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THE IMPACT OF COTTAGE DEVELOPMENT ON COMMON LOON REPRODUCTIVE SUCCESS IN CENTRAL ONTARIO

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In recent years, the increasing popularity of wilderness vacations has caused a sharp rise in recreational activity in many northern areas. In the Boundary Waters Canoe Area of Minnesota, for example, increased motorboat and canoe traffic appears to have a negative impact on the productivity of the Common Loon (*Gavia immer*); (Lucas 1967, Titus and Van Druff 1981). Lehtonen (1970) attributed a decline in the Arctic Loon (*G. arctica*) on Finnish lakes to increasing numbers of cottages and, in a 1-year study of 19 Alberta lakes, Vermeer (1973) found a significant, inverse correlation between the numbers of breeding Common Loons and the amount of human disturbance. Bundy (1979) and Andersson et al. (1980) also related that recreation appeared to have negative impacts on loons in Scotland and Sweden. The purpose of our study was to investigate the impact of cottage development on the reproductive success of Common Loons in central Ontario.

The Muskoka and Haliburton districts of central Ontario (Fig. 1) are favorite resort locations. Summer cottages are built along lakeshores and boating, swimming, fishing or other similar activities are common and often very intense for short periods, e.g., holiday weekends. Since loons must nest near the shoreline of small islands and bog hummocks, and young loons spend their time prior to fledging entirely on the water, extensive water-oriented recreation may be detrimental to loon productivity.

METHODS

Lakes selected for study were 31–190 ha in size and were similar in all respects except in intensity of cottage development, which ranged from totally undeveloped to a maximum of more than 10 cottages/500 m. Each lake had at least one Common Loon territory which included open water, free of emergent vegetation, sufficient room for display activity, a loafing area, and adequate food for a pair of adult loons with chicks. A bog or small island was considered essential for nesting.

All islands, bogs and mainland shore areas with bog fringes were surveyed once every 2 weeks as soon as the ice was off the lakes until most chicks had fledged. Thirty-four lakes were surveyed in 1977. In 1978 and 1979, one lake was eliminated, and seven added for a total of 40 lakes which contained 50 potential Common Loon territories (Table 1).

Nest locations and clutch-sizes were recorded. The date on which incubation was initiated was estimated by subtracting 29 days (Olson and Marshall 1952) from the date of hatching. When eggs failed to hatch, only the date on which the nest was found was recorded. The number of hatched eggs was calculated by counting chicks and/or shell membranes. When

