The Composition and Seasonal Variation of Bird Losses at a Tall Tower in Southeastern North Dakota

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Introduction

NUMEROUS REPORTS OF BIRD MORTALITY at towers have been published in the past 20 years. The most extensive studies have been those of Stoddard and Norris (1967) and Crawford (1974) near Tallahassee, Florida, and Laskey (1956 – 1969b) and her associates in Nashville, Tennessee. Although the mass mortality of birds at towers is regrettable, it does provide investigators with much otherwise unobtainable information concerning nocturnal migration. Tordoff and Mengel (1956) were the first to make extensive use of this source of data to obtain information on sex, age, weight, molt, and other characteristics of the migrants. Until means are developed to prevent bird losses at towers, it is urged that greater use be made of this otherwise wasted source of study material.

The 366-m transmitting tower of the U.S. Coast Guard's Omega Navigation Station in southeastern North Dakota was completed in September 1971. Because of concern by some conservationists over the possible effects of this structure on birds, particularly waterfowl, migrating through the James River Valley, a study was conducted from September 1971 through November 1973 to record and evaluate the extent of losses and seasonal variation in the composition of the kill at the Omega tower.

Methods

Description of Tower Site

THE OMEGA NAVIGATION STATION is about 1.5 km west of the James River and 3.0 km west of LaMoure. The tower is situated in a marshy area that includes some grassy upland. A complete description of the site and the tower has been published elsewhere (Avery *et al* 1976, 1977).

Sampling Plan

SINCE THE MARSHY NATURE of much of the habitat made it impossible to effectively search the entire area (168 ha) under the extensive transmitting cables and guy wires for dead birds, a sampling plan was devised (Fig. 1). The plan was based in part upon findings of previous studies of mortality at towers which indicated that most dead birds are found within about 60 m of the central structure. Thus, the intensity of the sampling was greatest near the tower. The inner gravel area within 46 m of the tower was examined completely for birds. The three service roads were also included in this stratum (A) because it was felt that these roads, lying under the three sets of supporting guy wires, might receive a disproportionately greater number of dead birds than areas between the sets of guys

Other strata (B, C, and D) were formed by concentric circles with radii of 92 m, 183 m, and 732 m, respectively. Two compass lines, one running north-south and the other east-west, divided these strata into 12 substrata beyond the central area. Two square sampling plots, 12.4 m on a side, were randomly located in each substratum. The 19 sampling plots in wet sites consisted of nylon netting suspended by steel frames 1.5 m high. The center of each net was anchored to the ground, and a wooden railing around the top at the perimeter of each net prevented birds from being blown out. The remaining five sampling plots were gravel surfaces on upland sites.

This initial sampling system was subsequently modified in spring 1972 when it was determined that the sampling intensity in the outermost stratum was not great enough to estimate accurately the kill in that stratum Consequently, the entrance road beyond 183m was incorporated into the sampling plan in

the outermost stratum. Although the road was not located randomly within the stratum, it did not lie directly beneath any of the transmitting cables or guy wires and, therefore, except for possible effects of prevailing winds, it was situated randomly with respect to the falling of dead birds. This modification increased the sampling area from 0.07 to 0.60 per cent in the stratum.

Searches for Dead and Injured Birds

EXCEPT FOR SEVEN DAYS, searches for tower casualties were made at dawn daily during four seasons: March 30 – June 4 and August 8 – November 15, 1972, and April 2 – June 2 and August 12 – November 3, 1973. In addition, searches were made on several days before and after each period of daily searches. Birds not found on sampling areas are included in the overall species list, but are not included in the projected kill estimates derived from the sampling plan (Table 1). In fall 1971, members of the staff of the Northern Prairie Wildlife Research Center conducted searches of the inner gravel area and roads two or three times weekly. These findings are included in Table 1, but no estimate of the total mortality for that season was possible because the sampling system was not in operation until spring 1972

Removal of tower-killed birds by scavengers was assessed each season in 1972 and 1973 by placing tagged, dead birds on the inner gravel area, roads, and some of the 24 sampling sites Usually, birds that were not taken overnight by scavengers were picked up in the morning during the search for tower casualties; however, some were left in place as long as 18 days before being removed by the investigator.

