recognition of neighboring birds. As noted by Snow (1975), repeated breeding through the year would be facilitated by repetition in mate choice, which could result in abbreviated courtship, comparatively rapid lowering of aggressive tendencies, and simplification and truncation of courtship displays.

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Pre-migratory behavior of Common Loons on the autumn staging grounds.—Animals are frequently depicted as social or non-social organisms. Evidence indicates that such rigid categorizing should be reevaluated (Stacey and Bock, Science 202:1298–1300, 1978). Common Loons (*Gavia immer*) claim large territories as mated pairs during the summer breeding season and have developed a reputation as non-social birds. They are highly visible at this time, and because lakes smaller than 100 ha are rarely occupied by more than a single pair, loons are termed "solitary."

However, they do form intraspecific associations throughout the year. Loons raft at night on the wintering grounds (McIntyre, Auk 95:396–403, 1978), begin migratory flights in groups (Williams, Wilson Bull. 95:238, 1973), have been recorded in large numbers during migration (Trautman, Univ. Mich. Mus. Zool. Misc. Publ. 44:99–100, 1940; Hochbaum, Travels and Traditions of Waterfowl, Univ. Minn. Press, Minneapolis, Minnesota, 1955) and have been noted in summer flocks (Rand, Can. Field Nat. 62:42–48, 1948; Predy, Blue Jay 30: 221, 1972; Nero, Blue Jay 30:85–86, 1972, and Blue Jay 32:113–114, 1974). Herein we report on aggregations and activities of Common Loons during autumn.

Study site and methods.—Mille Lacs Lake is a large (54,000 ha) shallow lake in Aitkin, Crow Wing, and Mille Lacs counties in central Minnesota, and is known for its walleye (*Stizostedion vitreum*) sport fishing. The major fish species in terms of biomass is yellow perch (*Perca flavescens*), and cisco (*Coregonis artedi*) is sufficiently abundant to provide an annual commercial harvest.

Observations were made 2–3 days each week from 24 September–11 November 1975; we were at the site daily from 20–25 October. Aerial surveys were made on 6, 20, and 25 October, and 3 and 11 November. The entire lake was covered during the first four surveys. Only the west side was covered during the last flight and the survey discontinued because we found no loons.

Shore surveys were made periodically from all vantage points around the lake, principally on the west side after it was found to be the site of most loon concentrations. On 21 October we followed loon flocks by boat from 09:15–11:45 and from 17:00–20:00. On October 22 and 23 we made continual observations from 07:30–10:30 CDST with one observer at each of two locations. All shore and boat surveys were made with 40× spotting scopes and/or 10 × 50 binoculars.

Results.—(1) Lake use. Loons congregate primarily on the west and northwest sides of the lake. Mille Lacs has a gradual slope over much of the lake (3000–6000 m to the 7.5 m contour line) but in some places the slope is steeper (<1800 m to the 7.5 m line) and feeding groups

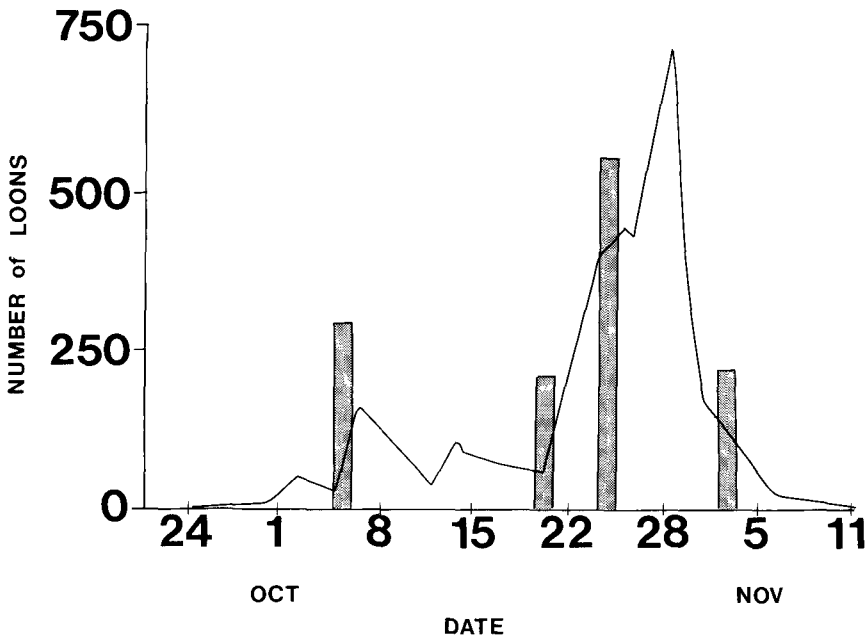

FIG. 1. Numbers of loons on Mille Lacs Lake during fall pre-migratory period. The line is plotted from shore surveys; vertical bars from aerial surveys.

were usually located at those sites with steeper slopes. Islands on the southwest and southeast sides were other points of diurnal loon concentrations.

