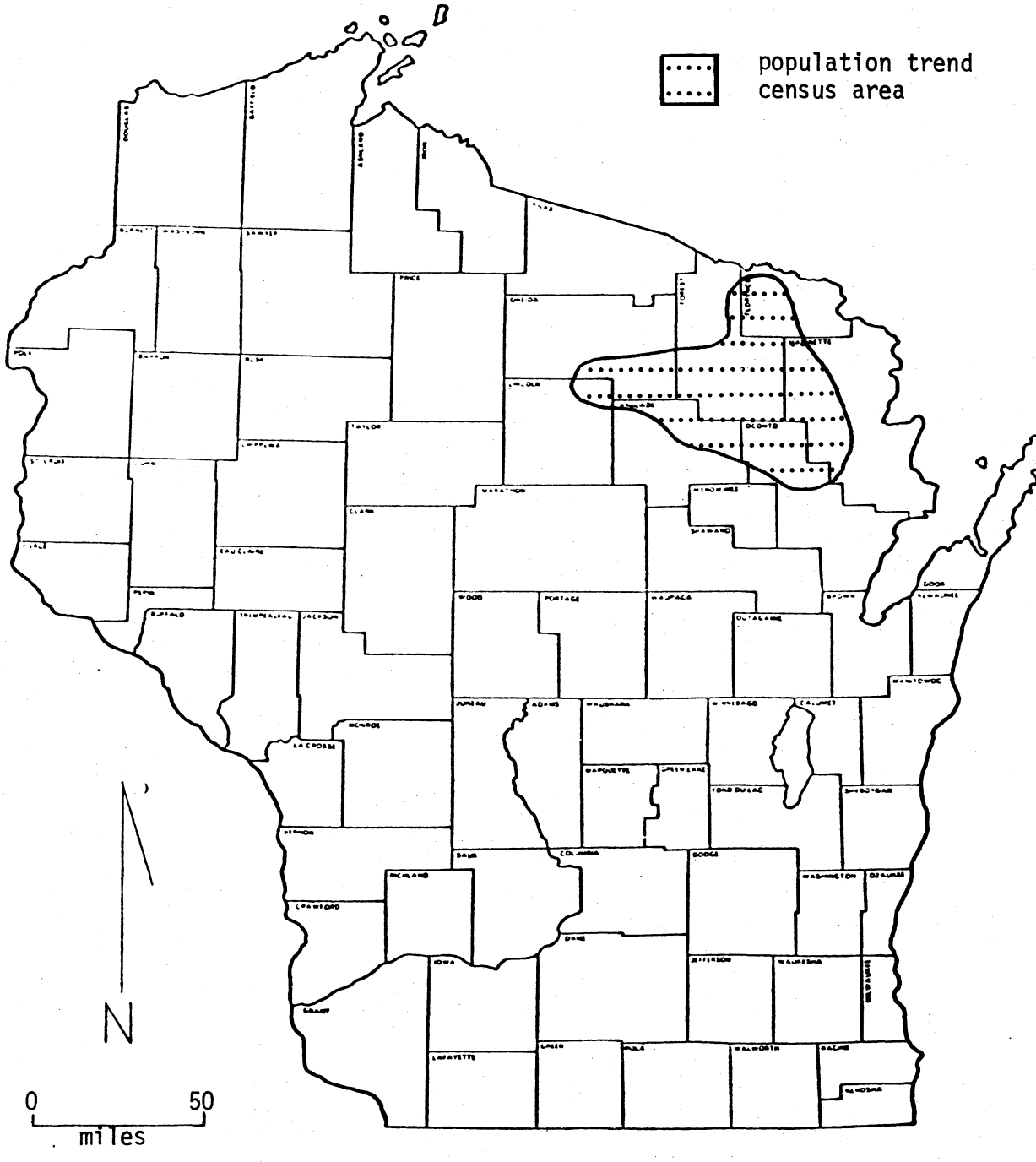

Fig. 2. Location of 236 lakes which were censused in 1976 and 1977 to determine population trends of loons in Wisconsin.

RESULTS AND DISCUSSION

Breeding Status and Distribution

The estimated Wisconsin loon population is 1300 adults and 258 juveniles. Loon population data for individual water areas is presented in Appendix D. A total of 976 adult and 222 juvenile loons were actually observed on lakes larger than 30 acres (Table 1). Five hundred thirty-eight (26.6 percent) of these 2,019 water areas contained loons. Five (3.5 percent) of 143 lakes less than 30 acres held loon populations (9 adult, 1 juvenile). Sjolander and Agren (1972), and McIntyre (1975) also report few loons on small water areas. The results of the small lake survey were extrapolated to all of the 5005 lakes which are less than 30 acres in the northern one-third of the state (Table 2), and added to those actually observed to arrive at a total estimated population of 1300 adult and 258 juveniles.

Most resident loon populations were located in the northern one-third of the state (Fig. 3). Two hundred forty-one (24.7 percent) of the 976 adult loons in the state were observed in Vilas County (Table 1). Adjacent Oneida County had the second largest adult loon population (138 adults). These counties also have the largest number of lakes in Wisconsin (over 1100 lakes in each). However, loons do not inhabit all lakes. Munro (1945) reports that, in British Columbia, loons occupy the same lakes each year, and avoid other lakes, which appear to have similar nesting habitat and food resources.

Details of the four largest loon concentrations in Wisconsin (Chippewa Flowage in Sawyer County, Crex Meadows Wildlife Area in Burnett County, Lake Superior - Wisconsin shoreline and the Turtle-Flambeau Flowage in Iron County) are presented in Table 3. Three of

Table 1. Distribution, by county, of the Wisconsin loon population on lakes larger than 30 acres (1976-1977). (Percentages in parentheses.)

County	Loon		Nests	Water areas with loons	Number of water areas surveyed
	Adult	Young			
Ashland	25(2.6)	7(3.2)	7(3.6)	11(2.0)	40(2.0)
Barron	9(0.9)	2(0.9)	1(0.5)	7(1.3)	62(3.1)
Bayfield	66(6.8)	14(6.3)	11(5.6)	36(6.7)	130(6.4)
Burnett	62(6.4)	23(10.4)	17(8.6)	29(5.4)	144(7.1)
Douglas	32(3.3)	9(4.1)	6(3.0)	18(3.3)	77(3.8)
Florence	22(2.3)	9(4.1)	7(3.6)	13(2.4)	48(2.4)
Forest	62(6.4)	6(2.7)	7(3.6)	38(7.1)	88(4.4)
Iron	70(7.2)	14(6.3)	12(6.1)	33(6.1)	92(4.6)
Langlade	11(1.1)	2(0.9)	2(1.0)	7(1.3)	52(2.6)
Lincoln	10(1.0)	2(0.9)	3(1.5)	7(1.3)	43(2.1)
Marinette	9(0.9)	2(0.9)	1(0.5)	6(1.1)	54(2.7)
Oconto	20(2.0)	7(3.2)	4(2.0)	10(1.9)	70(3.5)
Oneida	138(14.1)	31(14.0)	26(13.2)	80(14.9)	266(13.2)
Polk	12(1.3)	2(0.9)	2(1.0)	6(1.1)	105(5.2)
Price	21(2.2)	3(1.4)	3(1.5)	15(2.8)	67(3.3)
Rusk	6(0.6)	2(0.9)	2(1.0)	4(0.7)	35(1.7)
Sawyer	56(5.7)	12(5.4)	9(4.6)	27(5.0)	116(5.7)
Taylor	2(0.2)	0(0.0)	0(0.0)	2(0.4)	27(1.3)
Vilas	241(24.7)	60(27.0)	63(32.0)	130(24.2)	340(16.8)
Washburn	80(8.2)	14(6.3)	13(6.6)	45(8.4)	163(8.1)
Others	22(2.2)	1(0.4)	1(0.5)	14(2.6)	-
Total	976	222	197	538	2019

Table 2. Loon population in Wisconsin as calculated from field surveys and estimates from lakes less than 30 acres (1976-1977).

Survey type	Number of adults	Number of young	Number of water areas with loons
Direct observation (Lakes ≥ 30 acres)	976	222	538
Direct observation (Lakes < 30 acres)	9	1	5
Estimates (Lakes < 30 acres)	315	35	175
Total Population	1300	258	718

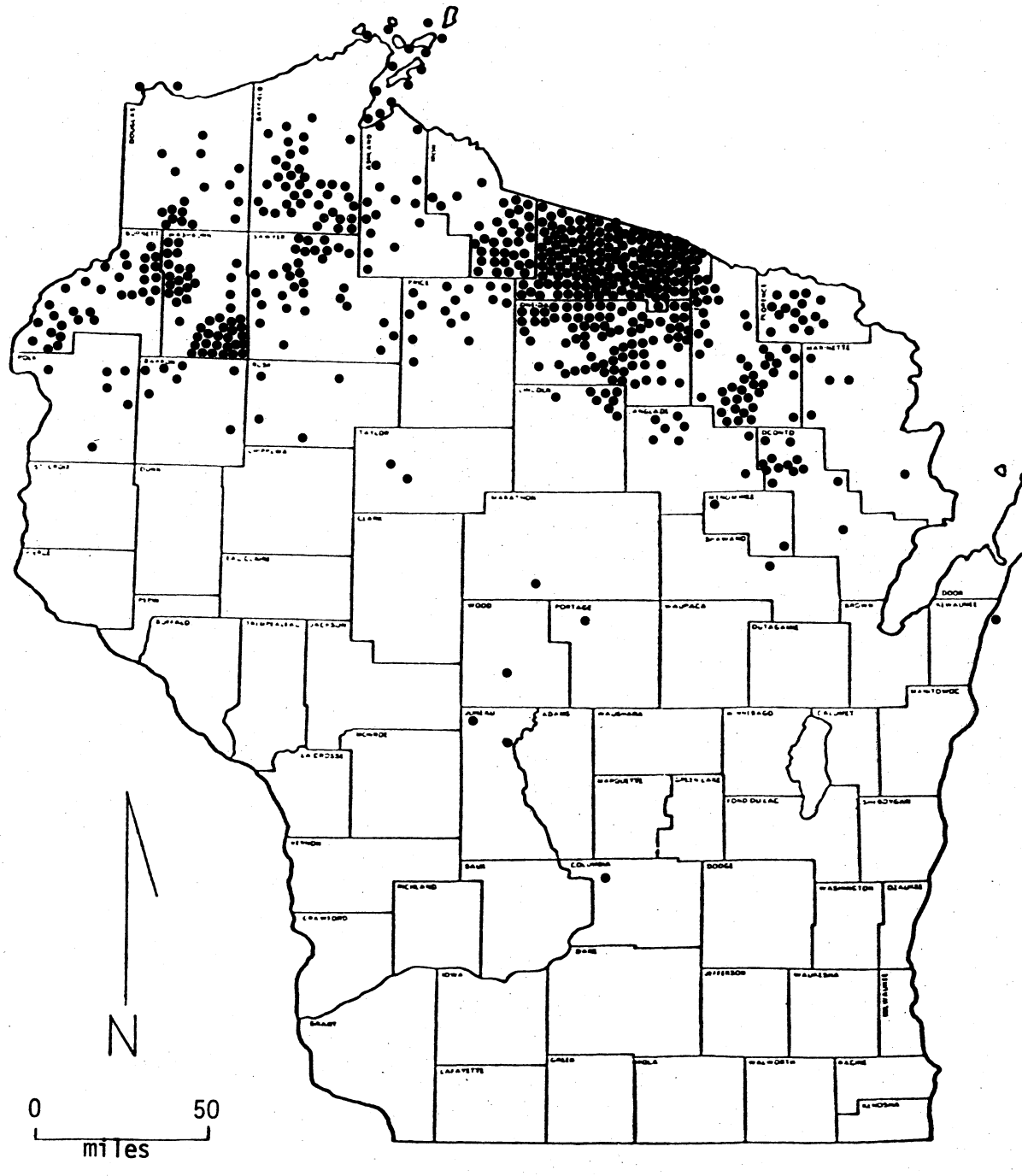

Fig. 3. Distribution of resident loon populations in Wisconsin, 1976-1977.