Surveys of Bird Inhabitants

IN ORDER TO DETERMINE the species frequenting the area, records were kept on the number of live birds seen in the marsh and upland within a distance of approximately 10 m

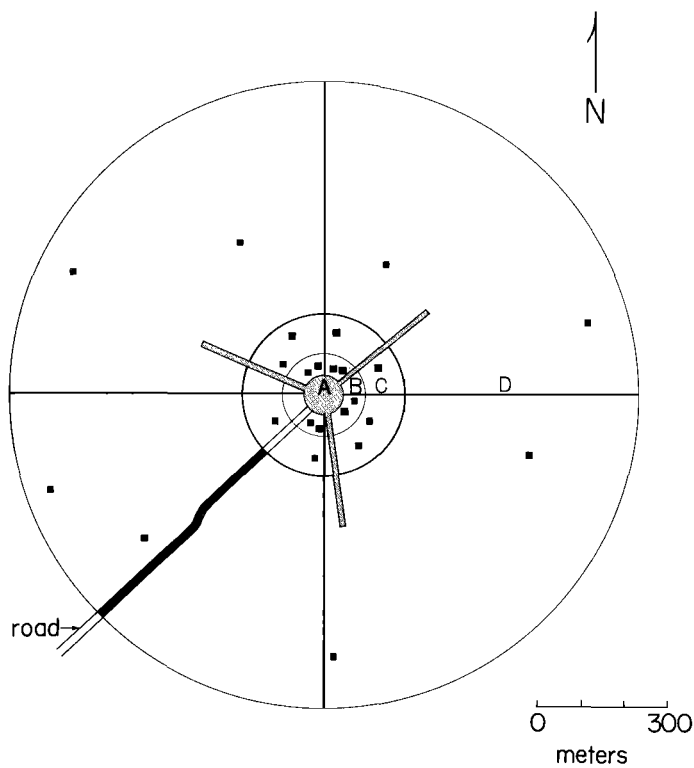

Figure 1 - Omega Navigation Station site showing sampling plan (road and sampling plots not drawn to scale)

on each side of the path of the investigator during his daily searches for tower casualties. In addition, surveys of birds were conducted at least three mornings weekly in the James River Valley along 40 km of roads north and east of the tower site. Habitats surveyed included a semipermanent marsh, a permanent lake, several agricultural fields and pastures, five shelterbelts, and a tract of wooded river bottomland. The surveys were made on foot in one shelterbelt and in the bottomland; the others were made from a car.

Statistical Methods

Seasonal variation in the composition of the losses was analyzed with chi-square tests of independence on the families and on the 26 most frequently killed species. Kendall's Tau (Conover 1971, Ghent 1972) was employed as a measure of rank correlation between the numbers of migrants seen in the field and the losses at the tower in 1972 and 1973. Due to space limitations the tabulation of the statistical test results could not be included fully in this paper, but they are available from the authors upon request.

Nomenclature

Common names of birds correspond with those in the A.O.U. Check-List, 5th edition and supplements.

Results and Discussion

Extent of Losses

From September 1971 through November 1973, 937 birds were found dead or injured at the Omega tower (Table 1). In addition, five Red Bats (*Lasiurus borealis*) were found dead, one in fall 1971 and four in fall 1972. The diversity in the composition of the losses — 102 species, 22 families, 10 orders — is notable in view of the relatively small number of individuals actually collected. The only other published data showing greater numbers of species are two long-term studies. Stoddard and Norris (1967) and Crawford (1974) made daily searches year-round at a TV tower near Tallahassee and collected about 35,000 individuals of 177 species during an 18-year period. Regular monitoring of two TV towers in Nashville produced over 17,000 birds of 110 species in 14 years (Ganier 1962, Laskey 1956-1969b).

Other studies reporting many more individuals but fewer species killed than at the Omega tower either did not include daily searches (e.g., Caldwell and Wallace 1966 — 6505 birds, 92 species) or included only spring or fall searches (e.g., Taylor and Anderson 1973 — 7782 birds, 82 species).

