RADIOTELEMETRY AND HERRING GULL FORAGING PATTERNS

By Ralph D. Morris and John E. Black

Since the development of the miniature transmitter, radiotelemetry has become an effective means of tracking wide-ranging animals. It has been used to monitor breeding and postbreeding movements and survival of game species (e.g., Lance, 1970; Bowman and Robel, 1977; Gilmer et al., 1977) and to record seasonal dispersal and migratory flights (Cochran et al., 1967). Most studies have relied on ground-based radio receivers, but relatively inexpensive modifications to light aircraft make aerial tracking feasible (Whitehouse and Stephen, 1976). Our long-term objective is to establish the relationship between the foraging patterns of brooding Herring Gulls (*Larus argentatus*) and brood success. Foraging is here defined as food gathering for the purpose of feeding chicks. Parents that are successful in raising and fledging chicks might be expected to exhibit a foraging strategy different from those that are unsuccessful. The present study represents the first step in realizing this objective. Since we chose to use radiotelemetry to track foraging birds, we had first to devise a technique for so doing and to test both it and the commercially available radio transmitters and receivers. The emphasis of this paper, therefore, is on the feasibility of the method rather than on foraging and other flight patterns, although information is presented on both.

METHODS

The radio transmitters (Model SD2, Module M; AVM Instrument Co., Champaign, IL) consisted of a waterproof package and 30-cm whip aerial. An operating current of 0.30 ma gave four months of continuous operation in a frequency range of 150–152 MHz. The radio receiver (AVM Model LA12) was connected either to one 4-element, hand-held Yagi antenna or to two 4-element Yagi antennae mounted at a 45° angle on a horizontal rod which was attached to an upright pole fixed to a tripod. The double antennae system gave a more precise bearing fix because it could be switched in or out of phase to function as a Null-detector.

In January and February 1978, the equipment was tested in the field. Two transmitters were attached to a vertical rod, one 5 m above ground, the second 0.2 m above ground. The intent was to simulate a "low-flying bird" (whip aerial horizontal) and a "standing bird" (whip aerial at 45° to the horizontal). The device was set on the shoreline of Lake Erie at two locations near the gull colony. The signal strength and bearing were determined at various locations and distances from the device. The variation of signal strength with the plane of polarization of the receiving antenna, and the effects of receiver height, hills, power lines, and houses were recorded. Similar tests were conducted with a "standing bird" transmitter on the ground at the colony site.

The Herring Gulls studied were members of a colony near Port Colborne, Ontario on the north shore of Lake Erie (cf., Morris and Haymes, 1977a, b). Since we had only five transmitters, we could study only five birds. We required five pairs of birds, similar in the time they began their clutches, clutch size (3 eggs), and incubation attentiveness. We would later place a transmitter on one bird from each pair. In order to identify clutches of similar dates and size, we used the following procedure. Beginning on 21 April 1978 and continuing through the last start of clutch on 17 May 1978, all clutches were marked and eggs numbered as they were laid. The number of clutches started peaked on 26–27 April. To identify similarly attentive pairs, we placed switches for recording incubation over the majority of peak nests (cf., Morris and Hunter, 1976). Nest watches were conducted from a blind every morning and evening during the first 10 days of incubation to observe which parent incubated and when each pair was at each nest site.

Adults were captured singly by means of a wire-mesh, walk-in trap (0.8 × 0.5 × 1.5 m) placed over the nest. Captured adults were weighed and bill measurements taken to confirm sex (Harris and Jones, 1969). A single green color band and USFWS band were placed on the right leg. The transmitter, attached to a harness (1.5 cm wide plastic strips with regularly spaced holes), was fixed to the back of the bird at the base of the neck. The harness straps were passed in front and behind each wing and the four ends brought together on the upper breast above the incubation patches and joined with clips. When in place and adjusted, the transmitter aerial extended along the back of the bird slightly beyond the folded wing tips. The total "package" weighed 32.5 g (3.8% of the weight of the lightest bird).