Table 3. Four largest Wisconsin loon concentrations (1976-1977).

Water area	County	Loon population		
		Adults	Young	Nests
Lake Superior (Wisconsin shoreline)	Ashland Bayfield Douglas	24	4	3
Crex Meadows Wildlife Area[a]	Burnett	17	11	7
Turtle-Flambeau Flowage	Iron	17	8	5
Chippewa Flowage	Sawyer	9	3	3

[a]Survey reported by Lombard (unpublished data).

the water areas (Chippewa Flowage, Crex Meadows and the Turtle-Flambeau Flowage) are man-made impoundments. Ten percent of the juvenile loons, located during this study, were produced on these water areas.

Resident loons were reported in 9 counties (Columbia, Door, Juneau, Kewaunee, Marathon, Menominee, Portage, Shawano and Wood) south of the field survey area (Fig. 3). However, loon populations were reported only on 10 water areas in these 9 counties. Six of these water areas (Swan Lake in Columbia County, Meadow Valley Wildlife Area and Pettinwell Flowage in Juneau County, Mead Wildlife Area in Marathon County, Lake Dubay in Portage County and Sandhill Wildlife Area in Wood County) are located within 20 miles of the Wisconsin River suggesting an association with this major river system. Jahn and Hunt (1964) report the Wisconsin River as being the main artery for diving duck migrations in Wisconsin. I have observed more than 60 loons in one group on the Wisconsin River near Stevens Point during the spring migrations of 1977 and 1978. These concentrations remained for 3 days (9-11 April 1977, 10-12 April 1978); some of them may have dispersed and remained for the summer months. McIntyre (1975) noted a similar pattern along the Mississippi River in Central Minnesota.

Forty percent of the adult loons were successful breeders. A nest was considered successful if one or more of the eggs hatched. Non-breeders and unsuccessful nesting pairs comprised the remaining 60 percent of the adult population. Twenty-eight percent of the adult population were single loons. Loons do not breed until 3 years of age; this may account for many of the non-breeders in the population (Taverner 1929, Roberts 1932). Twenty-eight of 35 nests observed throughout the nesting period were successful. An unknown predator destroyed two nests; three nests, on lakes with constant human

activity, were deserted.

There were 198 nests present on the study area (Fig. 4). The 63 nests in Vilas County comprised 32.0 percent of the total nests in the entire state (Table 1). Only one nest was located in the southern two-thirds of Wisconsin (Meadow Valley Wildlife Area in Juneau County).

Hatching, during both years of the study, began during the third week of June. Assuming a 29-day incubation period (Bent 1919, Olson and Marshall 1952), incubation began in mid-May. Human disturbance has been reported to cause adverse effects on loons (olson and Marshall 1952, Barr 1973). The Memorial Day Weekend, with the associated increase in human activities on water areas during the last week in May, could be an important nesting success factor (Olson and Marshall 1952). Human disturbance during this stage of incubation could lead to desertion of nests.

Brood size averaged 1.41 young per successful loon pair. A pair was determined to be successful if one or more young hatched. One hundred eighteen (60.5 percent) of 195 broods observed had only one chick (Table 4). Broods of three young were observed in Oneida (2) and Vilas (1) counties. Broods of three young have not been reported in other studies. McIntyre (1975) reported an average brood size of 1.4 for loon populations in Minnesota.

Population Trends

Loon distribution is currently restricted to the northern one-third of Wisconsin; loons are observed infrequently in the south (Fig. 3). Since the early 1900's, loons have abandoned previous nest sites in Southern Wisconsin. Human disturbance may be responsible for

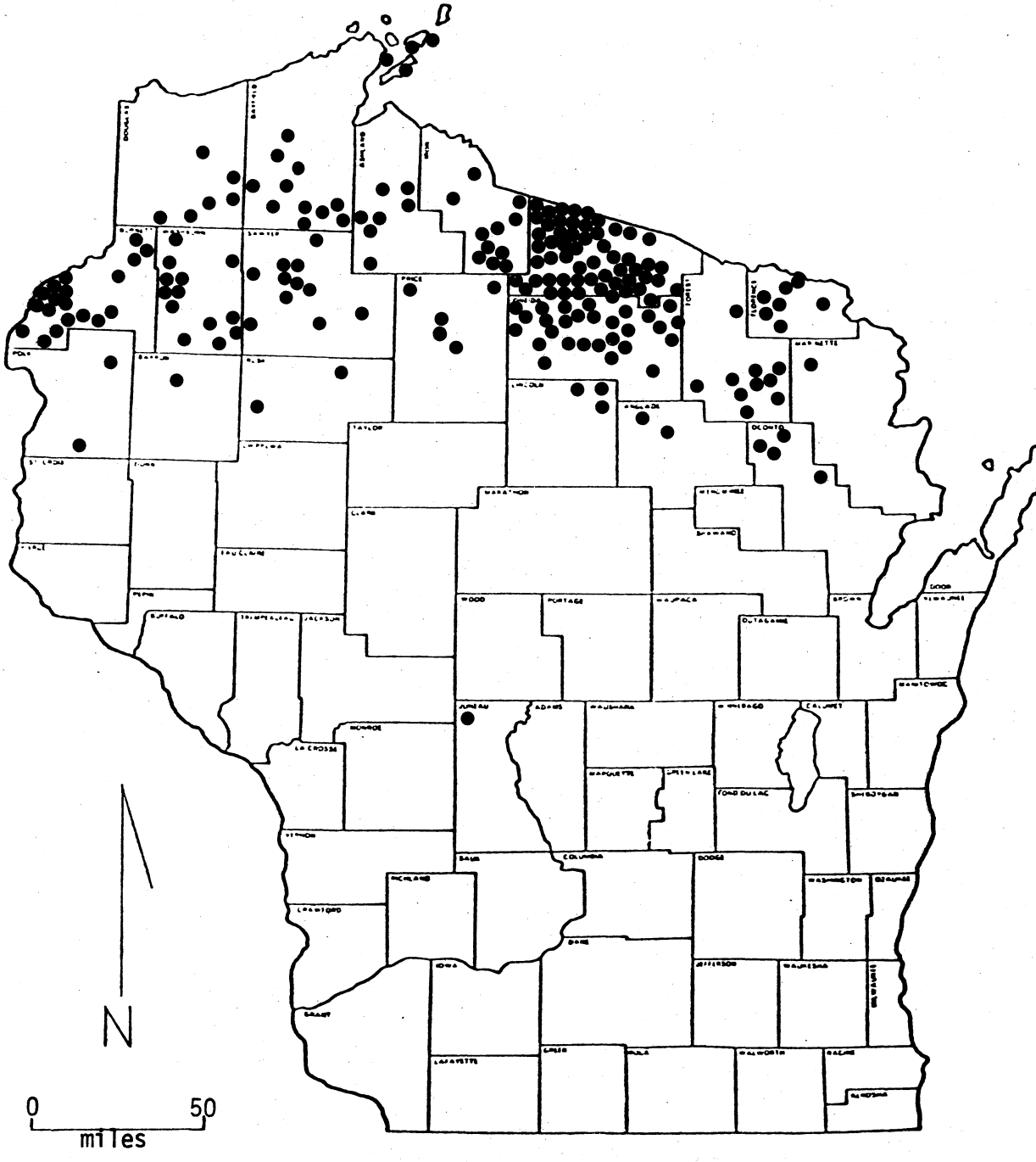

Fig. 4. Distribution of loon nests in Wisconsin, 1976-1977.

Table 4. Brood sizes of Wisconsin loons in 1976 and 1977. (Percentages in parentheses.)

Year	Brood size		
	One chick	Two chick	Three chick
1976	53(59.5)	35(39.3)	1(1.1)
1977	65(61.3)	39(36.8)	2(1.9)
Total	118(60.5)	74(37.9)	3(1.5)

this movement (Olson and Marshall 1952). Bent (1919) included the entire state as breeding range of the loon, with records of loon nesting in Waukesha County. W.S.O. field notes from 1946-1953 include reports of resident loons in Fond du Lac, Waupaca and Waushara counties. Wisdom et al. (1975) compiled records from W.S.O. members since 1954 which included observations of resident loons in Brown, Green Lake, Sheboygan and St. Croix counties. The remainder of the observations were reported from the northern one-third of the state. Kohel (1972) reported a few loon nesting records for northern Wisconsin in 1970.

There was a 5.7 percent decrease in the adult loon population between 1976 (105 adults) and 1977 (99 adults) on the 236-lake study area (Fig. 2). Type-E botulism killed at least 592 common loons in Lake Michigan during the fall of 1976 (Locke 1976, unpublished data, U.S. Fish and Wildlife Service, Madison, Wisconsin); this may account for a portion of the decrease in the adult loon populations in 1977. Adult loon populations remained unchanged on 84.7 percent of the water areas (Table 5). Reports from residents of northern Wisconsin indicate that there has been little change in loon populations over the last 15 years. Robbins (1977) reported no significant changes in loon populations from 1966 through 1975. Loon populations appear to be stationary in Wisconsin at this time but increased human disturbance could cause a decline in the future. The effect of continued disturbance may not be seen for many years because loons live for 30 to 40 years (McIntyre 1976).

Census Techniques

Aerial survey methods were 90 percent accurate in assessing loon populations. Fifty-two of 58 loons which were present on 90 lakes were detected from the air. All 6 young loons (100 percent

Table 5. Adult loon population fluctuations for lakes monitored for 2 consecutive years in northeastern Wisconsin (1976-1977). (Percentages in parentheses.)

Population status - 1977	Number of lakes
Increase	16(6.8)
Decrease	20(8.5)
No change	200(84.7)
Total	236

accuracy) and 46 of the 52 adults (88 percent accuracy) present were detected from the air. Aerial surveys were most accurate when conducted when winds were less than 5 mph and visibility was over 1 mile, and at an altitude of 300 feet above water level. They should be conducted after 1 July. Adult loons are on nests in May and June and would be difficult to detect from the air at that time. Young loon are approximately 2 weeks old by 1 July and can easily be observed from the air. The aerial surveys were faster than ground surveys; 15.0 lakes per hour were surveyed from the air compared with 3.0 lakes per hour from the ground. The cost of the aerial survey was $2.33 per lake. Aerial surveys are the only practical method for censusing large (greater than 1 thousand acres) water areas. Large water areas have been accurately censused by boat in other studies (McIntyre 1975, Olson and Marshall 1952, Vermeer 1973), but these surveys required many hours of observation.

The approaching airplaine caused some loons to dive. This required circling the area to accurately assess loon numbers. The 3-minute circling period was adequate as loons surfaced within 20 seconds after diving. Young loons dove repeatedly; adult loons with young swam in a small circle around the diving young. This behavior continued throughout the 3-minute survey period. The circling behavior was not noted in adults without young.