Loons were most numerous during the last week in October when their number peaked at 600–750 (Fig. 1). Aerial surveys are more accurate indicators of total numbers, but shore surveys were made more often, and data from them are also presented to confirm the trend shown from aerial surveys.

(2) Flying occurred primarily in the early morning when loons flew (75%) or swam in small groups from offshore rafting sites to inshore feeding locations from 08:00–08:45 (Fig. 2). Maintenance activity was predominant in late afternoon and no sleeping was seen at any time.

Feeding began about 09:00, declined from 11:00–12:00, and resumed after noon. Loons continued to forage all afternoon with a peak of activity between 14:00 and 16:00 when 85% of the birds were feeding. Most birds stopped by 17:15 and all birds ceased just prior to sundown.

Each feeding bout included the same sequence: peering by all group members, diving by one bird followed at once by diving by the rest, surfacing after 20–30 sec, and resumption of peering. Surface/underwater activities were coordinated and nearly simultaneous within feeding groups.

(3) Spatial relationships. Loons were recorded as singles or as group members, and the following figures are a composite from the 2 days in which we monitored all activities. From a total of 2218, 186 were lone birds and the rest were in flocks. Some lumping of group size

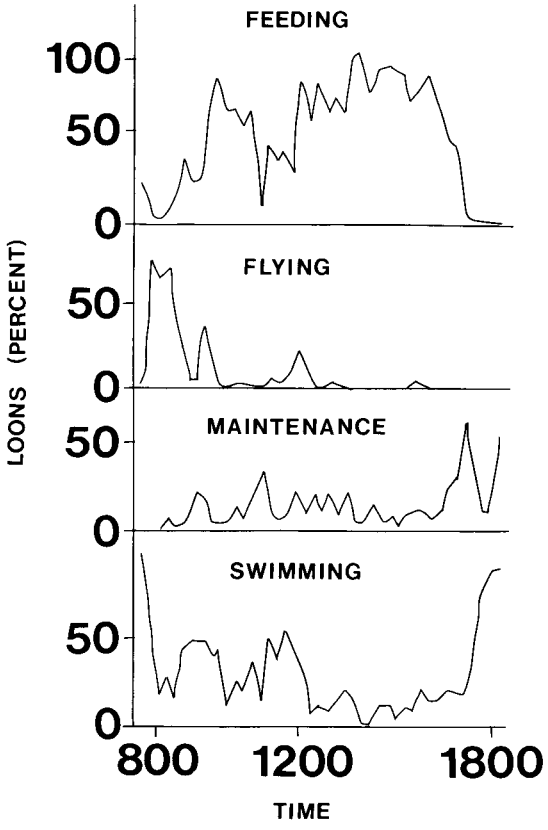

FIG. 2. Daily activity patterns of Common Loons, mid-October 1975.

was necessary, e.g., 15–20, 30–35, because distance between observers and birds was great, and the diving of flock members made exact counts impossible in all instances; however, precise counts were secured for 70 of the 103 groups recorded.

Most groups contained fewer than 20 individuals (Fig. 3). A test for random distribution of group size showed it was clumped ($\chi^2 = 17.47$, df = 9, $P < 0.05$), although the occasional formation of large groups gives a bimodal appearance to the histogram in Fig. 3. Feeding flock sizes were smaller than those with loons engaged in other activities; over 80% of all feeding groups had 20 or fewer individuals while only 47% of the other groups did.

Birds swam offshore in small groups at dusk. Rafting times were positively correlated with sunset times, later early in the fall and earliest in November. We followed six units of 10–30 birds ($\bar{x}$ = 21 birds/group) to their rafting sites by boat and found that although all birds rafted over the deepest part of the lake, the small groups remained as discrete units so that a single large aggregation did not occur. We surmised these groups remained intact overnight as we noted that birds also moved inshore in the morning as small units.

Discussion.—(1) Activity patterns. Feeding dominated afternoon activity (78.5% of all be-