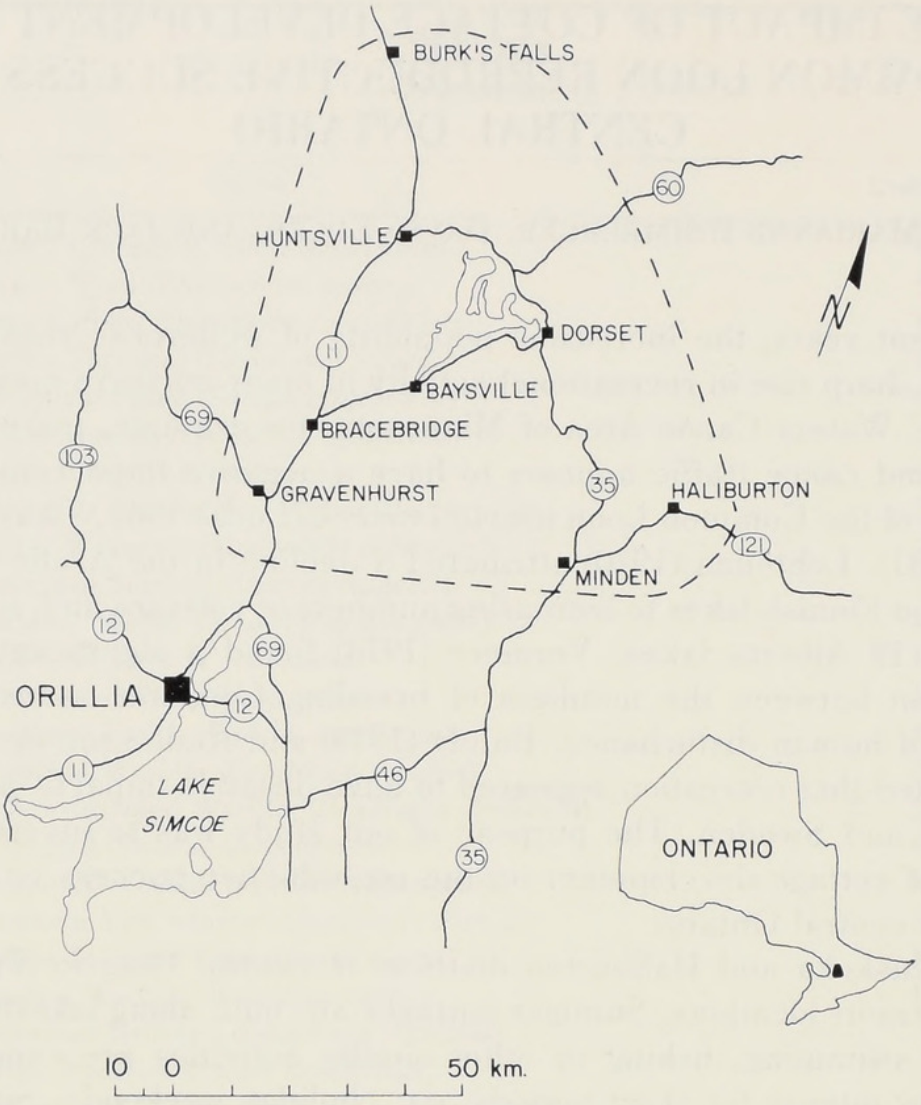

FIG. 1. Study area, Muskoka and Haliburton districts, Ontario.

the chicks were first seen their age was determined by size and color of their plumage (Olson and Marshall 1952), a method accurate to within 3 days, and hatch date estimated.

The number of areas on the lakes which contained conditions judged suitable for a loon nest was recorded. These were islands and bog areas with characteristics known to be important to loons (Bent 1919, Olson and Marshall 1952, McIntyre and Mathisen 1977). These are areas close to the water, often in bogs or marshes, with gentle inclines to permit the birds to move to and from the nest with ease.

The distance from the nest to the nearest cottage and the number of cottages within 150 m of the nest was recorded and in 1979, human activity around 16 nests was also investigated. Eight of these nests had no cottages within 250 m and eight were within 150 m of a minimum of three cottages. Each nest was monitored on 4 rainless, weekend days during one of four time periods (07:00–08:30, 10:00–11:30, 13:00–14:30, 16:00–17:30) during incubation. The type and location of all human activity observed within 500 m of the nest was recorded on a grid map once every 5 min for each time period. Human activity occurring within 150 m of a nest was closely examined because it was assumed that activity close to the nest would have a greater detrimental effect on loon reproduction than that further away. For each nest,

TABLE 1
SUMMARY OF COMMON LOON REPRODUCTIVE SUCCESS IN ONTARIO 1977–1979

	1977	1978	1979
No. of potential loon territories	44	50	50
No. of potential territories occupied	29	38	35
No. of territories with at least one nesting attempt	24	33	20
% potential territories with at least one nesting attempt	55	60	58
No. of territories with at least one egg hatching	17	23	20
No. of nesting attempts	28	43	39
No. of eggs laid	49	71	59
No. of eggs hatching	28	44	28
% nest success	61	53	51
% chick survival	68	75	86

the sum of the observations of a given activity occurring within 75 m of the nest over the four time periods was calculated and then multiplied by four. Similarly, activity which occurred 75–150 m from the nest was multiplied by three. Chi-square and Mann-Whitney *U*-tests were used to test for significant differences (Snedecor and Cochrane 1967).