Tape-recorded calls stimulated a vocal response at 39 (83.0 percent) of 47 lakes where loons were present. No response was obtained at three lakes where loons were known to be on nests. Five single adults, which were with young loons on five other lakes, also did not respond vocally; these adults swam directly away from the source of the audio

stimulation. Loon pairs with young responded by one adult approaching the speaker while the other adult accompanied the young to the opposite side of the lake. Two adult loons were attracted from lakes 0.5 mile away, calling as they flew. The tremalo call, used in this study, was reported by Olson and Marshall (1952) to be uttered when a pair's territory was being invaded. This accounts for the aggressive behavior noted in adult loons and the protective behavior provided the young. Response to the call lasted for up to 9 minutes if stimulation was continued. The audio stimulation was effective on small lakes (less than 200 acres), here the call could be heard over the entire lake by human ear. Weather conditions influenced the range of sound. Winds greater than 15 mph hindered both the range over which the loon call could be heard and the range loon responses were received. Loons responded to the calls at all times of the day.

Human Disturbance

Loon populations in Wisconsin are affected by human disturbance. The desertion of three loon nests in this study was linked to human disturbance. The presence of fisherman for lengthy periods (3-4 hours) near two of the nests prevented the return of the incubating adults. A third nest, located on a 1.2-acre island, was abandoned after the island was used as a campsite for 1 week in early June 1976. Olson and Marshall (1952) reported that 6 of 10 known cases of nest desertion were traceable to human disturbance. McIntyre (1977a) found that human activity increases the chances of predation. Loons, when disturbed, leave their nest and thus alert avian predators to the nest location and also increase the chances for mammalian predation of the unattended nest.

Loon behavior at the nest site varied with the intensity of the disturbance. Adult loons, aware of an approaching boat, would quietly slide off the nest, immediately dive, surface 50 to 100 yards away, dive regularly as the boat passed and then would return to the nest after the boat had passed. Incubating loons which were startled by boaters, would leave the nest and run across the water, calling repeatedly. The frantic calling would attract the mate and the loon pair would engage in a series of quick dives close to the intruder. A single engine airplane was also observed to startle an incubating adult from its nest.

Juvenile losses have been attributed to human activity. Two reports were received from observers who picked up young loons which had been overrun by motorboats and killed. Young loons, less than 2 weeks old, are vulnerable to fatigue, chill and exposure (Olson and Marshall 1952). Continuous harassing by humans could, therefore, cause mortality. Adult loons, with young, remain in isolated areas, away from human activity on lakes with many boaters. Aggressive behavior, directed toward humans by adult loons, was noted when the young loons were less than 1 month old. As I canoed toward the young, the adults would call loudly, run on the water for short distances toward me, and engage in a series of quick dives. If I continued to approach, one adult continued the aggressive behavior while the other adult accompanied the young away from me. Aggressive behavior decreased after the young were older than 1 month; the adults would then utter only a few calls and the young would swim away from me. At this age, the young were capable of sustained dives and easily outdistanced my approaches. McIntyre (1977b) reported that predation by snapping turtles and large fish increases on young loons which are left alone.

Adult loons were observed to dive to avoid motorboats. An adult loon on Black Oak Lake in Vilas County dove seven times in a 5 minute period to avoid boaters. Boats without motors were easily avoided by loons even when pursued. Two adult loons were observed feeding among 26 oar-powered boats and canoes on Hardwood Lake in Forest County. No motored boats were allowed on this 80-acre lake. The loons would dive at the approach of a boat and surface 200-300 yards away from the activity. Restricting motorboat activity on loon breeding lakes would reduce human disturbance.

Significantly more ($P<0.05$) lakes with public access had non-breeding adults present than those without public access (Table 6). There was no significant difference ($P>0.05$) between the presence of nesting loons and the availability of public access. However, there were more nests and young on lakes without public access. Public access increases lake use by providing access for persons other than private landowners. McIntyre (1975) indicated that the location of the public access was important in Minnesota; nests on lakes with an access were located away from the access point.

The length of public frontage of lakes with loon populations was significantly greater ($P<0.05$) than lakes without loons (Table 6). Public frontage in northern Wisconsin consists mainly of state and Federal forest land. Lakes with more public shoreline have fewer private dwellings on them. Islands, reported by Olson and Marshall (1952) to be preferred loon nesting sites, are often public lands. Islands, with little human activity, are important to loon breeding and need to be maintained in their natural condition. Vermeer (1973) reported that canoeists, using islands for campsites, caused loon nest failures in Minnesota.

Table 6. Human disturbance factors of 1746 northern Wisconsin lakes compared with the presence of loon populations (1976-1977).

Human disturbance factor	Nonbreeding adults			Nesting adults			Young		
	Present $\bar{X}$	Absent $\bar{X}$	P	Present $\bar{X}$	Absent $\bar{X}$	P	Present $\bar{X}$	Absent $\bar{X}$	P
Public access[a]	1.33	1.38	0.042	1.38	1.37	0.732	1.38	1.37	0.735
Miles of public frontage	0.08	0.04	<0.001	0.08	0.05	0.030	0.08	0.05	0.021
Number of dwellings per acre of water area	0.06	0.10	<0.001	0.06	0.09	0.015	0.05	0.09	0.009
Number of resorts per acre of water area	0.006	0.005	0.467	0.005	0.006	0.511	0.005	0.006	0.419

[a] Public access parameter coded for computer analysis. 1.00 = access present, 2.00 = access absent.

The number of dwellings per acre of water area of lakes with loon populations was significantly lower ($P<0.05$) than on lakes without loons (Table 6). One hundred twenty (81.6 percent) of 147 lakes with nesting loons had less than 0.1 dwellings per acre (Table 7). Only 22 (17.9 percent) of 123 lakes with young loons had more than 0.1 dwelling per acre. Large lakes buffer the effect of large numbers of dwellings. The 15,300 acre Chippewa Flowage in Sawyer County has approximately 150 dwellings located on its shoreline, a ratio of one dwelling per 100 acres. However, the dwellings are clustered providing much undeveloped shoreline.

There was no significant difference ($P>0.05$) between the presence of loon populations and the number of resorts per acre of water area (Table 6). The ratio of resorts per acre ranged from 0.000 - 0.046 on lakes with loons present. Eighty-four (57.1 percent) of 147 lakes with nesting loons had no resorts. Only 6 (11.5 percent) of 52 lakes with more than 10 resorts had nesting loons.

Direct human disturbance (harassment, boating activities) is more detrimental to successful breeding than human presence. Lakes adjacent to villages had successful nesting (e.g. Scattered Rice Lake, Forest County; Goodman Mill Pond, Marinette County). Although next to villages, these lakes had little direct human disturbance. Bogs surround these lakes preventing easy access; the shorelines are 80 percent free of development; human use consists of only a few fishermen and motor-boating is restricted by the presence of many stumps.

Comments by longtime residents of northern Wisconsin, as revealed by questionnaire, indicate a decline in loon numbers as human development increased. Increasing numbers of summer cottages and boating activities on lakes caused a decline of Arctic loons (Gavia arctica) in

Table 7. Relationship between loon breeding populations and the number of dwellings per acre of water area on 438 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Number of dwellings per acre of water area	Nonbreeding adults	Nesting adults	Young
0.000	64(22.0)	35(23.8)	30(24.4)
0.001 - 0.025	48(16.5)	37(25.2)	33(26.8)
0.026 - 0.050	47(16.2)	20(13.6)	15(12.2)
0.051 - 0.075	34(11.7)	18(12.2)	15(12.2)
0.076 - 0.100	24 (8.2)	10 (6.8)	8 (6.5)
0.101 - 0.125	28 (9.6)	12 (8.2)	11 (8.9)
0.126 - 0.150	14 (4.8)	2 (1.4)	1 (0.8)
0.151 - 0.200	12 (4.1)	7 (4.8)	5 (4.1)
0.201 - 0.300	14 (4.8)	3 (2.0)	3 (2.4)
0.301 - 0.500	6 (2.1)	1 (0.7)	1 (0.8)
0.501+	0 (0.0)	2 (1.4)	1 (0.8)
Total	291	147	123

southwestern Finland (Lehtonen 1970). Loons return to the same nest sites year after year (Wilson 1928, Olson and Marshall 1954) but, as human disturbance increases near nest sites, desertion can occur. Buffer zones, free of human disturbance and development, should be created at least 100 yards from nest sites to maintain present loon populations. Human disturbance within 100 yards of the nest caused adults to leave. The critical time of the loon breeding period in Wisconsin is from the onset of nesting (1 May) until the young are approximately 2 weeks old (1 July). Human disturbance during this period can cause nest desertion or juvenile mortality.

Habitat Characteristics

Lakes with loon populations were significantly larger ($P<0.05$) than lakes without loons (Table 8). However, 65 (44.2 percent) of 147 loon nests were located on lakes smaller than 100 acres (Table 9). Pine Lake, in Bayfield County, was the smallest water area (10 acres) with a resident loon (one nonbreeding adult). Wildwood Lake, in Vilas County, was the smallest lake (16 acres) with a breeding loon pair. Small lakes (less than 10 acres) do not provide enough space for loons to gain flight because they run along the water for a long distance before becoming airborne (Van Tyne and Berger 1959). The Chippewa Flowage, in Sawyer County, was the largest inland water area (15,300 acres) with a resident loon population (3 breeding pairs, 3 nonbreeding adults). No lake smaller than 252 acres had more than one breeding pair. Loon pairs, nesting on small lakes, often fed on an adjacent lake. I did not determine if the second lake was part of the loons' territory, but no defense behavior was noted there. Available water

Table 8. Physical habitat characteristics of 1746 northern Wisconsin lakes compared with the presence of loon populations (1976-1977).

Habitat characteristic	Nonbreeding adults			Nesting adults			Young		
	Present $\bar{X}$	Absent $\bar{X}$	P	Present $\bar{X}$	Absent $\bar{X}$	P	Present $\bar{X}$	Absent $\bar{X}$	P
Acres	386.14	166.82	< 0.001	448.22	201.06	< 0.001	488.82	201.64	< 0.001
Maximum water depth[a]	31.61	22.89	< 0.001	29.95	24.63	0.001	29.67	24.73	0.004
Miles of shoreline	5.39	2.95	< 0.001	7.00	3.25	< 0.001	7.60	3.26	< 0.001
Shoreline development factor	1.88	1.79	0.039	1.99	1.79	0.010	2.01	1.80	0.007
Percent of shoreline wetland	23.48	28.14	0.005	24.69	27.18	0.338	25.55	27.08	0.588

[a] Measured in feet.

Table 9. Relationship between loon populations and the size of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Acres	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
30-59	60(20.6)	568(39.0)	38(25.9)	590(37.0)	32(26.0)	596(36.8)
60-99	62(21.3)	309(21.2)	27(18.3)	344(21.5)	23(18.7)	348(21.5)
100-199	59(20.3)	273(18.8)	25(17.0)	307(19.2)	22(17.9)	310(19.1)
200-299	31(10.7)	122 (8.4)	20(13.6)	133 (8.3)	15(12.2)	138 (8.5)
300-499	24 (8.2)	83 (5.7)	16(10.9)	91 (5.7)	14(11.4)	93 (5.7)
500-999	30(10.3)	56 (3.8)	14 (9.5)	72 (4.5)	11 (8.9)	75 (4.6)
1000+	25 (8.6)	44 (3.0)	7 (4.7)	62 (3.9)	6 (4.9)	63 (3.9)
Total	291	1455	147	1599	123	1623

area does not appear to limit Wisconsin loon populations. Other factors, such as the type of shoreline, influence Wisconsin loon populations. Many of the larger water areas in northern Wisconsin could presumably support additional loons. The 13,545-acre Turtle-Flambeau Flowage in Iron County contained 17 adult loons in 1977 (approximately one adult per 800 acres). Lakes of comparable size in Minnesota supported from one adult per 108 acres to one adult per 284 acres of water (McIntyre 1975).