On the basis of the 484 birds found on sampling areas, the estimated kill for 1972 and 1973 averaged about 1075 birds per season (Table 1). The estimated seasonal losses remained fairly constant the first two seasons, but varied more thereafter. The contribution to the total estimated kill from Stratum D (183-732 m from the tower) was considerable in each season and suggests that at the Omega tower, most mortality was caused by guy wires and transmitting cables far from the central structure The estimated mortality must be viewed with caution because the sampling intensity in Stratum D was very low. More intensive sampling in this stratum would have made the estimates more reliable.

Scavengers and Predators

The presence of various scavengers and predators was noted in the vicinity of the tower throughout the study. Raccoons (*Procyon lotor*) were the most common mammalian components, but Red Foxes (*Vulpes vulpes*), Striped Skunks (*Mephitis mephitis*), Mink (*Mustela vison*), and Badgers (*Taxidea taxus*) were also present. Avian members included Red-tailed Hawks, Marsh Hawks, Great Horned Owls, and Short-eared Owls

To assess the impact of these scavengers and predators, a total of 296 test birds were placed out during the four seasons in 1972 and 1973. Test birds were not placed entirely at random; occasionally some were placed selectively where particularly active scavenging was suspected. Thus, losses of test birds during the first night varied with the season from 2.4 per cent in spring 1972 to 17.6 per cent in spring 1973, and averaged 7.4 per cent overall Six of the nine test birds lost during the night in spring 1973 were taken from two gravel sampling plots in Stratum D near an active fox den These birds were placed there specifically to test the possibility that the foxes were searching the two sampling plots regularly in their foraging activity. If these six birds are exclu-

ded, only 3 of 45 (6.7%) test birds were taken during the first night in spring 1973, and the overall average is reduced to 5 5 per cent. On the basis of these findings, we feel that daily searches kept the losses of tower-killed birds to scavengers and predators at a level that did not unduly affect the estimates of total mortality (Table 1).

The effectiveness of the 19 sampling nets in preventing losses to scavengers and predators was demonstrated by the fact that none of the 33 test birds placed in nets during the study were taken during the first night, whereas 12 of the 69 (17 4%) test birds placed on the five gravel sampling plots were taken during the same length of time.

The level of scavenging at the Omega tower was considerably less than that reported from the WCTV tower near Tallahassee (Crawford 1971) where only 10 per cent of the 157 test birds were left undisturbed after one night. Conceivably, tower-killed birds could form a substantial supplement to the diet of a scavenger or predator, especially at a site where mortality is of regular occurrence. Predator control measures may be deemed necessary in some instances if the collection of reliable data is to be assured (Crawford 1974). While it is not possible in many situations, daily monitoring of tower mortality is essential in order to keep the loss of specimens to scavengers and predators at a minimum. In addition, dead birds that are not collected soon after death deteriorate rapidly and are rendered useless in studies of fat content,

Table 1. Bird casualties and estimated mortality at the Omega tower, fall 1971 through fall 1973

Species	*Fall 1971*	*Spring 1972*	*Fall 1972*	*Spring 1973*	*Fall 1973*	*Total*
Eared Grebe			1			1
Western Grebe		2				2
Pied-billed Grebe		1		1	3	5
American Bittern			2	1		3
Mallard	1		1	2		4
Gadwall				1		1
Pintail		1	1			2
Blue-winged Teal	1		1		1	3
Northern Shoveler			1			1
Lesser Scaup		5	2			7
Ruddy Duck			1			1
Marsh Hawk			1			1
Virginia Rail		7	2	1	1	11
Sora	3	14	12	10	7	46
Yellow Rail			1			1
American Coot	1	8	13	1	3	26
Killdeer				1		1
Common Snipe			1	2		3
Pectoral Sandpiper				1		1
American Avocet				1		1
Northern Phalarope					1	1
Mourning Dove			1	1	1	3
Black-billed Cuckoo		1		1		2
Common Flicker				1	1	2
Eastern Kingbird				1	1	2
Yellow-bellied Flycatcher			1			1
Traill's Flycatcher	1		1	2	3	7
Least Flycatcher		1		2		3
Tree Swallow		1				1
Bank Swallow				1		1
Barn Swallow	1				1	2
Brown Creeper		1				1
House Wren	2	6	2	1	2	13
Long-billed Marsh Wren	2	11			1	14
Short-billed Marsh Wren	1	1			1	3
Gray Catbird		1		1	1	3
Brown Thrasher		2				2
Sage Thrasher				1		1
Hermit Thrush			1			1
Swainson's Thrush		4	4	5	2	15
Gray-cheeked Thrush		3	5	1		9
Veery		1	1			2
Golden-crowned Kinglet	1		3		4	8
Ruby-crowned Kinglet		2	3			5
Starling				2		2
Bell's Vireo		1				1
Solitary Vireo	2					2
Red-eyed Vireo	14	1	4	2	10	31
Philadelphia Vireo				1		1
Warbling Vireo	6	1	2	2	1	12
Black-and-white Warbler	1	1	3	1	1	7
Golden-winged Warbler			1			1
Tennessee Warbler	1	2	1	5	3	12
Orange-crowned Warbler	7		9	2	6	24
Yellow Warbler	15	1	19	4	21	60
Magnolia Warbler			1			1
Black-throated Blue Warbler					1	1
Yellow-rumped Warbler	2		13	1	4	20

