

at Cape Henrietta Maria indicates that this remaining barrier to the eastward spread of Ross' Geese has been overcome. It is probable that Ross' Geese now breed in all Lesser Snow Geese colonies in the Hudson Bay region.

Along with the recent increase of Ross' Geese around Hudson Bay, hybrids between the two species have been noted (Trauger et al. 1971). The incidence increased rapidly at the McConnell River after the first hybrids were noted there (Prevett and MacInnes 1972). Probably a significant reason is the relative scarcity of available conspecific mates for Ross' Geese in the Hudson Bay population. For example, in 1970 the ratio of Ross' Geese to Lesser Snow Geese in Texas and Louisiana was estimated at 1:718 (Prevett and MacInnes 1972:435).

The formation of hybrid pairs is a probable mechanism for the spread of Ross' Geese to new Lesser Snow Goose breeding colonies. Frequently male Snow Geese pair in winter or during spring migration with females from different colonies. Since females usually return to their natal colony to breed, males, as a result, often switch colonies (Cooke et al. 1975). The same tendency may be true of Ross' Geese. Hence, it is possible that the first Ross' Goose nesting at Cape Henrietta Maria was a male paired to a female Snow Goose. The hybrid female banded at the Cape Henrietta Maria colony in 1975 might have hatched from this nest and returned with a Ross' mate to nest. If this is true, and allowing two or three years to reach sexual maturity, a Ross' Goose bred in the Cape Henrietta Maria colony as early as 1972 or 1973. The implications of hybridization for the Ross' Goose are potentially serious and we intend to study them.

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AGE DIFFERENCES IN THE DIGGING FREQUENCY OF HERRING GULLS ON A DUMP

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Several recent studies have shown that in certain species which use skilled feeding methods, such as plunge diving, immature birds do not perform as well as adults (see Buckley and Buckley, *Ecology* 55: 1053-1063, 1974 for references). It is currently postulated that this lack of skill may be a factor contributing to delayed breeding in these species.

Herring Gulls (*Larus argentatus*) when feeding on garbage dumps dig for food by removing inedible items in order to expose edible ones. During a recent study of the feeding ecology of gulls on a dump on Walney Island, Cumbria, England, I had an opportunity to compare the feeding behavior of adult and immature Herring Gulls, especially with respect to

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their digging habits. Relatively few immatures fed on the dump and I thought that this might be due in part to their inefficiency in exploiting this food source. Examining this idea was the object of the present study between 1 March and 2 May 1974.

From the moment a bird landed on the dump I started a stopwatch and counted the number of large items it pulled out or threw aside over time. The period was terminated when the bird's head was completely obscured by other gulls. I scored only the removal of large items such as folded newspapers, cans, rags, and paper bags. These could be easily seen, even when the bird I was watching was partly hidden by others.

In another set of observations, I counted the number of food items (those lying on the surface and those found by digging) a bird ate over a timed period. These were small food items that could be swallowed easily on the spot. The discovery of a large food item ended the observation and the item was not included in the count.

TABLE 1. Number of objects moved by Herring Gulls of several age classes while digging for food on a garbage dump.

Age of bird	No. of birds	Total min. observed	No. of objects moved	No. of objects moved/min./bird ¹
First-year	37	44.8	10	.2
Second-year	39	49.5	52	1.1
Third-year	35	36.7	68	1.8
Adult	40	42.3	150	3.6

¹ Comparisons between any two year classes are significantly different ($P < 0.01$), except between second- and third-year birds ($P > 0.05$).

I also recorded the frequency of success of immature Herring Gulls when stealing food from adults. These data were collected partly at random and partly during the observations on feeding rate.

For the purpose of this study, aging was done as follows: All-brown individuals were considered to be first-year birds. Brown individuals with grey scapulars and a dark bill (might have some yellow near the base) were considered second-year birds. Individuals with grey wings with some brown on the tip of the tail and on the wing coverts, a yellow bill (might have a dark tip) and an eye as in the adult or nearly so were third-year birds. Birds with grey wings, a yellow bill, and a clear eye were adults.

