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THE MIGRATION OF COMMON LOONS THROUGH EASTERN NEW YORK

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ABSTRACT.—Tracking radar and direct visual observations were employed to study the migration of Common Loons (*Gavia immer*) through eastern New York. Single birds and groups of up to four individuals flew at altitudes between 1,500 and 2,700 m (above sea level), usually above the turbulent convective layer. These migrants were not readily visible without the aid of binoculars and the tracking radar. Loons flew downwind toward the Atlantic coast in autumn (124°) and toward the eastern end of Lake Ontario and the St. Lawrence River in spring (347°). Direction of migration was more variable in spring, possibly owing to the greater variability of winds on flight days and destination of migrants. Loons never flew into headwinds. Strong westerly winds in autumn promoted higher groundspeeds than in spring. Mean airspeed was faster than that reported for most other species and did not vary in relation to following wind component as did groundspeed. Estimated flight time between Lake Ontario and the Atlantic coast of southern New England was between three and four hours depending upon wind velocity.

In Canada and the northern United States, Common Loons (*Gavia immer*) breed primarily on freshwater lakes, and winter along the Atlantic and Gulf coasts (Palmer 1962). Because these birds depend upon water for landing, taking off and foraging, they must fly long distances over vast terrestrial habitat during migration. Stop-overs at large bodies of water such as the Great Lakes are well documented (Bull 1974). This overland migration is not well studied, although the data available indicate that loons migrate (1) at moderate altitudes (Williams 1973), (2) as individuals or flocks of 2–15 (Preston 1956, Williams 1973), and (3) at speeds in excess of 25 mps (Meinertzhagen 1955). To determine how Common Loons accomplish these long-distance migrations over inhospitable habitat, I employed tracking radar and direct observations of the flight behavior of this species in eastern New York. The behaviors examined include (1) selection of altitude, (2) direction of flight in relation to wind, (3) flight speed, (4) flock size, and (5) daily timing of migration.

STUDY SITE AND METHODS

During the migration seasons of spring 1978–1980 and autumn 1978 and 1979, I used a 10-cm tracking radar (Able 1978) to study the in-flight behavior of individual diurnal migrants. The radar is situated at Berne, Albany County, New York (42°35′N, 74°07′W, elev. 507 m). Dates of radar operation included 31 August to 12 November and 19 April to 20 May, for a total of 189 h on 80 days. Observations normally began at 09:00 or 09:30. The radar was operated primarily to track migrating raptors, but many other species of birds were also tracked. Unlike birds in nocturnal radar studies, diurnal migrants can usually be identified by an observer working with the radar operator. While the migrant is tracked, the observer finds the bird by looking along the radar beam, using binoculars. When the target is located, the number of individuals, species and the general flight behavior are noted. For loons I noted whether they were flying straight, turning, or circling in flight. Straight flight is defined here as flight without turns greater than 20°. Data include azimuth, elevation and slant range at 10-s intervals and notes made by the observer. Only tracks 20 s or greater were used for the analyses. Wind velocity was measured at the same altitudes as migrating loons by tracking weather balloons equipped with radar-reflective material. Direction of surface winds was taken from local climatological data recorded by the National Weather Service. Percent cloud cover and precipitation were recorded at the study site and other weather data were taken from the morning radiosonde at the Albany County Airport.

RESULTS AND DISCUSSION

GENERAL BEHAVIOR AND FLOCK SIZE

Twenty-four tracks of migrating loons were recorded. One additional migrant was not tracked, but was seen with binoculars. Twenty-three tracks were of birds flying along straight (Rayleigh statistic, $r > 0.90$, Batschelet 1965) level tracks. The remaining track was of two loons gaining altitude while flying in circles.

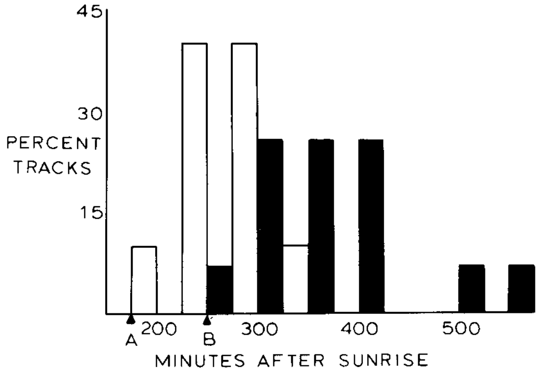

FIGURE 1. Distribution of daily passage time of loon migrants in minutes after sunrise. Autumn is shown as open bars and spring as solid bars. Arrows indicate approximate daily starting time of radar operations in autumn (A) and spring (B).

