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WEATHER, MIGRATION AND AUTUMN BIRD KILLS AT A NORTH FLORIDA TV TOWER

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Most accounts of nocturnal accidents to migrating birds emphasize occasional large kills and the bewildered behavior of birds encountering towers and lights in fog and overcast weather (Weir 1976, Avery et al. 1978). Tower kills are rarely compared to weather and migration on a daily basis (Avery et al. 1977), probably because few towers are checked for dead birds regularly. Possibly unique in this respect is the WCTV tower in northwest Florida where daily checks have been made since 1955 (Stoddard 1962, Stoddard and Norris 1967, Crawford 1974). This paper uses data from the WCTV tower to determine the influence of weather on autumn bird kills at the WCTV tower and relates these to other migration studies in the southeastern United States.

METHODS

Stoddard and Norris (1967) described the 308 m WCTV tower and its 14-ha cleared site located on Tall Timbers Research Station, Leon Co., Florida. Data on file at Tall Timbers include daily logs of dead birds (primarily passerines) and, for the years 1955–1967, maps of the tower grounds locating the dead birds as they were found on most mornings with ≥ 5 birds. I classified each night (24 August–15 November, 1962–1966) for the presence or absence of north winds, clouds and rain. Local climatological data sheets (U.S. Dept. Commerce) for Tallahassee, Florida, 33 km SW of the WCTV tower provide readings of sky cover, wind and rain at 1- or 3-h intervals for each night (dates herein are the mornings on which the birds were found; weather readings used were at 19:00 and 22:00 the day before and at 01:00, 04:00 and 07:00 the morning of the kill). Cloud data, expressed in tenths of sky covered by all types of clouds, were averaged; nights with a value of ≥4 were classified cloudy except that all nights with rain were considered cloudy. Nights with ≥2 wind readings >270° and <90° I classified for the north winds. Groups of nights with different weather conditions were compared for their numbers of birds with a Kruskal-Wallis test followed by Dunn's procedure for nonparametric multiple comparisons (Hollander and Wolfe 1973:115–120, 125) with significance at the $P < 0.05$ level.

RESULTS

In the 5 autumn periods (N = 420 nights), 8123 birds were killed (Table 1). Nights with north winds (N = 313, 74.5%) accounted for 6744 birds (83%) and nights with south winds (N = 107, 25.5%) had 1379 dead birds (17%). Two hundred and fourteen nights were classified cloudy (50.9%) and these accounted for 6686 birds (82.3%); the 206 clearer nights had only 1437 birds killed (17.7%). Birds were killed on all but 32 of the 420 nights (7%); one-half of these were south-wind nights (although only one-quarter of the nights were classified for south winds) and 22 (68%) were

TABLE 1
BIRD KILLS AND WEATHER CONDITIONS AT THE WCTV TOWER: AUTUMNS 1962–1966

Nights with		No clouds A	Clouds B	Clouds and rain C
North winds	No. nights	162	110	41
	No. birds	1326	3427	1991
	$\bar{x} \pm$ SD	8.19 ± 25.29	32.06 ± 84.22	48.56 ± 91.15
	Nights with 0	12	4	0
	Sig. dif.[a] from	B, C, D, F	A, D, E	D, E, A
	Not from	E	C, F	F, B
		D	E	F
South winds	No. nights	44	43	20
	No. birds	111	715	553
	$\bar{x} \pm$ SD	2.52 ± 3.73	16.62 ± 25.63	27.65 ± 30.17
	Nights with 0	10	5	1
	Sig. dif. from	A, B, C, E, F	B, C, D, F	A, D, E
	Not from	none	A	B, C

[a] $P < 0.05$, Kruskal-Wallis H-value = 103.141 ($P < 0.0005$).

classified as clear. Nights with clear skies and north winds resulted in more birds killed than those with clear skies and south winds but neither equalled the number killed with cloudy skies and north winds. Nights with cloudy skies and south winds had more birds killed than those nights with clear skies and south winds but neither had as great an effect as cloudy skies and north winds. There were no significant differences among groups classified for north winds and clouds, north winds, clouds and rain, and south winds, clouds and rain.