Lakes with loon populations were significantly deeper ($P<0.05$) than lakes without loons (Table 8). Eight hundred eighty-eight (50.8 percent) of 1746 lakes were less than 20 feet deep. However, only 105 (36.1 percent) of 291 lakes with nonbreeding adult loons were less than 20 feet deep (Table 10). Ninety-six (65.3 percent) of 147 nesting lakes were greater than 20 feet deep. Maximum water depths ranged from 5 to 91 feet on lakes with nesting loons. This preference for deeper water was also reported by Olson and Marshall (1952). Shallow lakes, subject to "winterkill" in northern Wisconsin, may not hold adequate fish populations to sustain juvenile loons. Barr (1973) noted that one loon pair and two chicks require 1050 kilograms of fish during a 15-week period.

The length of shoreline of lakes with loon populations was significantly greater ($P<0.05$) than lakes without loons (Table 8). The mean length of the shoreline of lakes with nesting adults (7.00 miles) and young (7.60 miles) was greater than lakes with nonbreeding adults present (5.39 miles). The presence of islands may account for the increase in shoreline length on lakes with nests and young. Previous studies indicate loon preference for nesting on islands (Olson and

Table 10. Relationship between loon populations and the maximum water depth of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Maximum[a] water depth	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
1-10	24 (8.2)	351(24.1)	26(17.7)	349(21.9)	23(18.7)	352(21.7)
11-20	81(27.8)	432(29.7)	25(17.0)	488(30.5)	20(16.3)	493(30.3)
21-30	64(22.0)	288(19.8)	36(24.5)	316(19.8)	31(25.2)	321(19.8)
31-50	73(25.1)	267(18.4)	41(27.9)	299(18.7)	33(26.8)	307(18.9)
51+	49(16.8)	117 (8.0)	19(12.9)	147 (9.2)	16(13.0)	150 (9.2)
Total	291	1455	147	1599	123	1623

[a] in feet.

Marshall 1952, Vermeer 1973). The data in Table 8 are influenced by the large shorelines of the Chippewa (232.9 miles) and Flambeau (211.0 miles) Flowages, both of which contained loon populations. The removal of these two water areas from the data lowers the mean shoreline lengths for lakes with loon populations but does not alter the significance levels. Table 11 shows the importance of lakes with smaller shorelines in the overall loon population. One hundred twelve (76.2 percent) of 147 lakes with nesting loons have less than 5 miles of shoreline.

The pH of lakes with loon populations was significantly higher ($P<0.05$) than those without loons (Table 12). The mean pH for lakes with nonbreeding adult loons was 6.92 compared to 6.39 for those without nonbreeders. Thirty-two (11.0 percent) of the 291 lakes with adult loons had a pH less than 6.0 (Table 13). One hundred twenty-six (85.7 percent) of 147 loon nesting lakes had a neutral pH (6.1-8.0). Ten (3.6 percent) of 274 lakes with pH less than 6.0 had young loons. Lakes with a more basic pH also were not preferred by loon populations. Only eight (5.9 percent) of 134 lakes with a pH greater than 8.0 had young loons. Loon preference for lakes with a neutral pH may be associated with their feeding habits. The abundance of fish populations increase as pH levels approach neutral in freshwater ecosystems (Macan 1963).

The mean alkalinity level of lakes with adult loons (breeders and nonbreeders) was significantly lower ($P<0.05$) than lakes without adults (Table 12). The mean alkalinity level of lakes with young loons was not significantly different ($P>0.05$) than lakes without young. One hundred twenty-three (83.7 percent) of 147 lakes with nests had alkalinity levels less than 50 ppm (Table 14). This preference for lower alkalinity can be explained by the distribution of loon populations. Wisconsin loon populations were primarily located in Oneida and Vilas counties, the

Table 11. Relationship between loon populations and the length of shoreline of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Miles of shoreline	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
0.5-2.0	107(36.8)	745(51.2)	58(39.5)	794(49.7)	49(39.9)	803(49.5)
2.1-5.0	113(38.8)	517(35.5)	54(36.7)	576(36.0)	44(35.7)	586(36.1)
5.1-10.0	43(14.8)	145(10.0)	27(18.4)	161(10.1)	23(18.7)	165(10.2)
10.1-25.0	25 (8.6)	37 (2.5)	4 (2.7)	58 (3.6)	3 (2.4)	59 (3.6)
25.1+	3 (1.0)	11 (0.8)	4 (2.7)	10 (0.7)	4 (3.2)	10 (0.7)
Total	291	1455	147	1599	123	1623

Table 12. Chemical habitat characteristics of 1746 northern Wisconsin lakes compared with the presence of loon populations (1976-1977).

Habitat characteristic	Nonbreeding adults			Nesting adults			Young		
	Present $\bar{X}$	Absent $\bar{X}$	P	Present $\bar{X}$	Absent $\bar{X}$	P	Present $\bar{X}$	Absent $\bar{X}$	P
pH	6.92	6.39	<0.001	6.96	6.48	0.004	6.93	6.49	0.013
Methyl purple[a] alkalinity	30.33	39.01	<0.001	30.18	37.44	0.016	31.14	37.26	0.062
Specific conductance[b]	68.08	85.53	<0.001	68.95	82.28	0.031	70.72	81.95	0.094
Water color[c]	1.50	1.57	0.250	1.48	1.56	0.344	1.51	1.56	0.643

[a] Measured in ppm $CaCO_3$.

[b] Measured in mmhos-77°F.

[c] Water color parameter coded for computer analysis. 1 = clear, 2 = light brown, 3 = medium brown, 4 = dark brown, 5 = turbid.

Table 13. Relationship between loon populations and the pH of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

pH	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
< 5.0	4 (1.4)	117 (8.0)	2 (1.4)	119 (7.4)	2 (1.6)	119 (7.3)
5.1-6.0	28 (9.6)	125 (8.6)	9 (6.2)	144 (9.0)	8 (6.5)	145 (9.0)
6.1-6.5	46(15.8)	196(13.5)	16(10.9)	226(14.1)	14(11.4)	228(14.0)
6.6-7.0	80(27.5)	427(29.3)	52(35.4)	455(28.5)	41(33.3)	466(28.7)
7.1-7.5	76(26.1)	362(24.9)	43(29.3)	395(24.7)	37(30.1)	401(24.7)
7.6-8.0	37(12.7)	114 (7.8)	15(10.2)	136 (8.5)	13(10.6)	138 (8.5)
8.0+	20 (6.9)	114 (7.8)	10 (6.8)	124 (7.8)	8 (6.5)	126 (7.8)
Total	291	1455	147	1599	123	1623

Table 14. Relationship between loon populations and the methyl purple alkalinity of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Alkalinity[a]	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
0-25	146(50.2)	704(48.4)	81(55.1)	769(48.1)	67(54.5)	783(48.2)
26-50	95(32.6)	372(25.6)	42(28.6)	425(26.6)	36(29.3)	431(26.6)
51-75	31(10.7)	155(10.6)	12 (8.2)	174(10.9)	9 (7.3)	177(10.9)
76-100	8 (2.7)	109 (7.5)	7 (4.8)	110 (6.9)	6 (4.9)	111 (6.8)
101-150	11 (3.8)	98 (6.7)	4 (2.7)	105 (6.6)	4 (3.2)	105 (6.5)
151+	0 (0.0)	17 (1.2)	1 (0.7)	16 (1.1)	1 (0.8)	16 (1.1)
Total	291	1455	147	1599	123	1623

[a] in ppm $CaCO_3$.

area with the most lakes (Table 1). No lakes in these two counties had alkaline levels higher than 100 ppm. Lakes along the southern edge of the study area have higher alkalinity levels and fewer loons.

Specific conductance results were similar to the alkalinity findings. Conductance levels of lakes with adult loons (breeders and non-breeders) were significantly lower ($P<0.05$) than lakes without adults (Table 12). One hundred twenty-two (83.0 percent) of 147 nesting lakes had conductance levels of less than 100 mm (Table 15). Conductance levels of lakes also decreased along the southern edge of the study area.

There was no significant difference ($P>0.05$) between the presence of loon populations and the water color of lakes (Table 12). However, one hundred ninety-one (66.8 percent) of 286 lakes with nonbreeding adult loons were clear in color (Table 16). Few lakes with water darker than medium brown had loons. Only 13 (4.9 percent) of 264 lakes with medium brown, dark brown or turbid water color had nesting loons. Preference for clear water may be associated with loon feeding habits. McIntyre (1975) found that the availability of fish, to loons, was dependant upon visibility. Fish were able to escape more readily in water of low visibility. Loon response to changing water color was noted on Himley Lake in Forest County. Loons nested on this clear water lake in 1976. Loons were not present in 1977 as an algal bloorm reduced water clarity in May and June. Clear water was present again in May 1978 along with a breeding loon pair. However, the number of lakes with clear water was not a limiting factor for loon populations in the study area. Nine hundred eighty-two (66.0 percent) of 1636 lakes had clear water. However, as lakes become eutrophic, water clarity declines (Macan 1963). Artificially stimulated eutrophication must be prevented and water quality maintained to ensure stable loon numbers.

Table 15. Relationship between loon populations and the specific conductance of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Specific conductance[a]	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
0-25	83(28.5)	328(22.5)	38(25.9)	373(23.3)	29(23.6)	382(23.5)
26-50	49(16.8)	271(18.6)	32(21.8)	288(18.0)	27(22.0)	293(18.1)
51-75	50(17.2)	253(17.4)	26(17.7)	277(17.3)	23(18.7)	280(17.3)
76-100	46(15.8)	201(13.8)	26(17.7)	221(13.8)	24(19.5)	223(13.7)
101-125	31(10.7)	99 (6.8)	5 (3.4)	125 (7.8)	4 (3.3)	126 (7.8)
126-150	10 (3.4)	59 (4.1)	7 (4.8)	62 (3.9)	4 (3.3)	65 (4.0)
151-175	7 (2.4)	59 (4.1)	2 (1.4)	64 (4.0)	2 (1.6)	64 (3.9)
176-200	4 (1.4)	55 (3.8)	4 (2.7)	55 (3.4)	3 (2.4)	56 (3.5)
200+	11 (3.8)	130 (8.9)	7 (4.8)	134 (8.4)	7 (5.7)	134 (8.3)
Total	291	1455	147	1599	123	1623

[a] in mm hos-77°F.

Table 16. Relationship between loon populations and the water color of 1636 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Water color	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
Clear	191(66.8)	791(58.6)	96(65.8)	886(59.5)	75(62.0)	907(59.9)
Light Brown	53(18.5)	337(25.0)	37(25.8)	353(23.7)	34(29.0)	356(23.5)
Medium Brown	30(10.5)	121 (9.0)	8 (5.5)	143 (9.6)	8 (6.6)	143 (9.5)
Dark Brown	7 (2.4)	59 (4.4)	3 (2.0)	63 (4.2)	2 (1.6)	64 (4.2)
Turbid	5 (1.7)	42 (3.1)	2 (1.4)	45 (3.0)	2 (1.6)	45 (3.0)
Total	286	1350	146	1490	121	1515

The shoreline development factor (S.D.F.) compares the surface area of the lake to the length of shoreline (S.D.F. = $\frac{\text{shoreline length}}{2\sqrt{\text{surface area } \pi}}$) (Hutchinson 1967). Lakes in the shape of a perfect circle would have a S.D.F. of 1.00. Increasing values indicate an increasingly irregular shoreline. Lakes with loon populations had a significantly greater ($P<0.05$) S.D.F. than lakes without loons (Table 8.) The mean S.D.F. for lakes with nests (1.99) and young (2.01) was greater than lakes with nonbreeding adults (1.88). Seventy-nine (8.0 percent) of 985 lakes with a S.D.F. greater than 1.50 had young loons compared to 44 (5.8 percent) of 757 lakes with a S.D.F. of less than 1.50 (Table 17). Olson and Marshall (1952) found that loon nest sites are selected where protection from wind and waves is available. Irregular shorelines with bays, islands and peninsulas provide the required protection.