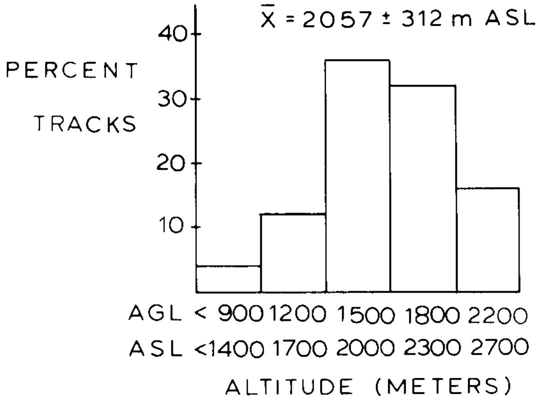

FIGURE 2. Distribution of altitudes of loon tracks. Twenty-five tracks were used including one loon that was not tracked, but was estimated to be below 900 m AGL. Both above ground level (AGL) and above sea level (ASL) altitudes are given on the abscissa.

Straight tracks ranged in duration from 20 to 145 s, averaging 79 s. Nineteen of 34 (55.8%) loons observed were lone birds, the remaining birds being in four groups of two (23.4%), one group of three and one of four individuals (20.6%). Mean group size was 1.39 individuals, close to the 1.45 individuals per group estimated by Preston (1956).

DAILY TIMING OF MIGRATION

Daily passage time ranged from 159 to 562 min after sunrise with the mean passage time being 324 min (SD = 97) after sunrise (Fig. 1). Radar operations began at about 150 min after sunrise in fall and 250 min in spring, so early migrants may have been missed, particularly in spring. My data do not show if daily timing of migration differs between spring and fall, but it seems that migration continues later in the day in spring. Passage times in eastern New York indicated that loons flew during more of the day than reported by Williams (1973), who rarely saw migrants after 09:30. The difference in passage times between Williams's (1973) study and mine reflects the geographic differences between sites in observer and take-off locales. Williams (1973) was closer to the coastal location where loons presumably started migration, while my study was conducted more than 100 km from where the loons probably began.

ALTITUDE OF MIGRATION

The altitudinal distribution of migrants ranged from 973–2,167 m above ground level (AGL). At the radar station this corresponds to 1,480–2,674 m above sea level (ASL). The mean altitude of migration was 2,057 m ASL (SD = 312). The proportion of migrants at different altitudes is shown in Figure 2. Convective depth, that part of the atmosphere where most thermally-induced vertical turbulence occurs, was determined for the time of each passing migrant by using the 07:00 National Weather Service sounding at Albany County Airport. Five hundred meters was added to all estimates in order to normalize for differences in altitude between the sounding site and the radar. This difference is probably greater than the actual convective depth so estimates of convective depth may be high. The average convective depth was 1,834 m ASL, over 200 m lower than the average altitude of loon migrants. Fifteen of 24 straight tracks were above the convective layer and all were above the estimates for the layer at the airport. Thus, loons probably encounter much less turbulence and more laminar air flow than lower-flying diurnal migrants.

In only one of the 24 tracks was climbing noted. Two loons were tracked as they flew in large circles, approximately 300 m in diameter. During 210 s of this observation these loons climbed from 1,627 to 2,338 m ASL, a total of 711 m. The climb rate equalled 3.39 mps. Flapping flight was maintained throughout the entire track. Climb rates of this magnitude during circular flight suggest that these migrants may use convective elements (columns or bubbles of ascending air that is warmer than the surrounding air) to attain some of their altitude. Migrant hawks soaring in convective elements achieved climb rates of 2–3 mps on that day.

Less turbulent air, or more laminar air flow, is only one of the advantages of flying at high altitudes. Theoretically, a flying object's airspeed increases by about 5% per kilometer above sea level because of the lower density of air. Loons flying at over 2,000 m ASL as in this study increase their airspeed by at least 10% because of the decreased density of the air. Temperatures at these altitudes were consistently 10°C lower than at the surface. A migrant the size of a loon has a surface-to-volume ratio lower than passerines, which predominantly fly at low altitudes, making heat stress a potential problem for loons (Tucker 1968). Over a long journey, factors associated with flight at higher altitudes could considerably reduce flight time and energy consumption.

