

SKY CONDITIONS IN RELATION TO RING-BILLED AND HERRING GULL ORIENTATION

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ABSTRACT. — The homing behavior of 379 Ring-billed and 50 Herring Gulls was contrasted with sky conditions that existed at release times. No evidence was obtained that supported the use of sun or stars as orientational cues. Gulls responded to topographical features during some trials. Juvenile Ring-billed Gulls showed directional preferences that correspond to headings required to reach the population's winter range.

This paper discusses one aspect of a study designed to investigate the orientation and migration of Ring-billed Gulls (*Larus delawarensis*) and Herring Gulls (*L. argentatus*) from a single breeding colony at Rogers City, Presque Isle County, Michigan.

MATERIALS AND METHODS

During the summers of 1963 and 1964, 320 adult, 3 subadult, and 56 juvenile Ring-billed Gulls and 50 adult Herring Gulls were used in 429 homing trials. Forty-one of the Herring Gulls were equipped with small transmitters and tracked for a combined total of 1302 miles with direction-finding receivers mounted in two vehicles. In addition, 294 Ring-billed Gull chicks, aged 1 to 20 days, and two Herring Gull chicks were subjected to orientation cage experiments (during 1964 see Southern, 1967a and 1969a).

Experimental gulls were released under varying amounts of sky cover, during winds from several directions, at different times of the day and night, in several directions from the colony, adjacent to major topographical features (e.g., large bodies of water), and at various distances (2 to 150 miles) from the colony. Whenever possible birds of

known age and sex were used. One to ten individuals were released at a time.

As controls 49 Ring-bills were released in or near the colony in an attempt to determine: (1) the accuracy of visual methods for calculating return times of color-marked gulls; (2) the effect of handling and confinement on return rates; and (3) the probability of recording color-marked individuals during any one visit to the colony.

Most of the adult Ring-billed Gulls were captured by means of a cannon net trap (Southern, 1967b). This method was not suitable for catching Herring Gulls because of their wariness and the relatively wide spacing of their nests. Adults of this species were snared with nylon loops placed on nests or perches. Each gull received a numbered band and was color-marked with alcohol-soluble stains for individual recognition.

As an improvement in handling, during 1964 the birds were given intramuscular injections of Equitol (supplier, Jensen-Salisbery Laboratories) at the rate of 20 ml/kg to quiet them during shipment and thereby reduce the chances of overheating. When ambient temperatures were below 88° F this dosage immobilized gulls for about two hours during the daytime; at night and at higher temperatures this amount was occasionally fatal. The gulls were put in burlap bags and carried to release sites by automobile. On the basis of my observations, the orientation of drugged birds was not different from that of the undrugged released in 1963. Controls released near the colony also received injections and their behavior supported this generalization.

Sky conditions at release times were recorded and also the changes that occurred during trials for comparison with concurrent homing success rates, speeds, and initial departure behavior. Sky conditions were divided into four categor-

ies: (A) cloudless; (B) scattered clouds up to 50 per cent cover; (C) over 50 per cent cloud cover — up to, but before the point where the sun's position was no longer visible to the observer; and, (D) complete overcast. In most instances sky conditions varied during the day, were not consistent for large areas, or were not consistent during the entire time the gulls needed to return. As most gulls took from several hours to several days to traverse return routes, it was impossible to determine whether or not particular sky conditions existed along the bird's entire flight path, except in the case of radio-tracked Herring Gulls (in press, Wilson Bulletin).

The Rayleigh test (Batschelet, 1965) was applied to the data presented in Figures 3, 4, and 6. This test is designed to determine whether the distribution of a population is uniform or whether it is unimodal. If the critical value of the test statistic $z > z_p$, the null hypothesis of a uniform distribution is rejected. If instead $z < z_p$, the assumption $p = 0$ is consistent with the data.

RESULTS

Trials with Adults.