The amount of wetlands on the shoreline of lakes with nonbreeding adult loons was significantly greater ($P<0.05$) than lakes without nonbreeders (Table 8). There was no significant difference ($P>0.05$) between the presence of nesting loons and the amount of wetlands on the shoreline. Lakes with 1-25 percent of the shoreline composed of wetlands held approximately 55 percent of the loon populations (Table 18). Some wetlands are important, as loons nest on floating bogs (Olson and Marshall 1952). In Alberta and Minnesota, islands are the primary nest sites (Vermeer 1973, McIntyre 1975). Loons nest on floating bogs on many Wisconsin lakes because islands are absent. These wetlands are relatively free from human disturbance. Lakes entirely surrounded by bogs had few loons. Acidic conditions of many bog lakes may account for this.

While loons showed preferences for certain habitat types, they do tolerate different types of water areas. There are sufficient

Table 17. Relationship between loon populations and the shoreline development factor (S.D.F.) of 1742 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

S.D.F.[a]	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
1.00-1.25	53(18.2)	254(17.5)	24(16.3)	283(17.7)	19(15.4)	288(17.8)
1.26-1.50	65(22.3)	385(26.5)	31(21.1)	419(26.3)	25(20.3)	425(26.3)
1.51-1.75	45(15.5)	262(18.1)	29(19.7)	278(17.4)	27(22.0)	280(17.3)
1.76-2.00	45(15.5)	198(13.6)	26(17.7)	217(13.6)	21(17.1)	222(13.7)
2.01-3.00	66(22.7)	257(17.7)	26(17.7)	297(18.6)	21(17.1)	302(18.7)
3.01+	17 (5.8)	95 (6.5)	11 (7.5)	101 (6.3)	10 (8.1)	102 (6.3)
Total	291	1451	147	1595	123	1619

[a] $\text{S.D.F.} = \frac{\text{shoreline length}}{2\sqrt{\pi \times \text{surface area}}}$.

Table 18. Relationship between loon populations and the amount of wetlands on the shoreline of 1746 northern Wisconsin lakes (1976-1977). (Percentages in parentheses.)

Percent wetlands	Nonbreeding adults		Nesting adults		Young	
	Present	Absent	Present	Absent	Present	Absent
0	37(12.7)	214(14.7)	19(12.9)	232(14.5)	15(12.2)	236(14.5)
1-25	164(56.4)	752(51.7)	82(55.8)	834(52.2)	67(54.5)	849(52.3)
26-50	51(17.5)	201(13.8)	21(14.3)	231(14.4)	20(16.3)	232(14.3)
51-75	24 (8.2)	108 (7.4)	11 (7.5)	121 (7.6)	9 (7.3)	123 (7.6)
76-99	10 (3.4)	85 (5.8)	10 (6.8)	85 (5.3)	9 (7.3)	86 (5.3)
100	5 (1.7)	95 (6.5)	4 (2.7)	96 (6.0)	3 (2.4)	97 (6.0)
Total	291	1455	147	1599	123	1623

numbers of suitable water areas, with appropriate habitat in Wisconsin, to maintain a higher loon population. Human disturbance appears to be limiting loon population growth.

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Appendix A. Mail questionnaire.

A 2-year study, sponsored by the Wisconsin Department of Natural Resources, is being conducted to determine the status and distribution of the common loon (Gavia immer) in Wisconsin. Any observations and past records of loon activity are needed.

Please indicate any information which you have on the presence of loons in Wisconsin lakes by completing the following questionnaire. Additional information can be included on the back of this form or on attached sheets. Return envelopes are provided for your convenience. Please continue to report future loon observations to the following address:

Gary Zimmer
College of Natural Resources
UW - Stevens Point
Stevens Point, Wisconsin 54481

Your help in this study is greatly needed and appreciated.

Sincerely,

Gary Zimmer
UW - SP Graduate Student

OBSERVER _____

ADDRESS _____

_____

DATE OF OBSERVATION (Mo.Day,Yr.)	LOCATION OF OBSERVATION			NO. OF LOONS	NEST PRESENT (Yes or No)	
	Lake	County	Township			

Appendix B. News release requesting loon observations in 1976 and 1977.

Have You Heard The Uncommon Common Loon

Clintonville Tribune-Gazette June 17, 1976

If you're in the neighborhood of a lake and hear the yodel of a common loon, a student at the University of Wisconsin-Stevens Point would like you to report the happening.

The common loon, some scientists believe, may be declining in numbers in Wisconsin. The Department of Natural Resources lists it in an undetermined status and consequently, has approved a grant of about $4,600 for a study to be conducted by Gary Zimmer of Laona, who is pursuing a master's degree in natural resources from UW-Stevens Point. He plans to personally visit most of the lakes over 30 acres in size in the northern third of the state, but is depending on the public to supply information in the other areas.

He has asked that reports of common loon sightings be forwarded to the College of Natural Resources, UW-Stevens Point, Stevens Point, Wis., 54481.

A city boy from Milwaukee, he moved with his f$mily to northern Wisconsin when he was in grade school and developed a fascination for non game species, especially the common loon. He describes its yodel-like call as being "almost eerie but beautiful in its own way."

The bird itself is primitive in its body structure, he says. There is a disproportionate difference in size between the body and wings. The legs are located in such a way that the birds can barely walk, hence their reason for nesting so close to the water's edge.

It's common to find only a pair of loons on a lake up to 100 acres in size. And it's also common that the female loon only hatches one of the two eggs she usually lays. Frequently, neither of the eggs hatch, he reports.

Once a hunted bird, the fish-eating loon didn't lend itself to tasty dishes. Zimmer suspects it will be difficult to track reasons for a decline in the loon population if that assumption is indeed true. But he believes one argument would be that the use of pesticides is a major culprit.

Zimmer's project is for two years. His master's degree thesis will be done on the basis of his field work. His professor is Dr. Raymond Anderson, a wildlife specialist, who is administering the financial support grant from DNR.

Appendix C. Water areas with loon populations in Wisconsin, 1976-1977.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976 Ad.	1976 Yg.	1976 Nest	1977 Ad.	1977 Yg.	1977 Nest
Ashland County									
Bad River Slough	17	48N	2W	1	0	0	0	0	0
Beaver Dam	36	45N	4W	-	-	-	1	0	0
Cub	36	41N	4W	-	-	-	2	1	1
Day	30	43N	4W	4	0	1	0	0	0
East Twin	22	43N	4W	2	0	1	2	0	0
English	8	44N	3W	-	-	-	1	0	0
Gates	23	42N	3W	2	0	0	-	-	-
Little Clam	5	42N	4W	2	0	0	2	0	1
Loon	29	45N	2W	2	2	1	2	1	1
Spillerberg	19	43N	2W	2	0	0	0	0	0
Superior				2	0	0	9	4	3
Three	3	44N	4W	2	0	0	1	1	1
Twin (West)	24	44N	2W	-	-	-	2	0	0
Upper Clam	31	43N	4W	-	-	-	1	0	0
Barron County									
Bass	34	33N	10W	2	0	0	2	0	0
Buck	34	36N	13W	2	0	1	2	2	1
Crystal	28	35N	14W	-	-	-	1	0	0
Little Granite	28	36N	13W	1	0	0	1	0	0
Little Sand	27	36N	14W	-	-	-	1	0	0
Red Cedar	10	36N	10W	-	-	-	1	0	0
Silver	24	36N	13W	-	-	-	1	0	0
Bayfield County									
Anderson	1	45N	8W	-	-	-	1	0	0
Atkins	19	44N	5W	2	0	0	2	0	0
Bass	24	44N	6W	1	0	0	0	0	0
Bismarck	19	47N	8W	-	-	-	1	0	0
Canthook	15	46N	8W	-	-	-	2	0	0
Chippewa	15	43N	5W	2	0	0	2	2	1
Club	13	44N	6W	2	2	1	2	2	1
Coffee	24	44N	5W	-	-	-	2	0	0
Cranberry	30	44N	9W	1	0	0	1	0	0
Crooked	26	47N	8W	-	-	-	2	0	0
Diamond	29	44N	6W	2	0	0	2	2	1
Duck	13	43N	5W	2	0	0	-	-	-
Esox	21	45N	7W	-	-	-	1	0	0
Finger	32	47N	7W	-	-	-	2	0	0
Five Island	34	47N	5W	-	-	-	2	1	1
Flynn	30	45N	7W	-	-	-	2	1	1

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Bayfield County(Cont.)									
George	18	45N	9W	-	-	-	1	0	0
Hammil	25	44N	8W	-	-	-	2	1	1
Hilder	2	46N	8W	1	0	0	1	0	0
Iron	24	47N	9W	1	0	0	0	0	0
Jackson	33	44N	6W	2	0	0	1	0	0
Kern	27	46N	7W	-	-	-	2	0	0
Loon	12	47N	8W	1	0	0	1	0	0
McCloud	31	43N	5W	-	-	-	1	0	0
Middle Eau Claire	17	44N	9W	-	-	-	1	0	0
Namekagon	10	43N	6W	-	-	-	1	1	1
Owen	14	44N	7W	-	-	-	2	0	0
Pickerel	5	44N	9W	-	-	-	2	1	1
Pine	10	48N	7W	-	-	-	1	0	0
Porcupine	17	44N	6W	-	-	-	1	0	0
Rock	29	43N	6W	-	-	-	2	1	1
Samoset	36	44N	8W	-	-	-	1	0	0
Spider	22	47N	7W	2	0	0	0	0	0
Star	10	45N	7W	-	-	-	2	1	1
Superior				3	0	1	10	0	0
Tahkodak	34	44N	7W	-	-	-	1	0	0
Taylor	30	44N	5W	-	-	-	2	0	0
Totogatic	32	43N	8W	1	0	0	0	0	0
Wabigon	13	45N	8W	-	-	-	2	0	0
White Bass	25	43N	5W	-	-	-	2	1	1
Wilderness	6	45N	8W	-	-	-	2	0	0
Burnett County									
Bass	17	37N	18W	2	0	0	1	0	0
Burlingham	30	41N	15W	-	-	-	1	0	0
Clam River Flowage	19	40N	17W	-	-	-	3	2	1
Crex Meadows W.A.		39N	18W	17	11	7	13	2	2
Crooked	12	40N	16W	-	-	-	1	0	0
Deep	23	40N	14W	-	-	-	1	0	0
Deer	13	41N	15W	-	-	-	1	0	0
Doctor	12	38N	17W	2	0	1	1	0	0
Fish	36	38N	20W	2	0	1	2	1	1
Fish	6	38N	16W	2	0	1	2	1	1
Gabelson	32	37N	18W	2	0	0	2	1	1
Grettam Flowage	10	37N	19W	1	0	0	-	-	-
Lily	34	41N	14W	-	-	-	1	0	0
Lindy	13	40N	14W	-	-	-	2	0	0
Little Bear	31	41N	14W	-	-	-	2	1	1
Loon	1	40N	15W	-	-	-	1	0	0