On 36 nights, more than 50 birds were killed; the largest kill was on 19 September 1962 (N = 828) and 10 other nights exceeded 100 birds. All but 2 of the nights with more than 50 birds were associated with cold-front passage (14 October 1964, with 57 birds and 4 September 1966, with 65 birds were not). Cold fronts, the leading edges of cold air masses, are often preceded by south winds and clouds in the vicinity of the WCTV tower. As fronts near the site, storms and rain may occur and then the winds shift to the north. During these conditions the largest kills at WCTV occur. The 2 nights with large kills that were not associated with the passage of cold fronts had clouds and north winds nonetheless. During these 5 autumns about 20 fronts passed the WCTV tower vicinity and did not result in kills of over 50 birds, although they regularly resulted in kills of 15–30 birds. Usually these fronts came through 2–4 days after another front, had relatively clear skies along their leading edges, or were early in the season.

DISCUSSION

The WCTV tower data show 4 consistant patterns: (1) kills occur virtually every night in autumn, (2) kills result during south winds as well as north winds, but north winds result in greater kills than south winds, (3) large kills usually result during the passage of cold fronts, and (4) overcast skies affect the number of birds killed whether with north or south winds. Except for the last, the effects of clouds, the characteristics of autumn kills at the WCTV tower are also those of passerine migration in the southeastern U.S., according to radar and direct-visual studies.

Able (1972, 1973) monitored night migration flights in autumn at Lake Charles, Louisiana and at Athens, Georgia. He recorded migration flights every night, but flights with north winds were greater than those with south winds: 70.5% of the migration volume he recorded at Athens was with north winds. Heaviest flights were with cold-front passage, but often large flights were with north winds not associated with a front, especially if several days had passed with no front. Buskirk (1968) watched incoming flights of autumn migrants in Yucatán; migrants arrived daily but large flights only occurred when cold fronts reached the northern waters of the Gulf of Mexico. Able (1972) noted a similar pattern in departing autumnal migrants from Louisiana and Richardson (1978:239) found this to be a pattern typical of migrants departing over water for long flights. Inland, however, large migration flights in the eastern U.S. seem dependent on synoptic conditions (north winds and a drop in temperature) that are usually present with the passage of a cold front but are not unique thereto (Graber and Cochran 1960, Hassler et al. 1963, Able 1973).

During intervals between fronts, the southeastern U.S. experiences southerly air flows but frontal passage brings colder, northerly winds rather abruptly (Able 1972). Observations that flights with north winds are greater than those with south winds suggest that a pool of physiologically prepared migrants accumulates in the presence of southerly winds. Frontal passage brings north winds and these apparently stimulate a large flight of migrants. At a given site, mass movements continue for 2–3 nights and then decline as the numbers of prepared migrants are fewer or as weather conditions become less favorable. These events are repeated every few days during autumn with the passage of fronts (Able 1973, Alerstam et al. 1973, Weir 1976).

Fig. 1 illustrates this sequence. Between 4 and 25 September 1965, no front passed over the WCTV site and during most of the interval a warm high-pressure center dominated the eastern U.S. A warm front went to Hudson Bay and the southerly flow of warm air precluded mass flights; a large pool of migrants was assembled for the next front which reached the WCTV vicinity on 24 September. The front stalled as it neared the tower;