Two birds from different pairs were captured and harnessed with transmitters on 12 May 1978. We observed no loss or malfunction of equipment and no apparent behavioral abnormalities of the radio-equipped birds over the next 10 days. On 23 May 1978, transmitters were placed on three more birds, one from each of three additional pairs. In total, two males and three females were captured and harnessed (Table 1). Four were from pairs nesting at the peak of the season and all had 3-egg clutches. Incubation attention to the clutch was greater than 98% in all pairs throughout the incubation period. The fifth bird was a smaller, lighter female whose clutch of two eggs was laid in the post-peak period. The hatching success of the peak nesting birds was high, with all but one of the 12 eggs hatching (Table 1). It was important that all pairs with a radio-equipped bird had a similar number of chicks at the start of the brooding period. Thus, three addled eggs were replaced with pipping eggs from adjacent nests (Table 1).

The radio-equipped birds were monitored daily or every other day from 29 May through 22 June 1978. Five monitoring locations were used, four on the mainland adjacent to the colony and one power boat moored to a breakwater within 100 m of the colony (Fig. 1). Data were collected at the mainland locations with the Null-detector system. The

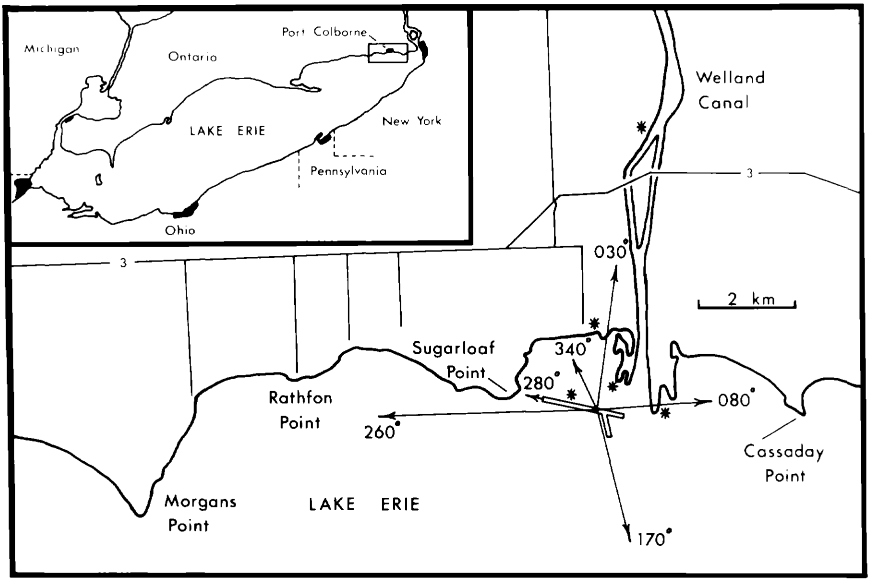

FIGURE 1. The Herring Gull colony offshore from Port Colborne, Ontario. The orientation of principal foraging and flight movements are indicated by arrows. The main locations for tracking radio-tagged birds are shown (*).

antennae were centered on the colony and movements of radio-equipped birds recorded as departures from this zero point. A car or boat was used to confirm movements visually with the aid of portable receiving equipment and a single, 4-element hand-held Yagi.

RESULTS

Preliminary testing showed that for a transmitter 0.2 m above ground and with an uninterrupted line of sight (no hills), the range was 3.2 to 5.2 km depending on the height of the receiving antenna. For a trans-

TABLE 1.
Characteristics of the five radio-tagged Herring Gulls.

Transmitter code	Sex	Weight (g)	Clutch start	Clutch size	Brood size
1-7	F	1,000	27 April	3	3
3-11	F	1,010	26 April	3	3
3-12	M	1,300	27 April	3	3
4-1	M	1,260	26 April	3	2 (+ 1)[1]
1-8	F	910	5 May	2	(1 + 1)

[1] Pipping eggs added to replace addled eggs.

mitter 5 m above ground, the range was 6.4 to 9.7 km. Intervening hills reduced the range of the ground transmitter to as little as 0.2 km and that of the elevated transmitter to around 3.0 km. A vertical polarization of the receiving antenna was optimal for the "flying bird," whereas a horizontal polarization was optimal for a "standing bird." The best procedure in searching for a signal was to work from the highest available landmark with the receiving antenna set at a 45° angle on the horizontal rod. Although a single Yagi received a relatively strong signal over an azimuth angle of about 60°, a more accurate bearing could be determined within ±5° by taking the average midpoint of the strongest signal from several sweeps. Still greater accuracy was possible with the Null-detector system. It yielded a Null signal over an azimuth angle of about 10°. Several sweeps yielded a bearing accurate to ±2°.