FLIGHT SPEED

Increasing wind strength with altitude is another advantage of flying high, but only when winds are favorable for migration. Loons increase groundspeed by flying with strong tailwinds. Mean airspeed was 33.6 mps (SD = 4.6), slightly faster than airspeeds reported for loons by Meinertzhagen (1955) and higher than airspeeds recorded for some migrating ducks (Bergman and Donner 1964). I found no relationship between following wind component and airspeed although I found a positive relationship between following component and groundspeed ($r = 0.778$, $P < 0.001$, slope = 0.741, Pearson correlation coefficient). This suggests that loons, unlike other migrants, fly at constant airspeeds regardless of the strength of following winds. Studies of migrating ducks (Bellrose 1967), Chaffinches (*Fringilla coelebs*; Bruderer and Steidinger 1972), nocturnal passerines (Able 1977), White-throated Sparrows (*Zonotrichia albicollis*; Emlen 1974) as well as numerous other species (Tucker and Schmidt-Koenig 1971) have found a strong negative relationship between following wind component and airspeed. Because loons never flew into head winds I could not explore the relationship fully.

Overall, groundspeed averaged 44.6 mps (SD = 7.2). Spring migrants averaged 41.6 mps (SD = 4.9), which was significantly slower than the 48.1 mps (SD = 8.2) recorded for autumn migrants ($F_{1,22} = 5.39$, $P < 0.05$). The reason for the difference became clear when autumn and spring winds were compared. Winds on days of fall loon migration were oriented toward 109° ($r = 0.85$, $P < 0.001$, Rayleigh statistic) at a mean speed of 16.2 mps. This is only 15° to the north of the mean track direction. Autumn winds contributed on the average of 32% of groundspeed. In spring, winds varied greatly on migration days and were not significantly oriented. Loons still flew on days with either following winds or days with light and variable winds.

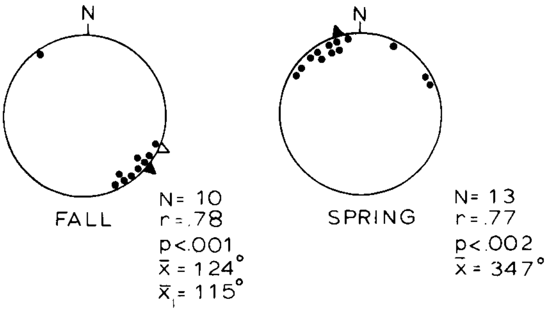

FIGURE 3. Directions of individual loon tracks in spring (A) and autumn (B), including sample size (N), mean direction (x̄, closed triangles), mean wind direction at altitudes of birds (x̄, open triangle) and Rayleigh statistic (r).

DIRECTION OF MIGRATION

The mean track direction of fall migration was to the south of east at 124° and was significantly oriented ($r = 0.78$, $P < 0.001$, Rayleigh statistic; Fig. 3). Mean heading was 134° ($r = 0.76$, $P < 0.002$). One bird was tracked flying to the northwest (324°) on 20 September 1979 with winds toward the northeast (42°) at 8 mps. This is an early date for migration of loons in New York (Bull 1974). Without this reverse migrant the Rayleigh value for tracks increased to 0.98. Mean track direction in spring was to the west of north (347°). Headings were almost identical toward 343°. The angular dispersion of tracks in spring was greater than during fall ($F_{1,18} = 5.636$, $P < 0.05$), but was still significantly oriented ($r = 0.77$, $P < 0.002$, Rayleigh statistic). A strong positive relationship was evident when both spring and fall tracks were regressed against wind direction at the altitude of migration ($r = 0.958$, $P < 0.001$, Pearson correlation coefficient), showing that loons flew on days with appropriate winds for migration or that they flew nearly downwind. The downwind flight relationship occurred during both spring ($r = 0.922$, $P < 0.001$) and fall ($r = 0.942$, $P < 0.001$). Forty-two percent of all tracks differed less than 10° from the direction of the wind and 58% differed less than 30°.

Both heading and track direction and flight time suggest that migrants tracked at Berne may have been flying between Lake Ontario and the Atlantic coast of southern New England. The evidence for this is better for autumn than spring. Minimum flight-time between Lake Ontario and the Atlantic Ocean would be approximately 180 min if a straight track were maintained. The return trip in spring would take approximately 220 min.

The larger dispersion of migratory directions in spring suggests a greater degree of direction selection by migrants at that time. Some Common Loons winter inland and thus do not start their migration at the coast. Three spring migrants were flying to the northeast. These birds flew with west, southeast and light and variable winds so their tracks were not caused by drift. Deleting these three tracks from the remaining spring data yields a mean track direction of 328° (SD = 16) or toward Lake Ontario, probably from the coast. The wider dispersion in spring can be explained by different migratory pathways and habits during different seasons. The most efficient and safest migratory behavior for a loon in autumn would be to fly downwind to the coast using prevailing westerlies to increase groundspeeds. This approximates optimal drift hypothesized by Alerstam (1979). Once the coast is reached, flight along the coast in a southerly direction would be facilitated by prevailing northeasterly winds (Gauthreaux 1981). This route would guarantee a quick passage to the coast with little danger of grounding.

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