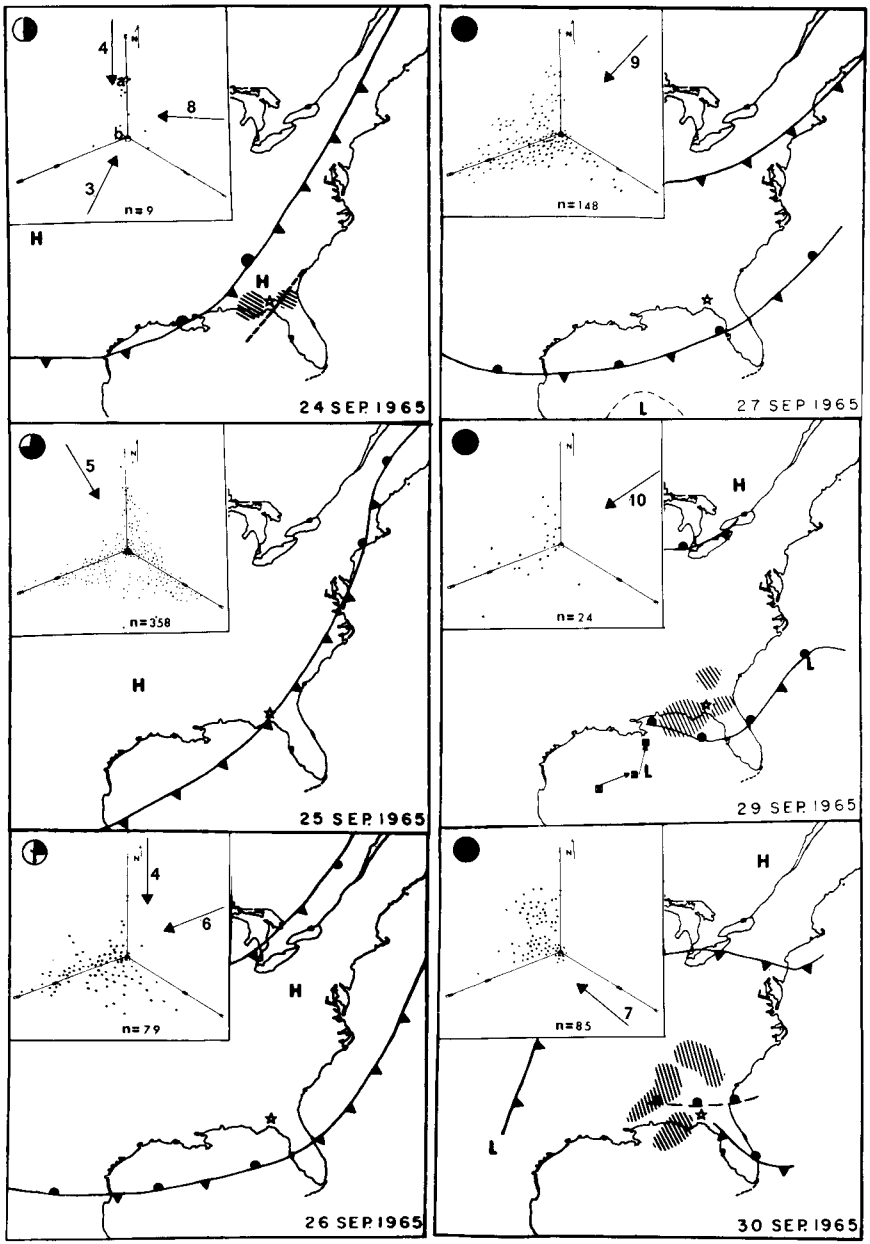

FIG. 1. Surface weather maps (at 01:00) for 24–30 September 1965, and (inserts) WCTV tower maps locating dead birds (dots) and the tower's 3 systems of guy-wires (scale on 24 September map points a–b:116 m). Arrows show predominant winds and speed in knots; partially or completely filled circles indicate amount of overcast; N = number of birds. Rain (hatched areas) is indicated on the weather maps only for the WCTV vicinity (star).