RESULTS

The numbers of pairs fledging two chicks, one chick or no chicks did not differ among years (Table 2; $\chi^2 = 1.35$, df = 8, $P > 0.05$). Likewise the number of eggs in successful nests was not different from the number of eggs in unsuccessful nests (Table 2; $\chi^2 = 0.71$, df = 2, $P > 0.05$). Two-egg clutches, however, were significantly more successful than one-egg clutches ($\chi^2 = 6.63$, df = 1, $P < 0.05$).

Twenty-two nests out of a 3-year total of 110 represented renesting attempts. Initial nest attempts had a success rate of 52% compared to 59% for subsequent attempts ($\chi^2 = 0.21$, df = 1, $P > 0.05$). The mean clutch-size of first nesting attempts was 1.76 ± 0.43 compared to 1.55 ± 0.51 in subsequent tries (Mann-Whitney *U*-test, $P < 0.05$). Incubation initiated after the third week of June was not as successful as that started earlier (Fig. 2).

There were 4.3 ± 3.1 and 4.6 ± 2.5 nesting sites available per occupied and unoccupied loon territories, respectively (Mann-Whitney *U*-test, $P > 0.05$). However, there were significantly fewer potential nesting sites available on occupied territories without nests, 3.17 ± 0.60 than on those with nests, 4.91 ± 2.62 (Mann-Whitney *U*-test, $P < 0.01$). When actual use of potential nest-sites is compared to cottage density, use is not different from availability until density reaches five cottages within 150 m of

TABLE 2
SUMMARY OF EGG PRODUCTION AND FLEDGING SUCCESS PER YEAR

Year	Successful nests[a] with		Unsuccessful nests with		Nesting pairs fledging		
	Two eggs	One egg	Two eggs	One egg	Two chicks	One chick	Zero chicks
1977	13	2	8	5	2	13	7
1978	23	3	5	12	5	13	10
1979	10	8	10	11	4	15	9

[a] A successful nest is one in which at least one egg hatches.

a site (Table 3). At five or above, loons avoided nest-sites with cottages within 150 m ($\chi^2 = 18.18$, df = 5, $P < 0.01$). Hatching success declined as cottage density increased ($\chi^2 = 7.96$, df = 2, $P < 0.05$, Table 4, Fig. 3) and nest success rates increased with distance from the nearest cottage (Table 5; $\chi^2 = 8.76$, df = 3, $P < 0.05$).

In areas that ranged from totally undeveloped to moderately developed (up to two cottages within 150 m of the nest), 0.78 chicks per egg hatched survived to the fledgling stage (95% confidence limit 0.63–0.84). In areas with more than two cottages within 150 m of the nest, 0.75 chicks per egg hatched survived to the fledgling stage (95% confidence limit 0.54–0.95;