Figures 1 and 2 illustrate the average success rates for Ring-billed and Herring Gulls released 2 to 150 miles from the colony under the four sky conditions. I combined data for the various distances as no variations were apparent. The data indicate that clouds obscuring the sun or stars did not alter homing behavior. Some of the birds released under Sky D may have been able to see the sun at some time during their return flights. As the behavior of radio-tracked gulls released under Sky D was not noticeably modified when the sun came out, all of the results from trials initiated during completely overcast conditions were retained and plotted in Category D. The lowest Ring-billed Gull success rate followed diurnal and nocturnal releases under clear skies (Fig. 1). Radio-tracking indicated that gulls follow-

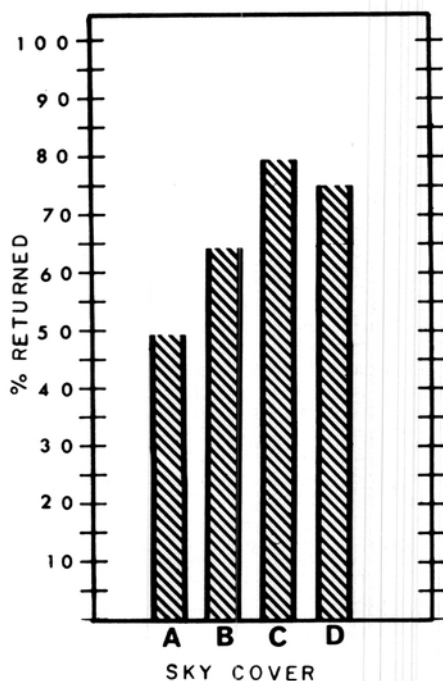


FIGURE 1. Ring-billed Gull returns with reference to sky cover. A = clear sky; B and C = partly cloudy; D = complete overcast. The number of gulls released under sky condition is as follows: A, 39 individuals; B, 99; C, 67; D, 61.

ed meandering routes in most instances and responded to particular types of topographical features.

Essentially all of the gulls released at night, regardless of sky conditions at the release locality, failed to return to the colony until several hours after daylight. Radio-tracked individuals spent most of the night resting on the ground or water.

The initial departure headings for adult gulls released under the four sky conditions are plotted in Figures 3 and 4. Categories B and C are combined in these figures as the sun was periodically visible in all instances and because no differences

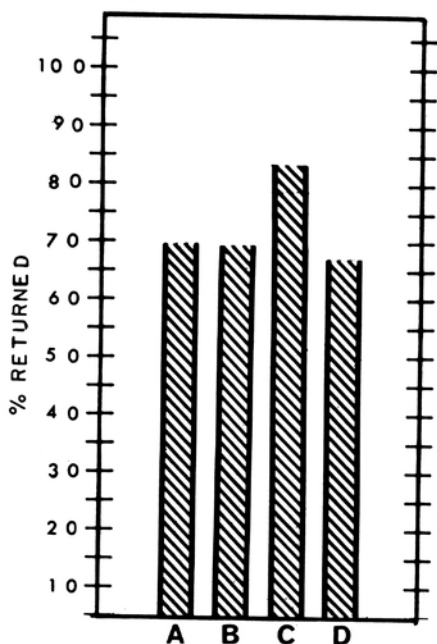


FIGURE 2. Herring Gull returns with reference to sky cover. The number of birds released under each sky category are as follows: A, 10 individuals; B, 13; C, 6; D, 3.

were apparent. Under clear skies (A) only 16.4 per cent of the gulls selected approximately homeward directions for departure (Fig. 3) but 55.1 per cent of the birds released actually homed. At the other extreme, Sky D, 25.0 per cent showed homeward tendencies at departure and 73.5 per cent returned. These results suggest that the presence or absence of solar cues does not influence the selection of departure directions or homing rates.

The mean angle of departure, relative to home, is similar for gulls released 16 to 150 miles from home under each of the three sky types (Fig. 3). In each instance the Rayleigh test shows the mean to be significant at the 5 per cent level since the

statistic z is equal to or larger than the z_p value of 3.0 for these sample sizes (Sky A, $z = 4.6$; Sky B-C, $z = 16.1$; Sky D, $z = 3.0$). The difference between the z values for Sky A and Sky D is not considered significant and, therefore, these data are interpreted as indicating that vision of the sun is not essential for the mode of orientation possessed by Ring-billed and Herring Gulls.