a warm high-pressure center northeast of WCTV and a squall line produced stormy, rainy weather with shifting winds which are conditions possibly not ideal for migration. By 25 September the high-pressure center behind the front moved eastward bringing clearing skies north of the WCTV tower and northwest winds which initiated a mass movement of birds. By 26 September, the center of the high had moved northeast and at WCTV the winds came from the north and northeast. By 27 September, the front was stationary 300 km south of WCTV and northeast winds continued to move birds in large numbers. A low-pressure storm began to develop in the mid-Gulf. No WCTV map is available for 28 September when 32 birds were killed under overcast skies with northeast winds; after 3 days of massed flights, the numbers of birds aloft began to decline. By 29 September, the low-pressure center in the Gulf became Tropical Storm Debbie and tracked towards the mouth of the Mississippi River. The storm created southerly winds and rain along the northeast Gulf coast but at WCTV winds were still northeast into the rain. On 30 September, Debbie went ashore and dissipated; a warm frontogenesis began north of WCTV; rain, overcast and southeast winds prevailed at the tower site. Richardson (1978:261) noted that "reverse flights," with winds contrary to the expected direction of autumn migration, are often associated with the approach of such a low-pressure area as Debbie. Other large kills at WCTV with southerly winds were usually ahead of a front oriented SW–NE, or behind a front with local wind shifts. Lowery and Newman (1966:281) and Able (*in* Bagg 1971:22) noted large autumnal flights with southerly winds under similar circumstances.

The regular association of large kills and cold front passage at WCTV can be attributed to mass movement of birds initiated by the north winds behind the fronts and the presence of cloudy, sometimes stormy weather often along the fronts. Birds encountering these inclemencies on night migration flights may experience north or south winds at the edge and this may account for the lack of significant difference between the night groups C and F (Table 1); they are essentially the same situation.

Apparently clouds are a major factor in tower kills. Weir (1976) and Avery et al. (1978) summarized avian mortality in migration; papers they listed regularly referred to overcast during the kills. Avery et al. (1977), in a thorough study of tower kills in North Dakota, found 70% of their autumn casualties after cloudy nights. Clouds may affect the birds in 2 ways. First, in the southeast U.S. birds generally fly at lower altitudes under overcast (Able 1970); this behavior may simply bring more birds into the range of a tower. Second, the bewildered behavior of birds around lights apparently occurs even without fog or precipitation because light is refracted by a greater number of minute moisture droplets in the air during overcast. Avery et al. (1976) considered Graber's (1968) explanation of the

phenomenon most appropriate: birds enter the illuminated area of a tower and are reluctant to leave; they mill around and many are killed by hitting the tower, guy wires, or other birds. The attraction to the lighted area is limited to the immediate vicinity of the tower; the birds are not drawn from a considerable distance. Herbert (1970) and Gochfeld (1973) discussed this behavior in birds and the effect has been recorded for a variety of lighted situations under overcast (Crawford 1974).

The high percentage of nights with overcast (50.9%) at WCTV may be because of the close proximity of the Gulf of Mexico (76 km S); warm, moist, marine air forms convection clouds and storm systems along cold fronts. If overcast is as important as it seems to the production of tower kills then towers in areas prone to cloudy conditions during migration may kill more birds than towers in areas where clear skies prevail. If the experiences from the WCTV tower are applicable elsewhere, however, birds will be killed nearly every night during autumn migration, even under clear skies. Large kills will be predictable and consistent with migration volume but the smaller day-to-day kills may not be noticed because of the activities of scavenging predators or the condition of the grounds (Crawford 1971, 1974, 1976).

SUMMARY

Autumn bird kills at the 308 m WCTV tower in northwest Florida during 1962–1966 were strongly associated with north winds and overcast. Nights with north winds (N = 313, 74.5% of total) accounted for 6744 (83%) dead birds; south-wind nights (N = 107, 25.5%) had 1379 (17%) birds. Cloudy nights (N = 214, 50.9%) had 6686 (82.3%) birds killed; non-cloudy nights (N = 206, 49.1%) had 1437 (17.7%) dead birds. Large kills were usually associated with the passage of a cold front, but birds were killed on all but 32 (7%) of the nights. The data seem consistent with radar and direct visual studies of migration in the southeastern U.S.

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