The Condor 103:189–191

SIZE CHARACTERISTICS OF STONES INGESTED BY COMMON LOONS[1]

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Abstract. Common Loon (*Gavia immer*) carcasses recovered in New England had more stones of greater combined mass in their stomachs than loons from the southeastern United States. Stones retained in sieves with mesh sizes between 4.75 and 8.00 mm accounted for the greatest percentage (by mass) of grit in loon stomachs. The median longest dimension of the largest single stone in each stomach was 12.5 mm in loons from New England and 10.7 mm in loons from the southeast (maximum = 23.1 mm and 16.8 mm, respectively). A recent national proposal to restrict the use of certain fishing weights in the United States called for a ban on lead fishing sinkers of 25.4 mm or less in any dimension. Our findings suggest it is unlikely that Common Loons would ingest lead fishing weights greater than 25.4 mm in any dimension, if such ingestion was solely the result of their search for replacement stones for their stomachs. However, this does not preclude the possibility that loons may ingest larger fishing weights under other circumstances, such as the consumption of fish with attached sinkers.

Key words: Common Loon, Gavia immer*, ingested stones, lead sinkers, stomach.*

Lead poisoning from the ingestion of lead fishing sinkers and jigs has been documented in several species of wild birds (Scheuhammer and Norris 1996). Lead poisoning of birds from ingested lead fishing tackle has resulted in a variety of proposed and enacted national legislation restricting the use of lead sinkers and jigs in England and Wales (Kirby et al. 1994), Canada (Canadian Wildlife Service 1997), and the United States (Environmental Protection Agency 1994). Restrictions are generally based on size or weight and are directed at small (≤25.4 mm in any dimension proposed in the United States, <28.36 g in England and Wales, and <50 g in Canada) sinkers and jigs, because larger sinkers are believed to be infrequently associated with cases of lead poisoning in water birds.

Of the possible circumstances resulting in the ingestion of lead weights by birds, one of the most likely for Common Loons (*Gavia immer*) may be the consumption of fish with attached fishing gear, including lead sinkers and jig heads (Barr 1996). However, it also has been suggested that loons inadvertently pick up lead sinkers from the bottom of water bodies as they ingest stones (Pokras and Chafel 1992, Environmental Protection Agency 1994). According to McIntyre and Barr (1997), Common Loons usually have 10–20 small (described as pea-sized) stones in their stomachs to aid in grinding food, and Barr (1996) reported that grit particles in stomachs of 40 Common Loons collected in Ontario, Canada ranged from 2–7 mm in diameter. If Common Loons ingest lead sinkers or jig heads as they search for replacement stones for their stomachs, the size distribution of ingested stones would be useful data to consider in management decisions regarding size-based restrictions of lead fishing tackle. Our objective in the current study was to evaluate stones in stomachs of Common Loons to determine the frequencies of various sizes that are selected, as well as the longest dimension of the largest single ingested stone.

METHODS

During 1990–1998, stomach contents were recovered from Common Loons that were found dead or that died in rehabilitation centers in New England (Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island; $n = 132$) and the southeastern coastal United States (North Carolina and Florida; $n = 173$). Carcasses from New England were necropsied at the Wildlife Clinic, Tufts University School of Veterinary Medicine, North Grafton, Massachusetts. Loons from the southeast were necropsied at wildlife rehabilitation centers in Ft. Lauderdale, Naples, Miami, and Indian Shores, Florida; Morehead City, North Carolina; and at the U.S. Geological Survey, National Wildlife Health Center (NWHC), Madison, Wisconsin. Sex was determined by visual examination of gonads. Prefledging birds were excluded from the study.