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Burnett County(Cont.)									
Lost Lakes	26	41N	14W	-	-	-	4	0	0
McGraw	6	42N	14W	-	-	-	2	1	1
Middle McKenzie	24	40N	14W	-	-	-	2	0	0
Minerva	35	41N	16W	2	0	0	0	0	0
Mud Hen	16	38N	17W	2	2	1	0	0	0
Mystery	11	40N	14W	-	-	-	2	0	0
Nicaboyne	2	40N	14W	-	-	-	2	0	0
Phernetton	20	40N	15W	-	-	-	2	1	1
Silver	36	38N	18W	1	2	1	2	2	1
Spirit	11	37N	18W	1	2	1	2	2	1
Stulen	4	41N	14W	2	0	0	-	-	-
Taylor	1	38N	16W	-	-	-	1	0	0
Trade	29	37N	18W	6	0	0	3	0	0
Upper Twin	30	40N	14W	-	-	-	1	0	0
Wood	34	38N	18W	2	0	0	1	0	0
Columbia County									
Swan		13N	8E	-	-	-	1	0	0
Door County									
Michigan				1	0	0	-	-	-
Douglas County									
Bardon	16	43N	12W	-	-	-	1	0	0
Bluegill	15	43N	12W	2	0	0	2	0	0
Buffalo	35	43N	12W	-	-	-	1	0	0
Clear	15	43N	12W	-	-	-	1	0	0
Gander	22	46N	11W	-	-	-	2	1	1
Leader	21	43N	12W	-	-	-	2	2	1
Loon	13	45N	10W	-	-	-	2	1	1
Lower Eau Claire	25	44N	10W	1	0	0	1	0	0
Lyman	22	46N	13W	-	-	-	1	0	0
Mud	12	44N	10W	2	0	1	2	2	1
Nebagoman	35	47N	11W	1	0	0	2	0	0
Person	22	43N	13W	2	0	1	2	1	1
Round	12	43N	13W	-	-	-	1	0	0
Snake	19	43N	10W	-	-	-	2	0	0
Spider	5	43N	12W	-	-	-	2	0	0
Superior				-	-	-	5	0	0
Upper Ox	14	44N	11W	-	-	-	2	2	1
Upper St. Croix	25	45N	12W	-	-	-	1	0	0

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Florence County									
Bell	13	40N	16E	2	0	0	-	-	-
Dreams	33	40N	15E	1	0	0	0	0	0
Grandma	34	39N	15E	2	2	1	1	0	0
Grubhoe	7	39N	16E	1	2	1	1	2	1
Keyes	36	40N	17E	1	0	0	0	0	0
Lost	12	39N	15E	1	0	0	1	0	0
Morgan	18	38N	16E	2	1	1	2	1	1
Mud	34	38N	15E	2	0	0	-	-	-
Perch	21	40N	16E	2	2	1	2	0	0
Reisner	4	39N	15E	2	1	1	2	0	0
Riley(South)	14	40N	16E	2	1	1	0	0	0
Savage	2	39N	16E	-	-	-	2	0	0
Sea Lion	11	39N	17E	2	0	0	0	0	0
Seidel	10	39N	17E	2	0	1	2	1	1
West Bass	14	38N	17E	0	0	0	1	0	0
Forest County									
Bailey	30	39N	12E	2	0	0	-	-	-
Bass	2	34N	14E	2	0	0	-	-	-
Bastille	28	39N	14E	2	1	1	2	2	1
Birch	29	36N	15E	2	0	0	2	2	1
Bose	23	40N	12E	1	0	0	1	0	0
Bradley	26	35N	13E	1	0	0	1	0	0
Butternut	28	40N	12E	2	0	0	-	-	-
Camp Six	13	36N	16E	2	0	1	-	-	-
Camp Three	3	36N	15E	2	0	0	-	-	-
Finnerty	26	35N	14E	1	0	0	-	-	-
Four Ducks	3	39N	14E	2	0	0	-	-	-
Franklin	16	40N	12E	2	0	0	1	0	0
Gordon	8	37N	16E	0	0	0	1	0	0
Hardwood	17	35N	14E	1	0	0	1	0	0
Harmony	33	40N	12E	-	-	-	1	0	0
Himley	4	34N	14E	2	0	1	0	0	0
Howell	13	40N	12E	3	0	0	-	-	-
Julia	6	38N	12E	-	-	-	1	0	0
Jungle	2	34N	13E	2	0	0	0	0	0
Kazmier	17	35N	15E	2	1	1	2	0	0
King	13	34N	16E	1	0	0	1	0	0
Kohlhoff	22	34N	14E	2	0	0	2	0	1
Langer	28	36N	15E	1	0	0	1	0	0
Laura	9	37N	16E	2	0	0	0	0	0
Lily	14	34N	13E	2	0	0	2	0	0
Little Birch	29	36N	15E	2	1	1	0	0	0

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Forest County(Cont.)									
Lucerne	10	35N	13E	1	0	0	1	0	0
Ludington	32	35N	14E	0	0	0	1	0	1
Luna	35	40N	12E	2	0	0	-	-	-
Metonga	8	35N	13E	0	0	0	2	0	0
Pine	22	37N	12E	1	0	0	-	-	-
Popple	20	35N	14E	2	2	1	2	2	1
Quartz	14	40N	12E	0	0	0	2	0	0
Rice	27	35N	12E	2	0	1	1	0	0
Richardson	10	34N	14E	2	0	0	0	0	0
Roberts	6	34N	14E	0	0	0	1	0	0
Ross	17	37N	15E	0	0	0	2	0	0
Scattered Rice	25	36N	14E	2	2	1	2	0	0
Shoe	16	34N	14E	0	0	0	1	0	0
Silver	35	36N	14E	1	0	0	1	0	0
Trump	31	35N	15E	0	0	0	1	0	0
White Deer	34	40N	12E	1	0	0	-	-	-
Wolf	32	39N	12E	2	0	0	2	0	0
Woodbury	8	38N	12E	2	0	0	-	-	-
Iron County									
Bearskull	25	41N	3E	2	0	0	1	0	0
Birch	11	41N	4E	-	-	-	1	0	0
Boot	8	41N	3E	-	-	-	1	0	0
Cedar	14	43N	4E	-	-	-	2	0	0
Charnley	20	41N	3E	-	-	-	2	0	1
Crystal	34	43N	3E	-	-	-	2	0	0
DuPage	27	43N	4E	1	0	0	0	0	0
Fat	24	41N	4E	-	-	-	2	2	1
Fisher	35	44N	4E	-	-	-	1	0	0
Flambeau Flowage		42N	2E	2	0	1	17	8	5
Fox	11	42N	2E	-	-	-	2	0	0
Frog	16	42N	4E	-	-	-	1	0	0
Gile Flowage	10	45N	2E	2	0	0	4	1	1
Grant	14	42N	3E	-	-	-	1	0	0
Hall	14	44N	2E	-	-	-	2	0	0
Hay Creek Flowage	29	41N	2E	-	-	-	1	0	0
Hewitt	10	44N	4E	-	-	-	2	0	0
Lake of the Falls	31	43N	3E	-	-	-	1	0	0
Long	32	44N	4E	-	-	-	1	0	0
McCarthy	18	44N	1W	-	-	-	2	0	0
McDermott	30	41N	3E	-	-	-	1	0	0
Moose	3	43N	2E	-	-	-	1	0	0
North Bass	23	43N	4E	-	-	-	2	1	1

Appendix C.--Continued.

Water area	Location Sec.	Town.	Range	Loon population 1976 Ad.	Yg.	Nest	1977 Ad.	Yg.	Nest
Iron County(Cont.)									
Owl	22	44N	4E	2	0	0	2	0	0
Pardee	24	44N	4E	2	2	1	3	1	1
Payment	21	43N	4E	-	-	-	1	0	0
Pine	29	44N	3E	2	0	0	0	0	0
Pleasant	27	44N	1E	-	-	-	2	1	1
Powell Marsh		42N	4E	-	-	-	1	0	0
Randall	17	41N	4E	-	-	-	2	0	0
Shirley	12	44N	1W	-	-	-	2	0	0
South Bass	35	43N	4E	-	-	-	2	0	0
Stone	21	41N	3E	2	2	1	2	0	1
Third Black	1	42N	2E	-	-	-	2	0	0
Trude	18	42N	3E	-	-	-	1	0	0
Upper Springstead	21	41N	3E	-	-	-	2	0	0
Weber	29	43N	3E	2	0	0	2	0	0
Juneau County									
Meadow Valley W. A.		20N	2E	2	1	1	-	-	-
Pettinwell Flowage	11	19N	4E	1	0	0	-	-	-
Kewaunee County									
Michigan		25N	25E	3	0	0	-	-	-
Langlade County									
Ada	3	33N	14E	2	0	0	1	0	0
Aninnan	24	34N	11E	1	0	0	2	0	0
Camp	7	34N	10E	2	1	1	2	0	1
Duck	33	34N	10E	0	0	0	1	0	0
Jack	22	33N	11E	2	1	1	2	0	0
Miniwakan	35	34N	11E	-	-	-	1	0	0
Partridge	17	33N	10E	2	0	0	2	0	0
White	17	31N	14E	1	0	0	1	0	0
Lincoln County									
Big Somo	16	35N	5E	1	0	0	2	0	0
Clara	20	35N	7E	2	0	1	2	0	1
Hilderbrand	1	35N	8E	2	0	0	1	0	0
Homestead	10	34N	8E	1	0	0	1	0	0
Lily	17	35N	7E	2	1	1	2	0	0
Otter	7	34N	8E	2	1	1	2	0	0
Squaw	10	35N	8E	0	0	0	1	0	0

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Marathon County									
Mead W. A.		26N	5E	2	0	0	-	-	-
Marinette County									
Coleman	8	36N	18E	1	0	0	1	0	0
Goodman Mill Pond	3	36N	17E	2	0	0	2	2	1
McCaslin	33	34N	17E	-	-	-	1	0	0
Moon	4	36N	18E	0	0	0	1	0	0
Noquebay	8	32N	21E	0	0	0	2	0	0
Porcupine	33	36N	17E	-	-	-	2	0	0
Menominee County									
Bass	25	28N	16E	2	0	0	-	-	-
Bass(Upper)	1	30N	13E	1	0	0	-	-	-
Oconto County									
Archibald	2	32N	15E	0	0	0	1	0	0
Barnes	16	32N	15E	2	0	0	1	0	0
Bass	4	32N	15E	2	1	1	1	0	0
Boot	9	32N	15E	0	0	0	1	0	0
Crooked	22	32N	17E	2	0	0	2	0	0
Kelly	6	29N	19E	2	0	0	-	-	-
Little Maiden	7	32N	16E	2	0	0	0	0	0
Lower Wheeler	22	33N	15E	2	0	0	0	0	0
Maiden	7	32N	16E	2	0	0	1	0	0
Mountain Lakes	1	31N	15E	2	0	0	-	-	-
Shay	18	31N	18E	2	2	1	2	0	0
Wheeler	22	33N	16E	2	2	1	2	2	1
Winslow	8	32N	16E	2	2	1	2	1	1
Oneida County									
Adrian	10	39N	5E	2	0	1	2	0	0
Aldridge	13	39N	9E	2	0	0	-	-	-
Bass	18	36N	5E	1	0	0	0	0	0
Bass	8	39N	7E	2	2	1	2	1	1
Bertram	12	37N	8E	1	0	0	-	-	-
Big Carr	9	38N	7E	2	0	1	2	0	0
Blue	29	39N	6E	2	1	1	2	0	0
Bootjack	9	38N	4E	-	-	-	1	1	1