Table 1 continued. Bird casualties and estimated mortality at the Omega tower, fall 1971 through fall 1973.

Species	*Fall 1971*	*Spring 1972*	*Fall 1972*	*Spring 1973*	*Fall 1973*	*Total*
Black-throated Green Warbler			1			1
Blackburnian Warbler	1				1	2
Bay-breasted Warbler			2			2
Blackpoll Warbler		2	2	1	3	8
Palm Warbler		3	9			12
Ovenbird	5	1	6		2	14
Northern Waterthrush	1	1	2	1	2	7
Mourning Warbler	15		6		5	26
Common Yellowthroat	3	16	8	5	5	37
Wilson's Warbler	10		4		6	20
Canada Warbler	3		1			4
American Redstart		2	2		1	5
Bobolink		3		1		4
Western Meadowlark		2		1	1	4
Yellow-headed Blackbird		7	1	2		10
Red-winged Blackbird	1	1	1	1		4
Orchard Oriole		1	1			2
Northern Oriole	2		1		3	6
Brown-headed Cowbird	1	4	2	1	2	10
Rose-breasted Grosbeak				1	1	2
Common Redpoll	1	2				3
Pine Siskin				1		1
Rufous-sided Towhee		1				1
Lark Bunting		2				2
Savannah Sparrow	8	22	10	6	8	54
Grasshopper Sparrow		21	3	3	1	28
Baird's Sparrow		2				2
Le Conte's Sparrow	2	16	3		3	24
Sharp-tailed Sparrow		1	1			2
Vesper Sparrow	1	3	2		3	9
Dark-eyed Junco		4	4	4	3	15
Tree Sparrow	5	8	7	3	5	28
Chipping Sparrow		4	1		2	7
Clay-colored Sparrow	2	20	7	2	26	57
Harris' Sparrow	4	2	3		3	12
White-crowned Sparrow		1			1	2
White-throated Sparrow	1	3	3	4	3	14
Fox Sparrow			1			1
Lincoln's Sparrow	6	4	4		12	26
Swamp Sparrow	1	1	3		3	8
Song Sparrow	1	4	2	1	1	9
Lapland Longspur	7	5	5	4	6	27
Smith's Longspur	1		1	1	1	4
Chestnut-collared Longspur					1	1
Unidentified	8	6	2	2	4	22
Total (102 species)	152	255	226	105	199	937
Number of birds found on sampling areas — Stratum A(1)[1]	—	131	142	54	110	437
B(16)	—	4	5	1	8	18
C(64)	—	1	5	3	3	12
D(165)	—	5	3	7	2	17
Estimated kill	—	1084	1037	1417	760	4298

[1] Expansion factor for each stratum is given in parentheses.

sex composition, etc. The use of nets such as those described herein, effectively discourages mammalian scavengers, but may be less effective against owls or other avian predators and scavengers.