At the NWHC, stomach contents were placed in a pan and rinsed with water to remove food items, including parts of fish, crayfish, and other invertebrates, which were not quantitatively characterized. The stones found in each stomach were washed through a series of six brass sieves with mesh sizes of 1.18, 2.36, 4.75, 6.30, 8.00, and 9.50 mm. Stomachs containing only sand or particles of stone <1.18 mm in diameter were not used in the analysis. The stones collected in each sieve were transferred to a weighed crucible, dried for ≥14 hr at 120°C, and the crucible was re-

[1] Received 9 March 2000. Accepted 8 September 2000.
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TABLE 1. Characteristics of stones[a] in stomachs of Common Loons (*Gavia immer*) from New England and the southeast United States.

	New England[b] (n = 129)	Southeast (n = 135)
Number of stones/stomach		
median	14	5
range	1–154	1–31
Mass (g)		
median	6.0	1.4
range	0.1–55.5	0.1–12.0
Longest dimension (mm)		
median	12.5	10.7
range	7.0–23.1	6.0–16.8

[a] Sand or particles of stone <1.18 mm in diameter were not used in the analysis.

[b] All medians significantly different between locations (Wilcoxon two-sample test, $P < 0.001$).

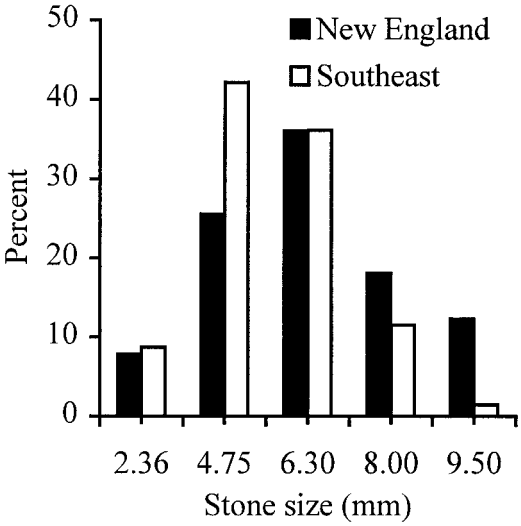

FIGURE 1. Average percent (by mass) of stones from Common Loons (*Gavia immer*) in New England (n = 129) and the southeastern United States (n = 135) that were retained in five sieves with mesh sizes of 2.36–9.50 mm.

weighed to the nearest 0.1 g. A subsample of stones from 30 stomachs was examined qualitatively for mineral type. For each of the loon stomachs, we determined the total mass of grit and calculated the proportion, by mass, of stones retained in each sieve. We also measured the longest dimension of the largest stone found in each stomach to the nearest 0.1 mm. Data for the number and total mass of stones were not normally distributed and were not normalized by commonly used log transformations, so we used nonparametric statistics to evaluate the results from the two geographic locations. Variables (number of stones, longest dimension, and total mass) were compared by sex and location with separate Wilcoxon two-sample tests, and the relationships among the same three variables were evaluated with Spearman correlation coefficients (SAS Institute, Inc. 1996).

RESULTS

Examination of the subsample of stones by a geologist showed that most stones consisted of hard minerals, the majority being composed of quartzite (E. M. Pokras, pers. comm.). Stones ≥1.18 mm in diameter were found in the stomachs of 129 of 132 (98%) Common Loons from New England and 135 of 173 (78%) loons from the southeastern U.S. The total number and mass of stones and the longest dimension of the largest stone differed by location, but not by sex, so the data for males and females from the two geographic locations were combined. Common Loon carcasses collected in New England had a median of 14 stones in their stomachs, compared with 5 in stomachs of loons found in the southeastern U.S. (Table 1). The longest dimension of the largest single ingested stone was greater in loons from New England than loons from the southeastern U.S. None of the loons from the southeast had grit that was retained in the 1.18-mm sieve, and in loons from New England the 1.18-mm size category represented <1.0% of grit mass. Stones 4.75–6.29 mm and 6.30–7.99 mm in size accounted for the majority (by mass) of grit found in loon stomachs. Stones ≥9.5 mm made up only about 12% of grit mass in loons collected in New England and <2% in loons from the southeast (Fig. 1). The total number of stones in stomachs of Common Loons was correlated with the total mass of stones (r_s = 0.92, $P < 0.001$) and the longest dimension of the largest stone (r_s = 0.51, $P < 0.001$). The longest dimension of the largest stone also was correlated with the total mass of stones (r_s = 0.71, $P < 0.001$).