Bird Response to Equipment

Immediately following their release, the harnessed birds flew strongly, returned to the colony within 2 hr (usually within 20 min) and spent the next several hours shaking, preening, and pulling at the harness and transmitter with their bills. The harness was completely preened under the feathers within two days and only the transmitter, partially obscured by neck feathers, was visible.

Since our presence in the blind appeared to discourage normal foraging flights, we did not remain there for extended periods. Consequently, we have no data to compare the behavior of radio-equipped birds with that of control birds (cf., Gilmer et al., 1974). Our impression is that radio-tagged birds spent much time during the first week after harnessing pulling at the harness, transmitter, and protruding aerial. All transmitters continued to operate and all harnesses remained intact; however, three of the birds removed all or part of the aerial. This greatly reduced the range and strength of the signals and resulted in a complete loss of data for one bird (3-11) and a loss of 15 days of data for another (1-7). The braided wire (approximately 22 gauge) on the original transmitter is clearly inappropriate for use with Herring Gulls.

Movement Patterns

Our data cover the period 29 May to 22 June 1978 during which a total of 74.5 hr of tracking time was obtained. Because chicks in all broods with a radio-equipped adult were hatching on 27–28 May, this period represents 25 days of the brooding period. The data were organized into five blocks which represent consecutive 5-day intervals following hatching for each of the broods. For each diurnal observation period (0600–0900, 0900–1200, etc.), we measured the mean time spent at the colony by each of the radio-equipped individuals (Fig. 2).

4-1 (male)

This bird spent an average of 71.5% of the total monitored time at the colony. His longest and most frequent absences occurred in the early morning, and his total time away during that period increased as the chicks aged (Fig. 2A). He moved less extensively during the evening period (1800–2100). During the middle part of the day (0900–1800), he loafed and brooded at the colony. No long-distance flights were detected during any of the periods. All his flights were of short duration (less than 30 min), and the majority were made into a bay area northwest of the colony (West Bay, Fig. 1). Nineteen visual confirmations of foraging flights into West Bay were obtained. During one early morning period, for example, the bird was seen feeding on the same dead fish that he had been eating the preceding evening. The heavy arrows (Fig. 2A) oriented at approximately 45°, record soaring (nonforaging) movements in the vicinity of grain elevators 0.5 km northeast of the colony. This activity was most frequent in the 0600–0900 period, in particular between 8 and 22 June when the chicks were 11–25 days old.

1-7 (female)

This bird had removed all but 1 cm of her aerial by 8 June 1978 at the end of the second 5-day block of chick development. We therefore have valid records only for the period 29 May to 7 June (Fig. 2B). The bird spent 81.2% of the total observation time of 47.75 hr at the colony. She spent more time on short foraging flights when the chicks were 6–10 days old than in the immediate posthatch period. She spent slightly more time at the colony during the middle parts of the day (0900–1800) than in the morning and evening periods. Most movements were of short duration except for two flights west to Rathfon Point that both lasted over 1 hr and took place on successive days (5–6 June) between 1800 and 2100. Her location was visually confirmed seven times in West Bay (340°), twice at Sugarloaf Point (280°), and once in flight (30°) up the Welland Canal. All flights were of short duration (Fig. 2B).

3-12 (male)

This bird spent an average of 68.5% of his time at the colony. His absence was most common during the late morning hours (0900–1200) of all periods of chick development and during early posthatch periods at all observation hours. Two visual confirmations were obtained of short foraging flights into West Bay. All his other flights were of long duration. Our early data contained suggestions of extended trips south of the colony (170°) on different days, characterized either by a return from the east (80°) or departure to the east (Fig. 2C). For example, on 1 June 1978, while young chicks were present in the nest, he departed at 1635. Our pursuit of the bird by boat on a bearing of 170° resulted in a signal loss in the same direction approximately 15 km south of the gull colony. He returned to the colony at 1900. Five subsequent flights of the same nature were taken during the period when his chicks were $<$10 days old. We conclude on the basis of this and similar supporting data that all such movements represented flights of extended duration to an unknown destination across Lake Erie.