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Oneida County(Cont.)									
Buck	19	36N	9E	1	0	0	0	0	0
Burnham	19	38N	7E	1	0	0	-	-	-
Carrol	4	39N	7E	1	0	0	1	0	0
Clear	2	39N	4E	-	-	-	1	0	0
Clear	16	39N	7E	1	0	0	1	0	0
Columbus	28	39N	10E	-	-	-	1	0	0
Crescent	17	36N	8E	1	0	0	2	0	0
Crystal	6	37N	9E	2	0	0	-	-	-
Crystal	17	38N	11E	0	0	0	1	0	0
Cunard	23	39N	7E	-	-	-	2	0	0
Curtis	8	39N	6E	-	-	-	1	0	0
Dam	17	39N	9E	1	0	0	-	-	-
DeMarce	29	36N	9E	-	-	-	1	0	0
Denton	24	39N	9E	2	1	1	2	1	1
Echo	33	39N	9E	2	1	1	-	-	-
Elm	13	38N	11E	-	-	-	1	0	0
Emma	21	36N	8E	1	0	0	2	0	0
Fifth	4	36N	10E	-	-	-	1	0	0
Flannery	28	37N	8E	2	0	0	1	0	0
Fourmile	23	39N	11E	4	3	2	2	0	0
Fuller	10	39N	4E	-	-	-	2	0	0
Gilmore	24	39N	7E	2	1	1	2	0	0
Green Bass	16	36N	8E	3	0	0	2	0	0
Hasbrook	26	39N	7E	2	0	1	-	-	-
Indian	1	38N	9E	2	0	0	-	-	-
Jennie Barnes	24	38N	8E	2	0	0	-	-	-
Jennie Raisen	19	37N	10E	2	1	1	2	0	1
Julia	12	36N	8E	1	0	0	1	0	0
Katherine	2	38N	6E	2	2	1	-	-	-
Kewaguesaga	16	39N	6E	-	-	-	2	0	0
Langley	2	36N	8E	2	0	0	2	0	0
Laurel	4	38N	11E	1	0	0	-	-	-
Little Bass	15	39N	7E	2	0	0	-	-	-
Long	8	39N	11E	3	0	0	5	0	0
Lost	30	38N	9E	1	0	0	-	-	-
McCabe	35	38N	8E	2	2	1	-	-	-
McGrath	8	38N	7E	1	0	0	-	-	-
Mercer	13	39N	5E	1	0	0	0	0	0
Minocqua	13	39N	6E	-	-	-	1	0	0
Mosquito	35	39N	11E	-	-	-	2	0	0
Muskellunge	10	38N	8E	2	0	0	2	0	0
North Nokomis	23	39N	8E	2	1	1	-	-	-

Appendix C.--Continued.

Water area	Location			Loon population					
	Sec.	Town.	Range	1976 Ad.	1976 Yg.	1976 Nest	1977 Ad.	1977 Yg.	1977 Nest
Oneida County(Cont.)									
Oatmeal	30	38N	9E	2	3	1	-	-	-
One Stone	27	39N	10E	2	2	1	-	-	-
Oscar Jenny	7	36N	7E	2	1	1	2	0	1
Patricia	8	39N	6E	1	0	0	-	-	-
Pickerel	31	38N	9E	2	2	1	-	-	-
Pine	4	37N	9E	0	0	0	2	0	0
Rainbow Flowage	20	39N	8E	2	1	1	1	0	0
Sand	5	37N	7E	2	0	1	-	-	-
Sand	20	39N	9E	1	0	0	-	-	-
Scotchman	23	39N	5E	2	0	0	-	-	-
Sevenmile	3	39N	11E	2	0	0	3	0	0
Seventeen	17	38N	6E	2	0	0	-	-	-
Silver	31	38N	9E	2	0	0	-	-	-
Spider	25	38N	8E	1	0	0	-	-	-
Spirit	5	38N	11E	2	1	1	2	1	1
Squaw	9	39N	4E	2	0	0	2	3	1
Squirrel	17	39N	5E	1	0	0	-	-	-
Stone	34	39N	4E	-	-	-	2	1	1
Sugar Camp	12	38N	9E	2	1	1	-	-	-
Swamp	6	36N	6E	-	-	-	1	0	0
Swampsauger	14	38N	4E	-	-	-	1	0	0
Tomahawk	31	39N	7E	2	0	0	2	0	0
Townline	35	37N	8E	1	0	0	2	0	0
Turtle	14	38N	8E	2	0	0	-	-	-
Two Sisters	20	38N	8E	4	3	2	2	2	1
Upper Kaubashine	16	38N	6E	1	0	0	0	0	0
Venus	30	36N	11E	0	0	0	4	0	0
Virgin	29	36N	7E	1	0	0	1	0	0
Virgin	11	38N	11E	2	0	0	1	0	0
Whitefish	14	38N	11E	2	1	1	2	2	1
Willow Reservoir	9	37N	5E	4	0	0	0	0	0
Yawkey	15	38N	6E	3	0	0	-	-	-
Polk County									
Bass	31	36N	15W	-	-	-	5	0	0
Bone	7	35N	16W	-	-	-	1	0	0
Chelstrom	19	34N	15W	-	-	-	2	0	0
Island	30	32N	16W	-	-	-	2	1	1
McKenzie	13	36N	16W	-	-	-	1	1	1

Appendix C.--Continued.

Water Area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Polk County(Cont.)									
Wolf	13	36N	19W	-	-	-	1	0	0
Portage County									
Dubay		25N	7E	1	0	0	-	-	-
Price County									
Bass	18	38N	2W	-	-	-	2	1	1
Bass	15	40N	2W	2	0	0	2	0	0
Blockhouse	10	40N	1E	-	-	-	2	0	0
Bog	30	40N	2W	1	0	0	1	0	0
Cochran	9	40N	3E	-	-	-	1	0	0
Hay	1	40N	1E	1	0	0	2	0	0
Lac Sault Dore	12	37N	2W	1	0	0	1	0	0
Long	31	39N	2W	-	-	-	1	0	0
Musser	31	38N	2E	2	1	1	1	0	0
Newman	7	40N	3E	-	-	-	1	0	1
Patterson	1	40N	2E	1	0	0	1	0	0
Sailor Cr.Flow.		39N	1E	2	2	1	2	0	0
Sailor	29	39N	2E	-	-	-	2	0	0
Sweeny	20	39N	1E	-	-	-	2	2	1
Tucker	13	40N	3E	-	-	-	2	0	0
Whitcomb	5	40N	3E	-	-	-	1	0	0
Rusk County									
Big Falls Flowage	35	36N	5W	-	-	-	2	1	1
Boot	17	33N	7W	-	-	-	1	0	0
Bucks	26	36N	9W	-	-	-	1	0	0
Parker	17	34N	9W	-	-	-	2	1	1
Sawyer County									
Barber	3	39N	5W	-	-	-	3	0	0
Black Dan	1	39N	5W	2	2	1	0	0	0
Blueberry	9	39N	7W	-	-	-	1	0	0
Callahan	33	41N	7W	-	-	-	2	2	1
Camp Four(West)	11	41N	7W	2	2	1	-	-	-
Chippewa Flowage		40N	7W	-	-	-	9	3	3
Christner	8	40N	8W	2	0	0	2	0	0
Clear	20	41N	7W	2	0	1	0	0	0

Appendix C.--Continued.

Water Area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Sawyer County(Cont.)									
Colbroth	17	40N	9W	-	-	-	2	1	1
Connor	22	38N	3W	-	-	-	1	0	0
Deer	8	37N	8W	-	-	-	2	0	0
Durphee	35	40N	9W	-	-	-	1	0	0
Fishtrap	14	40N	5W	-	-	-	1	0	0
Grindstone		40N	8W	1	0	0	2	0	0
Hadley	3	42N	5W	-	-	-	1	0	0
Ham	27	39N	9W	-	-	-	1	0	0
Holmes	13	42N	7W	-	-	-	2	0	0
Lewis	25	42N	7W	-	-	-	1	0	0
Ltl. Ct. Oreilles		39N	8W	2	0	0	0	0	0
Ltl. Pelican	25	39N	3W	2	0	0	2	0	0
Ltl. Sissabagama	20	38N	9W	2	2	1	2	2	1
Lost Land	20	42N	6W	1	0	0	3	0	0
Lower Clam	12	42N	5W	-	-	-	1	0	0
Lower Twin	8	41N	7W	2	0	0	0	0	0
Mason	35	39N	3W	-	-	-	2	0	0
Mirror	7	41N	7W	-	-	-	1	0	0
North	14	42N	7W	-	-	-	1	0	0
Ole	31	42N	6W	3	0	0	2	0	0
Round		41N	8W	2	0	0	2	0	0
Smith	4	41N	9W	2	0	0	0	0	0
Spider		42N	7W	4	0	0	0	0	0
Star	4	42N	6W	1	0	0	2	1	1
Tiger Cat Flowage	16	41N	7W	1	0	0	2	0	0
Upper Holly	22	39N	9W	6	0	0	-	-	-
Upper Twin	6	41N	7W	-	-	-	4	1	1
Wilson	9	42N	6W	1	0	0	0	0	0
Shawano County									
Shawano		27N	15E	1	0	0	-	-	-
Taylor County									
Chequamegon Waters	23	32N	3W	1	0	0	1	0	0
Richter	11	31N	2W	-	-	-	1	0	0
Vilas County									
Adelade	32	44N	5E	2	0	0	2	0	0

Appendix C.--Continued.

Water area	Location Sec.	Town.	Range	Loon population 1976 Ad.	Yg.	Nest	1977 Ad.	Yg.	Nest
Vilas County(Cont.)									
Allequash	9	41N	7E	2	1	1	-	-	-
Amik	19	40N	4E	-	-	-	2	3	1
Anderson	12	40N	8E	-	-	-	1	0	0
Anvil	13	40N	11E	2	0	0	-	-	-
Arbor Vitae, Big	19	40N	7E	2	0	0	-	-	-
Armour	10	43N	6E	2	0	1	2	0	1
Bass, Little	15	40N	8E	2	1	1	-	-	-
Bear	36	43N	6E	2	0	0	-	-	-
Benny	25	43N	8E	2	0	0	-	-	-
Big	4	42N	6E	2	1	1	2	2	1
Bills	22	40N	4E	2	1	1	-	-	-
Birch, White	5	41N	8E	2	0	0	-	-	-
Bittersweet	22	40N	7E	2	0	0	-	-	-
Blueberry	23	41N	7E	-	-	-	1	0	0
Bolton	12	40N	5E	2	2	1	2	0	1
Boot	2	40N	9E	1	1	1	-	-	-
Boulder	7	42N	7E	0	0	0	2	0	0
Boygon	2	42N	9E	2	0	0	-	-	-
Broken Bow	26	40N	4E	2	0	0	1	0	0
Camp	27	41N	6E	2	0	0	-	-	-
Camp 10	28	41N	9E	2	2	1	2	2	1
Carlin	17	43N	6E	2	0	1	2	0	1
Catfish	25	40N	10E	1	0	0	2	2	1
Clear	12	42N	5E	2	0	1	3	0	0
Crab	14	43N	6E	2	0	0	1	0	0
Cranberry	31	40N	11E	2	0	0	3	0	0
Crooked, Big	15	41N	5E	2	2	1	-	-	-
Crooked, Big	6	42N	6E	2	0	0	-	-	-
Crooked, Little	1	42N	6E	1	0	0	0	0	0
Dads	31	41N	9E	2	2	1	-	-	-
Deer	29	42N	10E	1	0	0	-	-	-
Deerskin	6	40N	11E	2	0	1	-	-	-
Denton	34	42N	10E	-	-	-	1	0	0
Devine	4	40N	6E	-	-	-	2	1	1
Dollar	26	40N	10E	1	0	0	-	-	-
Donahue, Big	25	43N	9E	2	0	1	-	-	-
Dorothy	30	43N	8E	2	0	0	2	0	0
Eagle	14	41N	5E	1	0	0	-	-	-
Eagle	22	40N	10E	1	0	0	-	-	-
Eagle River		40N	10E	1	0	0	-	-	-
Elsie	30	41N	6E	2	0	0	3	0	0