At distances under 15 miles, the departure headings form a unimodal distribution (Fig. 4). The sample size is small for Skies A and D but in the latter instance the Rayleigh test shows the mean angle to be significant ($z = 3.2$; $z_p = 2.8$ at the 5 per cent level). The mean direction for Sky B-C is also significant ($z = 7.9$; $z_p = 3.0$).

Figure 5 shows the average homing speeds for two groups of 46 gulls released under clear and overcast skies and at distances between 10 and 110 miles. I was unable to release gulls at sites within each distance category during both clear and overcast conditions and thereby contrast their homing speeds. However, I was able to release birds under Skies A and D at distances up to 75 miles. Comparison of these data showed that gulls released under Sky D had homing rates similar to birds released under Sky A. This further supports my speculation that the sun is not an essential clue for orientation or homing by these species. Furthermore visibility of the sun does not seem to enhance any aspect of the homing performance, i.e., the selection of homeward headings, success rates, or the distance flown.

Trials with Juveniles.

Ring-billed Gull chicks used in

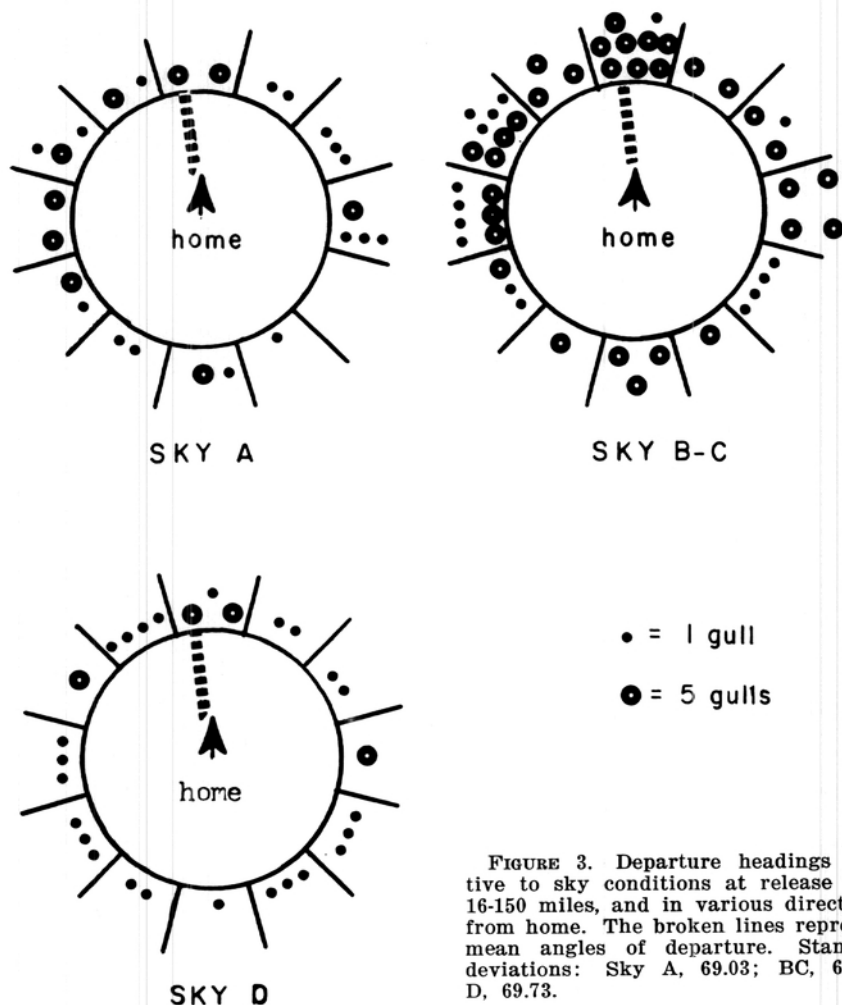


FIGURE 3. Departure headings relative to sky conditions at release sites 16-150 miles, and in various directions, from home. The broken lines represent mean angles of departure. Standard deviations: Sky A, 69.03; BC, 67.67; D, 69.73.