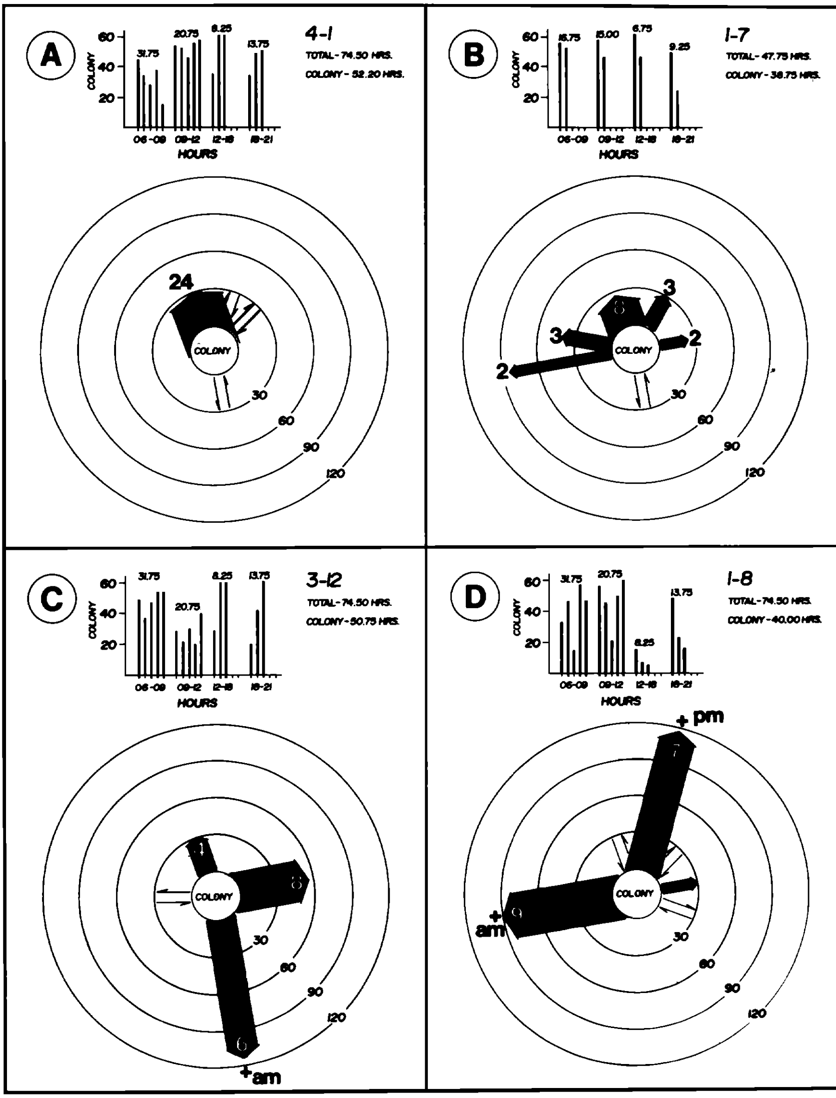

FIGURE 2. The duration and bearing of flights from the colony for each of the radio-tagged birds. The orientation of the arrows corresponds to the compass bearings noted in Fig. 1. The concentric circles represent duration of flights in 30-min intervals. The histograms represent mean time spent at the colony during each of the 5-day intervals of chick age from hatching (see text for further explanation).