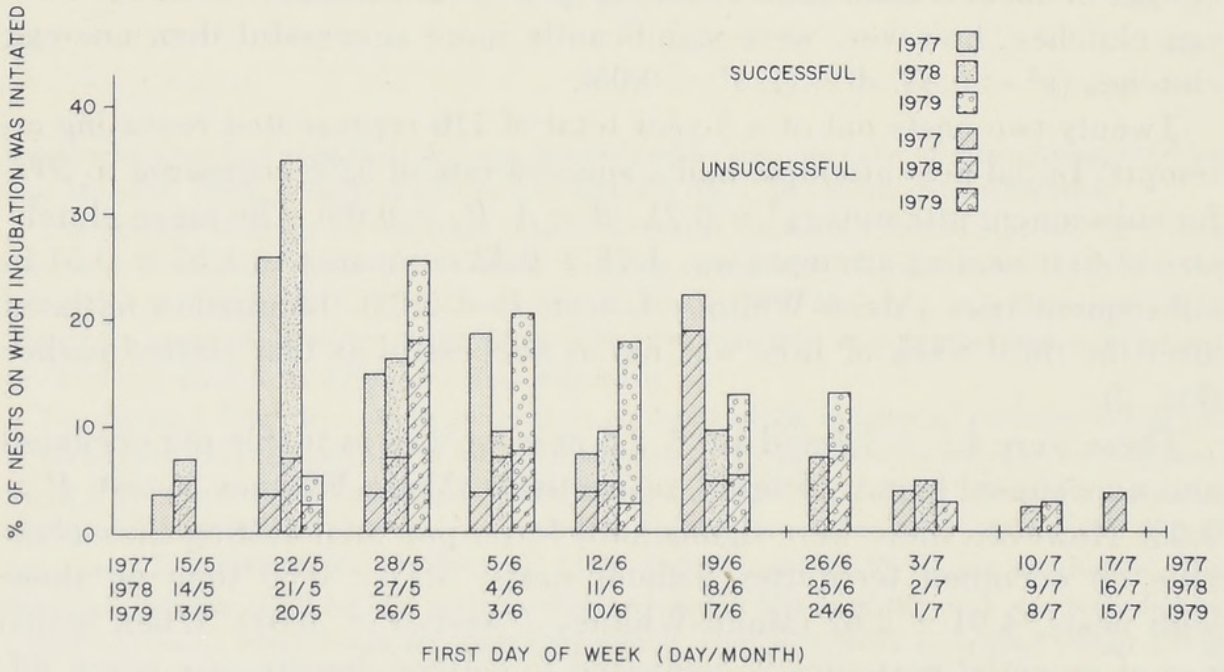

FIG. 2. Date of initiation of incubation (data from 1977, 1978, and 1979).

TABLE 3
OCCUPIED LOON TERRITORIES WITH NESTS

No. of cottages within 150 m of a potential nest-site	No. of potential nest-sites	No. of actual nest-sites	No. actual nests/potential nest-sites
0	160	40	0.25
1	59	14	0.24
2	11	6	0.55
3	4	6	1.5
4	14	6	0.43
5 or more	32	1	0.03
Total	280	73	—

Cochrane 1977). The difference between the two areas was not significant, $P > 0.05$ (Cochrane 1977:57).

The weighted human activities that occur within 150 m of a nest demonstrate significantly more total activity around developed nests than undeveloped ones (Table 6). There was also a greater number of motorboats, nonmotorized water craft, and people on shore (Mann-Whitney U-test, $P < 0.05$).

DISCUSSION

The average reproductive success of the Common Loon was consistent over the 3-year period of this study. Despite a slightly smaller percentage of eggs hatched in 1979, a higher percentage of chicks fledged than in the previous 2 years. Compensating for high nest loss is expected in these birds. A study of the Red-throated (*G. stellata*) and Arctic loons indicated that, when food is limited, a pair can more readily rear one chick

TABLE 4
COTTAGE DENSITY AND COMMON LOON NESTING SUCCESS

No. of cottages within 150 m of the nest	No. of successful nests	No. of unsuccessful nests
0	32	17
1	9	3
2 or more	8	15
Total	49	35