orientation cage trials and juvenile Ring-bills released for their maiden flights at locations 7 to 16 miles from the colony showed preferences for southeast and east directions (Fig. 6). Juveniles occasionally circled for about 20 minutes or longer before selecting a course that finally took them beyond my range of vision. As a sizeable proportion of the young Ring-bills from this population mi-

grate along the Atlantic Coast (Southern, 1967b; 1968), these directional preferences may represent an innate ability to select appropriate migrational headings.

The sun was not apparently involved in these direction preferences by young Ring-bills (Fig. 6). Similar mean angles of flight are evidenced for each sky condition but only those for Skies A and D are

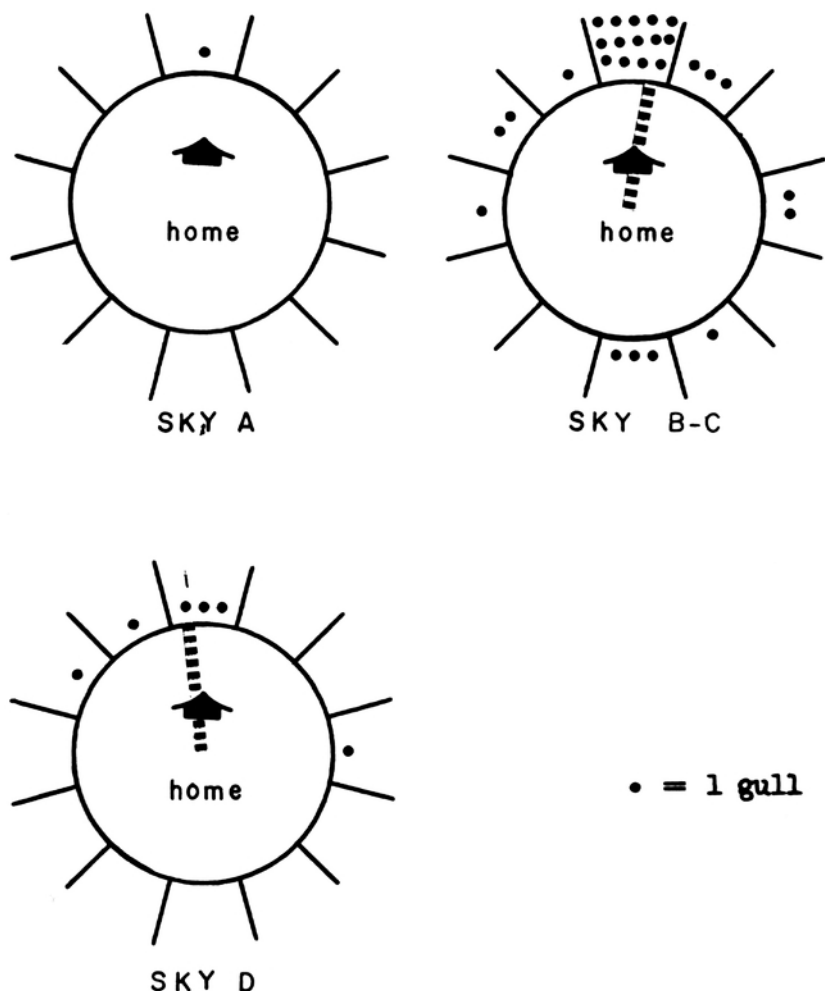


FIGURE 4. Departure headings relative to sky conditions at release sites 1-15 miles, and in various directions, from home. Broken lines represent the mean angles of departure. Standard deviations: Sky A, 0.0; BC, 54.87; D, 42.09.

significant (A, $z = 6.39$, $z_p = 2.95$; B-C, $z = 0.20$, $z_p = 2.93$; D, $z = 4.75$, $z_p = 2.95$). It seems, therefore, that the ability to select east or south-east courses during trials, and possibly upon dispersal from the colony, is based on some mechanism other than the use of solar cues.