First-year Herring Gulls moved significantly ($P < 0.01$) fewer objects per minute than adults (table 1). Older birds moved progressively more objects. First-year gulls found significantly fewer small food items per minute than did third-year birds ($P = 0.037$) and adults ($P = 0.001$), and second-year birds differed significantly in this respect from adults ($P = 0.004$). As the gulls mature they find progressively more small food items per unit time (table 2).

First-year birds usually walked or even ran rapidly among adult Herring Gulls searching for food. When they saw one feeding they often tried to steal its food. In 13 such attempts to steal food only 6 were successful. More often, first-year birds kept standing near a feeding gull without apparently daring to displace it. They frequently assumed the hunched posture (Timbergen, *The Herring Gull's world*, Doubleday, New York, 1967) with *head tossing* and the begging call. I saw one first-year bird *head tossing* as late as 6 June when it must have been about 1 year old. Such begging young were never fed. Most of the first-year birds were easily discouraged by a *long call* or by a pecking movement in their direction. Some first-year birds used surprise attacks, usually from behind the feeding adult. Similar observations regarding the behavior of first-year birds have been made by Drury and Smith (*Evolution* 22:193-201, 1968). Second- and third-year birds also stole food from adults. In 20 attempts, 15 were successful. This number of successes did not differ significantly ($\chi^2 = 1.72$, d.f. 1, $P > 0.05$) from those of first-year birds.

All Herring Gulls on a dump probably dig sooner or later, regardless of their age. First-year birds dig less than adults. There may be several reasons for this. 1) Some young birds may not try to dig, but

TABLE 2. Number of small food items eaten per minute by Herring Gulls of several age classes while walking over and digging on a garbage dump.

Age of bird	No. of birds	Total min. observed	No. of items eaten	No. of items eaten/min./bird ¹
First-year	26	27.5	23	0.8
Second-year	20	24.7	33	1.3
Third-year	12	16.9	24	1.4
Adult	40	46.6	113	2.4

¹ Comparisons between any two age classes are significantly different between first-year and third-year birds ($P = 0.037$), first-year versus adult ($P < 0.001$), and second-year versus adult ($P = 0.004$). In all other combinations $P > 0.05$.

others did try (table 1). 2) It might also be argued that young birds do not need to dig because they can find enough food on the surface. The data in table 2 do not favor such a supposition. Furthermore, the often frantic nature of their behavior, running from one adult to the other, trying to steal their food, suggested that they were not very successful in finding their own food. Even if the young did not need to dig because they could find enough food on the surface, it is puzzling why the adults could not do the same. 3) The differences between young birds and adults might be caused by breeding season activities. Adults may forage harder than first-year birds, because the adults spend much time on the territory long before incubation starts, courtship feeding requires extra food, females need extra food to produce eggs, and they have to raise a brood. On 2 May, when for this last reason I ended the study, only a minority of the Herring Gulls had begun to incubate (MacRoberts and MacRoberts, *Ibis* 114:93-97, 1972; pers. obs.). None of them were feeding young at the time of this study. Although breeding season activities might help to explain why first-year birds appear to forage less hard than adults, they do not account for the feeding effort of second- and third-year birds. Clearly, breeding season activities alone cannot explain my findings. 4) Young birds may resort to stealing rather than finding their own food. Their brown color and appropriate submissive behavior might allow them to approach older birds more closely than adults would be able to, thereby enhancing their success in stealing food (Drury and Smith 1968). However, their frequency of success in stealing is no better than for second- and third-year birds, which look and behave progressively more like adults. As older birds dig more than younger birds, there appears to be a strong selection for *this* behavior rather than for stealing. For a young bird, stealing might be easier, but only because it has not yet learned to dig. I therefore favor the next explanation. 5) It takes time to learn by trial and error to associate the removal of inedible objects with food that might be hidden under them. Food items are often hidden by several layers of inedible material. It will also require time to learn where to dig, as much energy and time is wasted when digging in the wrong place. Buckley and Buckley (1974) found that juvenile Royal Terns (*Sterna maxima*) often searched for fish in unproductive areas, which were avoided by the adults. Adult Herring Gulls may have learned

to associate certain clues at the surface (see for example Shaffer, Specializations in the feeding behaviour of gulls and other birds, D. Phil. Thesis, Oxford Univ., 1971) with hidden food. However, not all of the adults' digging efforts were rewarded.