Appendix C.--Continued

Water Area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Vilas County(Cont.)									
Erickson	16	40N	7E	1	0	0	-	-	-
Escanaba	2	41N	7E	2	1	1	-	-	-
Fence	10	40N	5E	2	0	0	-	-	-
Finger	12	40N	10E	1	0	0	-	-	-
Flambeau	12	40N	4E	2	0	0	-	-	-
Flora	29	43N	7E	-	-	-	2	0	0
Forest	4	42N	9E	2	0	0	-	-	-
Found	13	40N	8E	1	0	0	-	-	-
Gibson, Big	7	42N	8E	3	0	0	-	-	-
Grassy	3	42N	7E	2	0	0	2	1	1
Gresham, Lower	9	41N	6E	2	0	0	-	-	-
Harmony	13	40N	10E	1	0	0	-	-	-
Harvey	5	43N	5E	2	0	0	2	0	0
High	31	43N	8E	1	0	0	1	0	0
Horsehead	2	43N	6E	2	0	0	2	0	1
Hunter	25	41N	9E	3	0	0	-	-	-
Hurst, Big	28	43N	6E	0	0	0	2	0	1
Ike Walton	24	41N	5E	2	1	1	1	0	0
Imogene	31	41N	12E	1	0	0	-	-	-
Island	18	42N	6E	2	0	0	-	-	-
Jag	26	42N	6E	1	0	0	-	-	-
Jean	25	42N	8E	2	0	0	-	-	-
Jenny	24	43N	6E	3	0	0	-	-	-
Jones	29	43N	8E	2	2	1	2	0	0
Joyce	15	42N	9E	1	0	0	-	-	-
Katinka	17	43N	6E	2	0	1	-	-	-
Lac des Fluers	15	42N	10E	1	0	0	-	-	-
Lac du Lune	8	42N	9E	3	0	0	-	-	-
Lake of the Hills	33	41N	10E	1	0	0	-	-	-
Landing	29	43N	10E	2	0	1	-	-	-
Laura	1	41N	8E	1	0	0	-	-	-
Long	5	41N	12E	2	0	0	-	-	-
Lynx	18	43N	7E	2	0	1	4	1	2
Mamie	20	43N	9E	2	0	0	-	-	-
Manitowish	22	42N	5E	2	0	0	2	2	1
Manuel	15	41N	11E	2	0	0	-	-	-
Merril	34	43N	9E	2	0	0	2	0	0
Meta	1	39N	10E	1	0	0	-	-	-
Mielke, Otto	28	40N	7E	2	0	0	-	-	-
Mill	33	43N	10E	2	0	0	-	-	-
Moon	25	40N	8E	2	1	1	-	-	-

Appendix C.--Continued

Water Area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Vilas County(Cont.)									
Muskellunge, Big	21	41N	7E	2	0	0	2	2	1
Muskie, Little	26	40N	6E	0	0	0	1	0	0
Nelson	22	40N	9E	-	-	-	3	0	0
Nine Mile, Lower	34	40N	11E	2	0	1	-	-	-
Nine Mile, Upper	25	40N	11E	2	0	0	-	-	-
Nixon	19	42N	8E	2	2	1	-	-	-
No Man	17	44N	5E	-	-	-	2	1	1
Oak, Black	30	43N	9E	1	0	0	-	-	-
Oxbow	36	44N	6E	2	0	1	2	0	0
Pallette	3	41N	7E	1	0	0	-	-	-
Palmer	16	43N	8E	2	0	0	1	0	0
Papoose	19	43N	6E	2	0	1	-	-	-
Papoose, Little	24	43N	5E	2	0	0	-	-	-
Partridge	28	42N	8E	2	0	0	-	-	-
Perch	35	40N	9E	2	0	1	-	-	-
Pickeral	5	40N	9E	2	2	1	2	2	1
Pine Island	35	41N	10E	2	0	1	2	1	1
Pine, Lone	9	43N	7E	2	0	0	0	0	0
Plum	31	41N	8E	0	0	0	1	0	0
Pokegama	32	41N	5E	2	0	0	-	-	-
Poupart	30	41N	5E	2	0	0	-	-	-
Presque Isle	5	43N	6E	2	0	1	-	-	-
Rainbow	34	44N	5E	-	-	-	1	0	0
Raxorback	20	41N	8E	2	1	1	2	0	1
Rest	3	42N	5E	1	0	0	-	-	-
Rice, Scattering	13	40N	10E	2	0	0	-	-	-
Rudolph	26	42N	6E	2	2	1	-	-	-
Rudolph	17	43N	7E	1	0	0	2	1	1
Salsich	11	41N	8E	-	-	-	2	0	0
Sand, Little	14	41N	5E	1	0	0	-	-	-
Sand, White	26	42N	7E	0	0	0	2	0	0
Sand, White	22	41N	5E	1	0	0	-	-	-
Sanford	24	43N	6E	2	0	0	-	-	-
Shannon	12	41N	8E	2	0	0	-	-	-
Snipe	15	40N	9E	2	1	1	2	0	0
Spirit	11	40N	10E	0	0	0	3	0	0
Star	14	41N	8E	1	0	0	2	0	0
Star, Little	15	42N	5E	2	2	1	2	0	0
Star, Little	10	41N	8E	2	1	1	-	-	-
Stateline	26	44N	6E	1	0	0	-	-	-
Statenaker	32	41N	6E	2	1	1	-	-	-

Appendix C.--Continued

Water area	Location			Loon population					
	Sec.	Town.	Range	1976			1977		
				Ad.	Yg.	Nest	Ad.	Yg.	Nest
Vilas County(Cont.)									
Stearns	31	41N	6E	2	0	0	-	-	-
Stewart	20	41N	9E	1	0	0	-	-	-
Stone	11	42N	5E	1	0	0	-	-	-
Stone, Crawling	16	40N	5E	1	0	0	-	-	-
Stone, Ltl. Crawl.	19	40N	5E	1	0	0	-	-	-
Stormy	1	41N	9E	-	-	-	1	0	0
Sugarbush, Middle	16	41N	5E	1	0	0	-	-	-
Sunfish	22	41N	5E	1	0	0	-	-	-
Tamarack, Little	26	42N	9E	1	0	0	-	-	-
Tippecanoe	23	40N	4E	2	1	1	-	-	-
Torch	20	41N	10E	2	0	0	2	0	1
Towanda	14	40N	6E	2	2	1	2	2	1
Tree, Lone	9	41N	8E	2	1	1	-	-	-
Trilby	11	40N	6E	-	-	-	1	0	0
Trout	5	41N	7E	2	0	0	2	0	0
Trout, Little	34	42N	5E	2	1	1	-	-	-
Turtle, North	3	43N	5E	0	0	0	2	0	0
Twin, North	2	41N	11E	2	0	0	-	-	-
Van Vliet	16	43N	6E	1	0	1	2	0	1
Wabasso	4	40N	4E	2	0	0	2	0	0
Whispering	26	41N	11E	1	0	0	-	-	-
Whitney	15	42N	6E	2	2	1	-	-	-
Wildcat	27	43N	7E	2	1	1	-	-	-
Wildwood	33	41N	7E	2	1	1	-	-	-
Wishow	18	40N	6E	0	0	0	2	0	0
Witches, East	2	40N	7E	2	1	1	-	-	-
Wolf	31	43N	7E	2	0	0	2	1	1
15-	15	39N	10E	1	0	0	2	0	0
33-7	33	43N	6E	-	-	-	1	0	0
2-2	2	42N	7E	-	-	-	1	1	1
16-15	16	43N	7E	-	-	-	2	1	1
Washburn County									
Bass	17	40N	10W	-	-	-	1	0	0
Bass	29	40N	13W	-	-	-	2	0	0
Beartrack	7	42N	13W	2	0	0	2	0	0
Big Birch	24	37N	10W	-	-	-	1	0	0
Casey	15	40N	13W	-	-	-	2	0	0
Casey Flowage	5	40N	13W	-	-	-	1	0	0
Chippanazie	13	41N	10W	-	-	-	2	0	0
County Line	25	38N	10W	2	0	0	0	0	0

Appendix C.--Continued.

Water area	Location Sec.	Town.	Range	Loon population 1976 Ad.	Yg.	Nest	1977 Ad.	Yg.	Nest
Washburn County(Cont.)									
Deep	19	38N	11W	-	-	-	2	0	0
Deer	17	40N	13W	-	-	-	2	1	1
Dilly	14	39N	11W	-	-	-	1	0	0
Dugan	29	39N	10W	2	0	0	0	0	0
Dunn	23	40N	13W	-	-	-	2	0	0
Ellsworth	17	39N	13W	-	-	-	2	1	1
Fenton	28	37N	11W	-	-	-	1	0	0
Harmon	13	38N	11W	-	-	-	2	1	1
Island	11	40N	13W	-	-	-	2	0	0
Lakeside	2	41N	12W	-	-	-	1	0	0
Lazy Island	18	37N	10W	-	-	-	1	0	0
Leesome	16	38N	11W	-	-	-	1	0	0
Leisure	12	40N	13W	2	0	1	0	0	0
Little Ripley	8	37N	12W	-	-	-	2	1	1
Long		37N	11W	5	0	0	3	0	0
Loon	8	37N	10W	-	-	-	2	1	1
Loon	22	40N	13W	-	-	-	2	0	0
Lower Kimball	14	42N	13W	2	0	1	1	0	0
Lower Mckenzie	32	41N	13W	-	-	-	2	1	1
Loyhead	13	38N	10W	-	-	-	1	1	1
MacRae	28	38N	10W	-	-	-	1	0	0
Mallard		37N	10W	1	0	0	2	1	1
Mckinley	36	40N	13W	-	-	-	2	0	0
Middle Kimball	11	42N	13W	-	-	-	1	0	0
Moody	21	38N	11W	-	-	-	2	0	0
Mud	31	38N	10W	3	0	0	0	0	0
Nancy	27	42N	13W	1	0	0	2	0	0
Oak	19	41N	13W	-	-	-	2	0	0
Peufald	34	38N	10W	3	0	0	3	0	0
Pokegama	28	42N	12W	-	-	-	1	0	0
Rice	16	42N	12W	-	-	-	2	0	0
Ripley	29	38N	11W	-	-	-	1	0	0
Seymour	15	38N	11W	-	-	-	2	0	0
Sherman	35	42N	13W	-	-	-	1	0	0
Slim	1	38N	10W	-	-	-	2	1	1
Spider No. 1	2	37N	10W	-	-	-	2	0	0
Stauffer	13	38N	11W	-	-	-	2	0	0
Stone, Big	24	39N	10W	4	0	0	0	0	0
Sunfish	22	40N	13W	-	-	-	2	1	1
Tranus	19	41N	10W	-	-	-	2	1	1
Upper Martin		37N	10W	-	-	-	2	2	1

Appendix C.--Continued.

	Location			Loon population					
				1976			1977		
	Sec.	Town.	Range	Ad.	Yg.	Nest	Ad.	Yg.	Nest
Washburn County(Cont.)									
Vollmers	35	38N	10W	-	-	-	2	0	0
15-	15	41N	13W	-	-	-	2	1	1
6-	6	42N	12W	-	-	-	2	0	0
Wood County									
Sandhill W.A.		22N	3E	2	0	0	-	-	-