1-8 (female)

This bird spent only 53.7% of her time at the colony. Her absence was most marked during the middle parts of the day (1200–1800) although it occurred during all posthatch periods and at all times of the day (Fig. 2D). No foraging flights to West Bay were observed. Two principal patterns of long-distance flight were noted and visual confirmations were obtained on both. Trips taken during the morning (0600–1200) were westerly (260°) to Rathfon and Morgan's Points. On two successive days, the bird was observed sitting on the same rock at Rathfon Point. Trips taken during the afternoon and evening (1200–2100) were northerly (30°). We pursued the bird across the Niagara peninsula by car on 5 June 1978. The signal was lost in a northward direction from the south shore of Lake Ontario. We conclude that all flights on a bearing of 30° represent movements of extended duration across the lake toward Toronto, Ontario.

The movement patterns of two of the birds (4-1, 1-7) were characterized by frequent flights of short duration to locations proximate to the colony (Fig. 2A, B). The movement patterns of the other two birds (3-12, 1-8) were characterized by flights of long duration and distance to points distant from the colony (Fig. 2C, D). Chi-square tests of time spent at and away from the colony for all combinations of these four birds show no difference between 1-7 and 4-1 or between 3-12 and 1-8. In effect, the former were individuals foraging close to the colony whereas the latter were long-distance travellers. All other differences were significant ($P < 0.05$) with the exception of 3-12 and 4-1. In this case, the two birds spent approximately the same amount of time away from the colony, but they did so in different patterns. 4-1 took a large number of relatively short flights, whereas 3-12 took a smaller number of extended flights. Thus, the pattern of absence was quite different and is consistent with the hypothesis of the different nature of the activity of these two individuals.

Brood Success

We have little information on the success of chicks in broods of radio-equipped birds. Observations obtained by spotting scope (40×) showed that 1-8 lost her chicks within two days of hatching whereas 3-12 lost chicks within the first 10 days after hatching. On 20 June 1978, 3-12 was observed collecting grass for construction of a new nest, a confirmation of brood loss from the original nest. Conversely, the other two birds were observed with chicks (1-7, 3 chicks; 4-1, 2 chicks) on 18 June, 21–22 days into the posthatch period. Since the highest chick mortality in Herring Gulls normally occurs during the first 7–10 days posthatch (e.g., Haycock and Threlfall 1975), it is likely that young from both broods fledged successfully.

DISCUSSION

Our results demonstrate the effectiveness of commercially available telemetry equipment at tracking foraging and other movements of adult Herring Gulls. The four radio-equipped Herring Gulls exhibited individual and predictable patterns of movement which varied little during the 25 days of our study. The predictable nature of these movements by each individual, detected within the first few days of monitoring, allowed us to locate reliably birds that foraged close to the colony with a single bearing. Triangulation was required initially to establish the pattern of long-distance movements. We were later able to use single bearings once the characteristic pattern of the flights was determined. Such predictability in flight and foraging behavior may be characteristic of individual Herring Gull parents during the brooding period. This has not been previously reported, although Davis (1975) showed that adult Herring Gulls were more traditional in selection of foraging sites than younger birds. Three of our four radio-equipped birds were peak-nesters with the same clutch (brood) size and all showed high incubation attentiveness. Despite these similarities, the movement patterns of all three were highly individualistic. Clearly, telemetry has great potential as a means of discovering such patterns.

Finally, the limited amount of data collected suggests a clear relationship between the movement patterns and eventual brood success of the birds studied. Our results are consistent with those of Hunt (1972) and Yom-Tov (1974), who both reported a positive correlation between brood success and parental attendance for Herring Gulls and crows (*Corvus corone*), respectively. In each case, chick mortality was greatest when parents foraged widely for food. In our study, two radio-equipped birds repeatedly took long-distance flights of substantial duration, and both lost their chicks early in the brooding period. Conversely, two other birds that foraged locally raised chicks successfully. These results suggest a relationship between the activity patterns of at least one member of a pair and eventual brood success.

SUMMARY

The movements of four brooding Herring Gull adults were followed for 25 days using commercially available telemetry equipment. Techniques to obtain precise information on distance, duration, and patterns of flight movements are described. Movement patterns of each bird were predictable and highly individualistic. Two individuals foraged at specific locations within 1 km of the colony whereas the other two took extended daily flights to destinations >30 km away. The former individuals successfully raised young whereas the latter lost chicks early in the brooding period. We suggest that radiotelemetry has great potential for defining clear relationships between adult movement patterns and differential brood success among pairs.

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