DISCUSSION

In other species of birds, seasonal changes in the amount and size of grit have been linked to variations in food habits and environmental conditions (Norris et al. 1975, Gionfriddo and Best 1995). Similar factors may have contributed to the differences that we found in size characteristics of stones ingested by loons in New England and the southeastern United States. For example, replacement stones may be more available on the bottom of lakes and streams in the breeding areas of Common Loons in New England than in coastal marine migratory routes and wintering areas. Perhaps grit particles had been eliminated with greater frequency by the loons collected in the southeast, possibly because of seasonal or dietary differences. In a study of grit retention in captive Mallards (*Anas platyrhynchos*), Trost (1981) reported that elimination of grit was apparently the result of periodic evacuations of the gizzard, rather than a constant turnover. Most (98%) of the loon stomachs from New England contained stones; similarly, Barr (1996) found that 100% of 40 Common Loons from Algonquin Provincial Park, Ontario, Canada had stones in their stomachs, although loons in our study had larger grit than the

maximum size of 7 mm reported in the Ontario study. According to McIntyre and Barr (1997), the average number of stones found in 74 loon stomachs was 11.6, intermediate to the medians we found in New England and the southeastern U.S. The geographical location of their samples was not identified.

Although stones ≥9.5 mm in size accounted for about 12% of grit in the stomachs from Common Loons found in New England, the median longest dimension of the stones from loons in that area was 12.5 mm and the longest single stone in the entire study was 23.1 mm. The size distribution of grit contained in the stomach of a loon is likely to fluctuate over time as stones are eliminated, whether one-by-one or simultaneously, and as new ones are ingested. Furthermore, the grinding action of the muscular stomach is likely to reduce the size of ingested grit particles to a degree that is proportional to retention time. Thus, size characteristics based on ingested grit may provide an underestimate of the size of particles originally selected.

Our findings with regard to grit size selection lead us to conclude that, unless lead tackle is preferentially selected, it is unlikely that Common Loons would ingest lead sinkers or jig heads larger than 25.4 mm in any dimension as they search for replacement stones for their stomachs. Of the lead fishing weights that were found in the stomachs of 33 Common Loons in our study, only one was larger than 25.4 mm in length (J. C. Franson and M. A. Pokras, unpubl. data). Part of a fishhook and a piece of fishing line were found in the stomach of the same loon, suggesting the possibility that the loon consumed a fish with the accompanying sinker. According to Barr (1996), loons are likely to be attracted by the atypical behavior of a fish with an attached hook and sinker, and the possibility that they could ingest relatively heavy sinkers via this mechanism is supported by the large sizes of fish reported taken by loons. Flick (1983) found two brook trout (*Salvelinus fontinalis*) of 29 and 34 cm in length that had been ingested by Common Loons and, in the stomach of one of the loons, a jaw tag from a brook trout that was 41 cm long when it was tagged and released. In an earlier report, a fish that was 38 cm long and weighed over 794 g was found in the throat of a Common Loon (Sutton 1927).

Funding support was provided by the U.S. Fish and Wildlife Service, Division of Federal Aid, Administrative Grant No. AP95-018, North American Loon Fund, Davis Conservation Foundation, the Wood Family Foundation, and Massachusetts Environmental Trust. We thank D. Anderson, S. Goetzinger, D. Jochimsen, J. Kaplan, H. Kelton, K. Litzenberger, A. Schrader, and D. Singler for providing specimens and technical assistance. Helpful comments on the manuscript were provided by C. Brand and two anonymous reviewers.

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