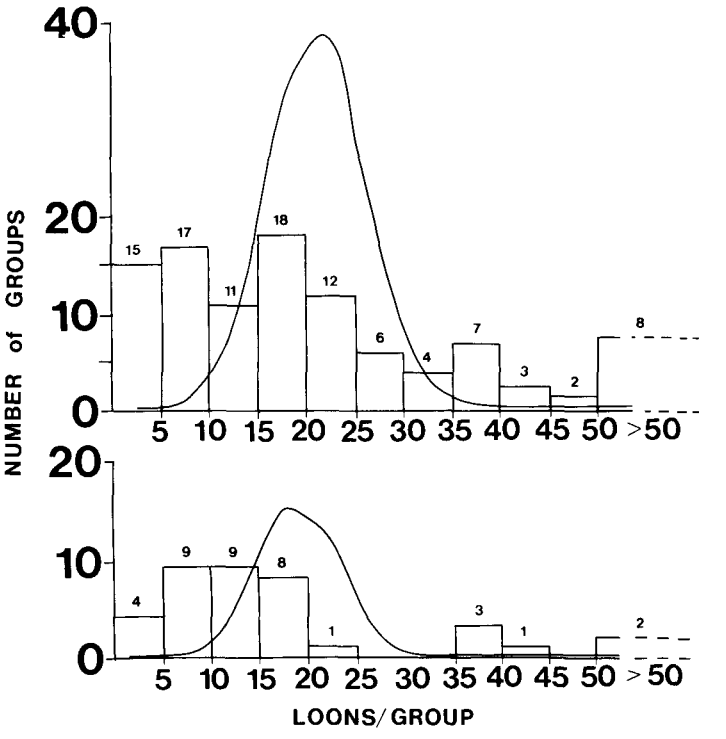

FIG. 3. Number of loon groups in each size category. The line is the expected distribution if groups follow a Poisson distribution; bars are observed values presented as grouped data. Numbers below the histogram indicate upper limit of each column's interval; numbers above each column are number of groups in each category. Upper histogram includes loons engaged in all activities; lower histogram includes only feeding groups.

havior between 13:00 and 17:00). However, total daily foraging time (46.3%) was slightly less, but not significantly so, from time spent foraging on the wintering grounds (55.3%, McIntyre 1978), hence daily budgets allotted approximately equal time to feeding and non-feeding activities in both seasons. We had not expected this; rather we had anticipated that loons would spend more time feeding just prior to migration than when on the wintering grounds. This may indicate that they stop frequently during migration and do not require an abundance of migratory fat; or it may provide a clue that food is more abundant and/or readily available at Mille Lacs Lake than it is in coastal waters in the winter, or it may suggest that energy requirements for loons are greater during the winter.

Location of rafts over maximum water depths as shown on lake contour maps, number of individuals in each, and time of day the birds settled were similar to rafting patterns on the wintering grounds (see McIntyre 1978 for techniques used to map loon locations). Loons are visual, diurnal predators (Barr, Ph.D. thesis, Guelph Univ., Guelph, Ontario, 1973) and the positive correlation between rafting and sunset times in both studies reinforces the concept that feeding time is related to light levels.

Rafting by groups as individual units assures "ready-made" feeding associations in the

morning. This practice may assure: (a) continuation of optimal foraging group size day after day; (b) that individuals known to each other will feed together daily, which may in turn result in feeding efficiency by reducing aggressive levels (Morse, Ecol. Monogr. 40:119–168, 1970); or (c) that rafts function as information centers to decrease search time to feeding sites (Siegfried, Trans. Roy. Soc. Afr. 39:419–443, 1971; Krebs, Behaviour 51:99–131, 1974). These are only speculations on our part, but are questions for future studies.

Loons raft offshore during all times of the year (McIntyre, Ph.D. thesis, Univ. Minn., Minneapolis, Minnesota, 1975; 1978; this study). The possibility that remaining offshore and in deep water promotes safety from potential predators and minimizes tidal effects has been offered as an adaptive value for winter rafting (McIntyre 1978). In the fall, lakes begin freezing along the shoreline and remain open longest over deep water. Loons may raft offshore in late fall to minimize chances of becoming trapped in ice should a lake begin to freeze during the night. It is very likely there are different primary selective pressures operating at different times of the year, and a single factor should not be invoked for all seasons.

(2) Social relationships. Selective pressures favoring social feeding include predator avoidance and increased foraging efficiency (Hamilton, J. Theoret. Biol. 31:295–311, 1971; Cody, Theoret. Pop. Biol. 2:142–158, 1971), assuming that they ultimately contribute to increased fitness. As we know of no loon predators at Mille Lacs Lake, we reason that the proximate selective factor in social feeding is related to maximizing foraging efficiency.

Feeding associations include 10–20 members in most instances. Larger groups arose through occasional convergence of smaller units (sudden concentrations of food?). The fact that loons stayed in small groups overnight lends credence to the idea that there are "basic" small groups (neighbors from the breeding grounds?); however, stability of these smaller units awaits testing using marked individuals.

This is the only time during the year when Common Loons are known to consistently feed in flocks. Animals do switch strategies in response to ecological conditions (e.g., Krebs 1974; Gill and Wolf, Ecology 56:333–345, 1975; Stacey and Bock 1978). We suggest that behavioral flexibility may be the usual mode for migrants whose resource base changes as a factor of location as well as for non-migrants subjected to seasonal resource variability. Long term studies of the annual biology of many species should be encouraged in order to answer more general questions of strategy-switching behavior.

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Loon migrations off the coast of the northeastern United States.—In eastern North America the Common Loon (*Gavia immer*) breeds throughout boreal and arctic life zones, whereas the range of the Red-throated Loon (*G. stellata*) is farther north (82°N) but not as far south, reaching its southern limit in Newfoundland and the Gaspé Peninsula (Todd, Birds