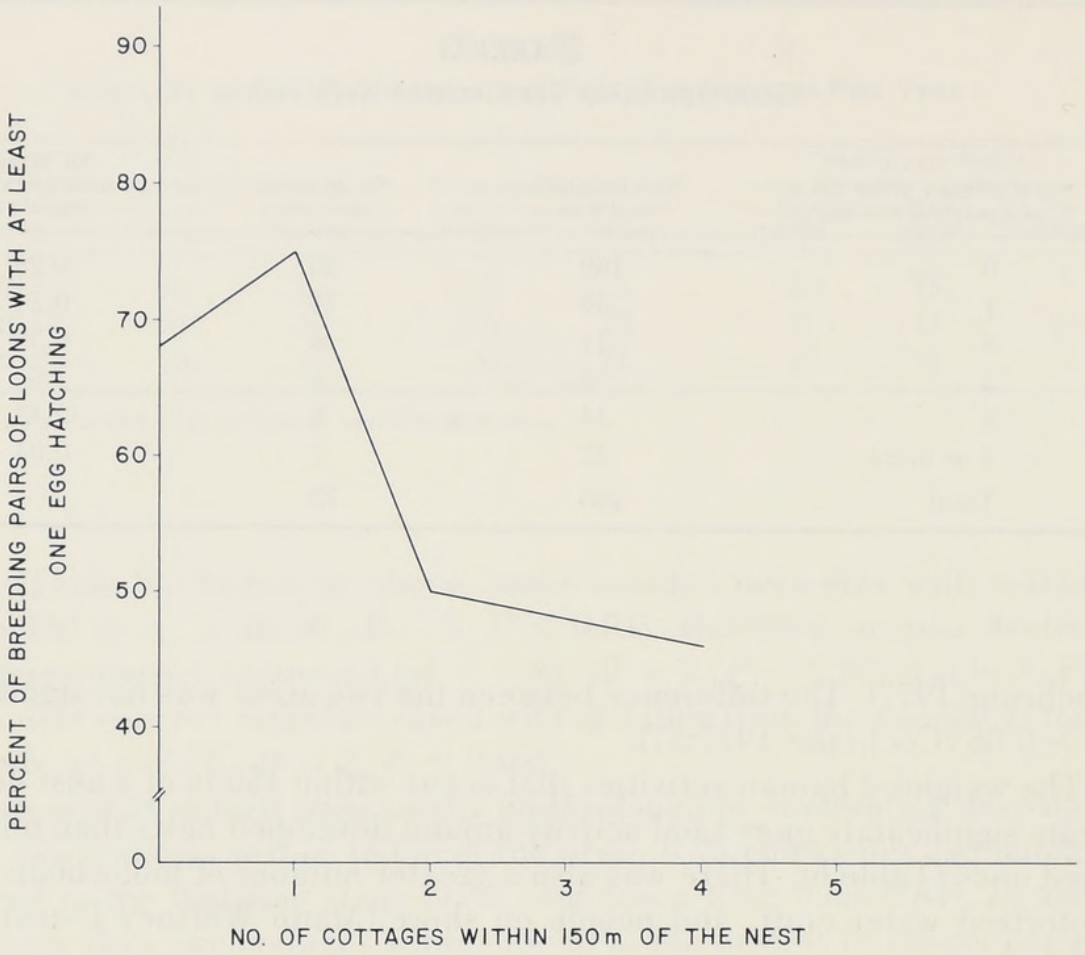

FIG. 3. Percent of breeding pairs of loons with at least one egg hatching vs development within 150 m of a loon nest.

than two to the fledgling stage (Davis 1972). Yonge (1981) suggested that the second egg of Common Loons is expendable and that two-egg clutches are an adjustment to relatively high loss of eggs or chicks. He also showed that the second chick is more vulnerable to loss than the first.

We also found that two-egg clutches were more successful than one-egg clutches as did Titus and Van Druff (1981). One-egg clutches are more readily abandoned by loons and thus have a lower chance of success (Olson and Marshall 1952).

One of the difficulties in studying nest success related to clutch-size is the problem of not finding all eggs laid. Thus, although we were surveying lakes as soon as the birds arrived back from the south, and began monitoring their nesting habits early, some nests may have lost one egg before we observed it. Yonge (1981) found that virtually all loons laid two eggs but sometimes one was lost. In this study, one-egg clutches may have started with two eggs, however, the majority of the incubation time was spent on one egg.