Although I have not shown that a gull who digs finds more food than one who does not dig, I think it is safe to assume that digging is profitable. My data (tables 1 and 2) show a strong correlation between increased digging and the number of food items found. As the frequency of successful stealing does not seem to improve with age, but digging does, stealing becomes an occasional activity, rather than a way of life. Most adults find their own food, but all of them probably try to steal when the opportunity arises.

MATE ATTRACTION FUNCTION OF SONG IN THE WHITE-THROATED SPARROW

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It is postulated that male advertising song in passerines functions sexually to attract the female and maintain the pair bond, and/or functions aggressively as a threat to rival males. The degree to which song serves both functions concurrently is dependent upon the stage in the breeding cycle and the presence or absence of such external stimuli as an intruding male, the absence of a female, or a conspecific song.

Falls (*in* R. A. Hinde [ed.] *Bird vocalizations*, Cambridge Univ. Press, Cambridge, 1969) proposed that the song of the White-throated Sparrow (*Zonotrichia albicollis*) serves three functions: (1) to attract mates (2) coordinate breeding activities and (3) exclude rivals from a home area. This study investigates the possibility that unmated male White-throated Sparrows use song to attract females.

Under natural conditions I investigated the daily singing activity of six males. I observed singing before and after pair formation (table 1). After a female paired with male One for seven days and another female paired with male Two for thirteen days, I removed the females and compared singing activity before and after removal (table 2). Male Two, after two days, formed a pair bond with a new female and I studied his singing activity before and after the second pairing (table 2).

The study took place in northern coniferous forest at two locations in New Hampshire. I observed one White-throated Sparrow (Wilmot Co.) from 5 May to 31 July 1974 and the five other individuals (Danbury Co.) from 9 May to 24 June 1975. Observations began when males established territories. At the Danbury study site I recognized the color-banded sparrows by their song alone and I monitored all five birds simultaneously from one place. For the six birds, I recorded the number of minutes a male sang for three 30-min periods each day. If a male sang at least once during the one-minute interval

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I recorded him as singing for that minute. I collected singing data between two and four hours after sunrise and observed males daily to determine whether pairing occurred.

I used the Student-Newman-Keuls test to examine the differences between all possible pairs of daily means when a one-way analysis of variance indicated a difference in daily singing activity.

Considering all six sparrows as a group, males sang significantly more before they paired with females than afterward. Daily singing behavior differed significantly over the nine-day period (see table 1, $F = 53.10$, $df = 8, 120$, $P < 0.001$). Comparison of individual daily means of singing frequency, taken two at a time, revealed no significant differences in singing frequency between days either before or after pairing ($P > 0.05$). Singing frequency during the four days before pairing, however, was significantly different from singing frequency on each of the five days after pairing ($P < 0.05$). Thus, the arrival of a female corresponds to a significant decrease in the male's singing behavior.

For both birds in the removal experiments, the four days examined (day -1 to day +2, female removed on day 0, see table 2), had significantly different daily singing frequency means ($F = 26.86$, $df = 3, 8$, $P < 0.001$, for bird One; $F = 6.55$, $df = 3, 8$, $P < 0.05$, for bird Two). In both cases, singing behavior for the two days before female removal did not vary, nor did that of the two days after removal ($P > 0.05$). The days before removal, however, differed significantly from each of the days after removal ($P < 0.05$). After female removal, singing increased significantly.

After bird Two paired again, his singing decreased significantly. Considering the two observations immediately before and after pairing (day +1 to +4, see table 2), the daily singing frequency means differed significantly ($F = 19.61$, $df = 3, 8$, $P < 0.001$). There was no significant difference between the two daily means before or between the two daily means after pairing ($P > 0.05$). When the days before pairing were compared to the days after pairing there was a significant difference ($P < 0.05$). Thus, before pairing, in the absence of the