DISCUSSION

The data presented herein indicate that departure directions of Ring-billed and Herring Gulls from the Rogers City population are not affected by cloud cover although flight patterns and general behavior may be (*e. g.*, the gulls flew at lower al-

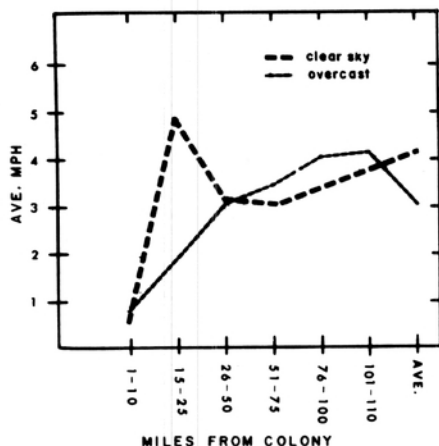


FIGURE 5. Average flight speeds of gulls released at various distances under clear and overcast skies (Skies A and D respectively).

titudes on overcast days).

Some localities at which gulls were released (2-15 mile locations) were within the normal feeding range of the population and, in addition, high flying gulls were probably able to see Lake Huron. When birds were able to see large bodies of water, they usually headed toward them, regardless of the direction from home. Other behaviors also indicated that landmarks (*e. g.*, rivers, high hills) affected homing behavior (Southern, 1967a). Possibly gulls released under the four sky conditions at distances over 15 miles from home also responded to landmarks during trials and the range of performances I recorded was the result of individual differences in familiarity with the terrain or in homing ability. In either case, experiences acquired during one flight should modify the future responses of individuals during migration and possibly during homing trials. However, successful homers

were not, in most instances, more efficient during later trials (Southern, 1969b). The reason for this may be that some gulls react less favorably to handling and the other treatment usually associated with the experiment and are, for that reason, more hesitant to return to the colony. Several radio-tracked gulls returned to within sight of the colony but failed to enter. This type of behavior could account for the apparent range of homing abilities the gulls exhibited. It is important to remember that birds are probably reacting to a variety of stimuli during homing experiments and that each of their responses need not be related to stimuli associated with displacement from their familiar territory. Furthermore, during migration and homing experiments, birds may not be motivated to perform rigorous flights during unfavorable conditions. Instead, initial departure may be in other than homeward directions and homeward progress may be slow, or absent, prior to improved conditions.

The usual measures of homing (orientation) ability relative to the presence of solar cues have been based on initial flight directions, departure directions, homing success rates, and/or comparative homing speeds. Each of these variables has been considered during this project and no evidence supports a hypothesis that solar clues are essential for orientation as performed by Ring-billed and Herring Gulls. I believe that orientation by these species is equally efficient during the presence, or absence of the sun. Proponents of a sun hypothesis may argue that the distances used during these trials were too short and that gulls were