TABLE 5
DISTANCE FROM COTTAGE(S) TO COMMON LOON NESTS

Distance (m)	No. of successful nests	No. of unsuccessful nests	Percent successful
0–200	27	29	48
201–400	8	14	36
401–600	8	5	62
>600	9	1	90
Total	52	49	56

Like Yonge (1981) we observed that nests initiated early had a better chance of success. To determine the onset of incubation we aged young birds using plumage characteristics and then added 29 days for the incubation period as reported by Olson and Marshall (1952). More recently Yonge (1981) reported that actual incubation time was 26 days and the 29 days included the interval between egg-laying and onset of incubation. If true, the potential error from aging chicks and backdating to initiation of incubation was up to 6 days rather than the 3 days we thought when we were doing the study. This problem, however, was consistent throughout the study and does not detract from the major conclusion.

The percentage of chicks at the fledgling stage during the first 2 years was similar to the figure of 78% reported by Olson and Marshall (1952) in Minnesota, and 68% by Yonge (1981) from Saskatchewan, but less than the 94.4% observed by McIntyre (1975). The 1979 results were close to

TABLE 6
COMPARISON OF WEIGHTED ACTIVITY WITHIN 150 M OF EIGHT DEVELOPED AND EIGHT UNDEVELOPED COMMON LOON NESTS IN 1979

Activities	Average activity in four, 1.5-h visits	
	Developed nests	Undeveloped nests
Total activity	81.6	7.2
Large motorboats	14.9	0.0
Non-motorized water craft	16.0	1.3
People on shore	28.4	0.0
Swimmers	0.8	0.0
Fishermen	8.6	0.0
Small motorboats	12.9	5.9

the 88.4% reported by Sutcliffe (1978) in New Hampshire. The number of chicks per pair of loons with at least one hatched egg in this study compares favorably with other studies (Olson and Marshall 1952, McIntyre 1975, Sutcliffe 1978, Yonge 1981).

It seems clear that loons can cope with recreational activity of humans, as long as this activity is at a relatively low level. In central Ontario Common Loon reproductive effort is similar to that in other areas and there does not appear to be any significant reduction in the loon's biological ability to produce young. Many cottages and excessive human activity around the nest appear to reduce the probability of young hatching successfully. Once a chick is hatched, however, the parent birds usually move to a relatively quiet spot on the lake. At that point, the probability of success of raising the chick to fledging seems independent of recreational activities at the level studied here.

This conclusion must be modified, however, by the fact that some loons become habituated to human presence. For example, despite the high level of cottage development around a Dickie Lake nest (four cottages within 150 m), the loons reared two chicks to the fledgling stage in both 1978 and 1979. The incubating loons did not flush from the nest even when approached quite closely by canoe, and the offspring of these loons exhibited the same lack of fear of humans. These loons may nest successfully on highly developed lakes, whereas loons with little or no prior exposure to human activity would fail to nest or even to occupy the territory.

During the course of this work we did not actually observe the events which caused nest loss or chick mortality. Most observations of nest loss involve reconstructing the probable cause from evidence at the site (Yonge 1981). Nevertheless, the reduction in nest success near cottages and the higher level of human activity around nests in developed areas certainly suggest that the most probable cause of failure is associated with human activity.

Despite the fact that recreational activity has a negative influence on loon reproductive success, these animals have a considerable ability to adjust to human activity. More investigation into this behavior and how it affects a loon population is needed.

SUMMARY

Reproductive success of the Common Loon (*Gavia immer*) in relation to cottage development was studied from 1977–1979 in central Ontario. Two-egg clutches were significantly more successful than one-egg clutches and loons that initiated incubation early in their breeding season tended to be more successful than those that nested later when the risk of human disturbance was greater.

Hatching success declined as the number of cottages within 150 m of the nest increased. Once the eggs had hatched, chick survival appeared to be independent of cottage development around the nest. When human activity near eight nests within 150 m of at least three

cottages were compared to eight nests where there was no development, the difference in human activity was highly significant ($P < 0.01$). It is believed that some loons nesting in developed areas may have become habituated to humans.

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