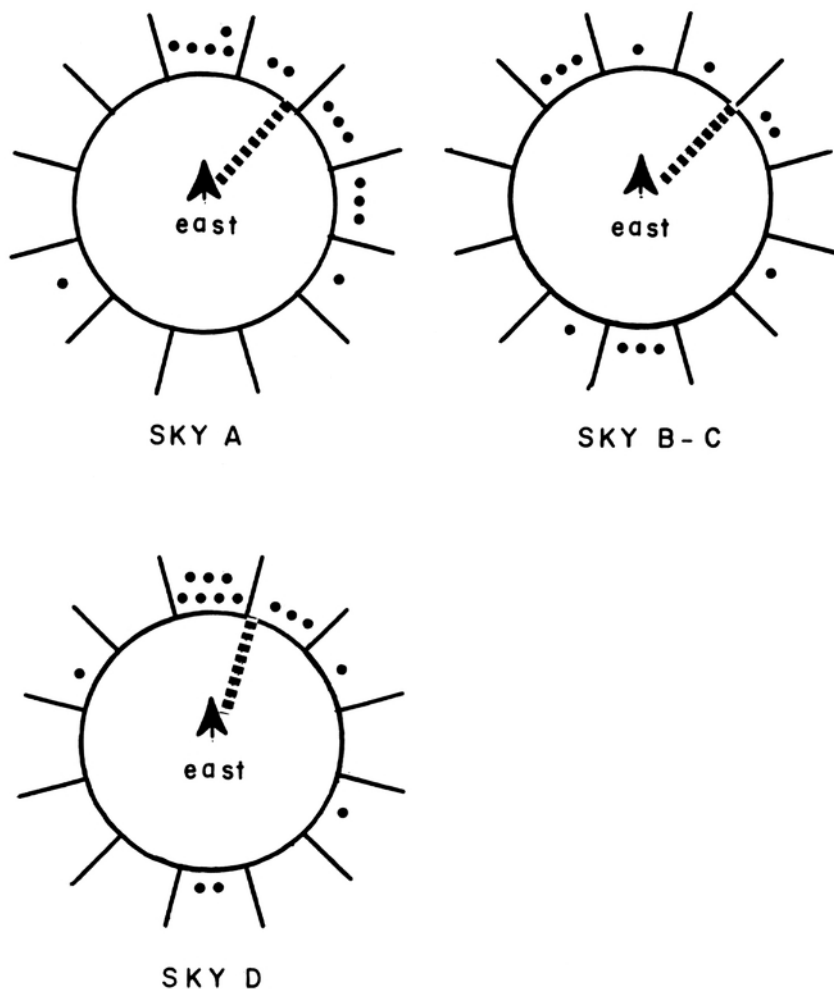


FIGURE 6. Departure headings of juvenile Ring-billed Gulls in relation to variations in sky conditions. Broken lines represent mean departure angles. Standard deviations: Sky A, 47.76; BC, 75.60; D, 53.60.

homing by means of landmark recognition. While I concur with the possibility of landmark orientation, my radio-tracking data and direct observations indicated that the gulls did not appear to recognize release localities that were more than 15 miles inland. In fact, inland dis-

placement of lesser distances may have caused some disorientation.

The possibility remains that the sun, whenever visible, might be used to some extent in compass-orientation, thereby supplementing the method used at other times. In such instances, the sun would only pro-

vide a gross clue for aid in selection of a general heading.

Fluctuations in the earth's magnetic field was the only environmental factor that could be correlated with alterations in directional preferences of young Ring-billed Gulls. Chicks showed reduced preferences for southeast, east, and south headings with increasing levels of magnetic disturbance (based on K-values of magnetic storm activity obtained from the Coast and Geodetic Survey's Fredricksburg Observatory). The existing data (Southern, in press) are still inconclusive but suggest that factors other than celestial cues or geographical features are involved in the selection of initial migratory headings by young gulls. Further studies are being conducted. If young gulls possess an inherited ability to select appropriate headings for initial migration, the adults should also; however, their basic response pattern may be modified by experiences gained during migrations, feeding flights, and other activities. As a result, adults fail to show similar tendencies during homing experiments.

SUMMARY

Of 429 adult and subadult Ring-billed and Herring Gulls used in homing trials, 41 of the Herring Gulls were radio-tracked. Homing behavior was contrasted with existing sky conditions. No evidence was obtained that supported the use of the sun or stars as orientational cues by these species. Juvenile Ring-billed Gulls showed preferences for

southeast and east headings when tested during homing trials, suggesting that members of these species have an innate ability to select courses suitable for reaching the winter range. Such behavior is modified in adults as a result of experiences gained during migration.

ACKNOWLEDGMENTS

This research was supported by grants from the Frank M. Chapman Memorial Fund (American Museum of Natural History) and The Society of Sigma Xi. Jerrold H. Zar prepared the computer program that was run on an IBM 360/40 in the NIU Computer Center.

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Manuscript received December 10, 1968.