Seasonal Variation in Kill

THE COMPOSITION OF THE KILL varied considerably by season. Chi-square analysis showed that two families accounted for over half of the overall seasonal variation — warblers (44%) and vireos (11%). These birds were killed predominately in the fall Wrens, icterids, and fringillids, all of which suffered greater spring than fall losses, each accounted for about 8 per cent of the total variation.

Table 2 shows that seasonal variation of losses was highly significant at the species level Of the 26 most frequently killed species, mortality was proportionately higher for 6 in the spring and 8 in the fall. The remaining 12 species displayed no large seasonal differences in mortality, contributing less than 3.0 each to the overall x^2 value. Among the warblers and vireos, only the Common Yellowthroat incurred appreciably greater spring than fall losses, and among the fringillids, only the Lincoln's Sparrow suffered appreciably greater fall than spring losses.

The species in Table 2 that had proportionately greater spring than fall losses were observed commonly in the marsh and upland around the tower during the spring months and are common or locally common breeding birds in the southeastern part of the state (Stewart 1975). Stoddard

Table 2. Seasonal losses, by species, at the Omega tower.

Species[1]	Mortality: Spring	Fall	Total	Contrib. to x^2
	2 seasons	3 seasons		
(S) Sora	24	22	46	3.46
(E) American Coot	9	17	26	0.16
(E) House Wren	7	6	13	1.29
(S) Long-b. Marsh Wren	11	3	14	9.51
(E) Swainson's Thrush	9	6	15	2.94
(F) Red-eyed Vireo	3	28	31	10.86
(E) Warbling Vireo	3	9	12	0.92
(E) Tennessee Warbler	7	5	12	2.00
(F) Orange-c. Warbler	2	22	24	9.21
(F) Yellow Warbler	5	55	60	23.02
(F) Yellow-rumped Warbler	1	19	20	9.47
(E) Palm Warbler	3	9	12	0.92
(F) Ovenbird	1	13	14	5.80
(F) Mourning Warbler	0	26	26	16.26
(S) Common Yellowthroat	21	16	37	5.23
(F) Wilson's Warbler	0	20	20	12.50
(S) Savannah Sparrow	28	26	54	4.09
(S) Grasshopper Sparrow	24	4	28	26.40
(S) Le Conte's Sparrow	16	8	24	8.06
(E) Dark-eyed Junco	8	7	15	1.40
(E) Tree Sparrow	11	17	28	0.01
(E) Clay-colored Sparrow	22	35	57	0.00
(E) Harris' Sparrow	2	10	12	2.41
(E) White-th. Sparrow	7	7	14	0.79
(F) Lincoln's Sparrow	4	22	26	5.85
(E) Lapland Longspur	9	18	27	0.30
	237	430	667	162.86
All other species	115	133	248	6.54
Total[2]	352	563	915	169.40

[1] (S) = greater spring losses, (F) = greater fall losses, (E) = approximately equal spring and fall losses.
[2] Does not include 22 unidentified birds.

and Norris (1967:71) noticed a similar relationship in their study: " . a relatively large spring kill seems more likely to pertain to species that breed abundantly with us . . . than to ones that travel farther north to their breeding ground." It would be interesting to know if this same pattern occurs elsewhere, but no other detailed reports of spring mortality at towers are known to us.

We hypothesize that migrants of locally breeding species are more selective in the spring than in the fall as to where they alight following a night's migration. As they descend in the early hours of the morning, birds whose characteristic nesting habitat resembles the area around the Omega station encounter a greater concentration of guy wires near the tower and suffer greater mortality than do species that breed in other habitats and remain at higher altitudes, not attracted to the marsh and grassy upland surrounding the tower.

Some mortality at the Omega tower may occur at dawn or dusk during local flights by resident birds Depending on the extent of such activity, it, too, might help account for the abundance of locally breeding species in the spring kill. Throughout the study, birds observed flying in daylight hours near the Omega station avoided the guy wires and tower. However, it is conceivable that during times of poor visibility in the breeding season, birds engaging in aerial chases or flight displays occasionally strike guy wires.

THE SPECIES THAT EXHIBITED greater fall mortality (Table 2) were rarely seen in the vicinity of the tower at any time, and most do not breed commonly in the southeastern portion of the state (Stewart 1975). Exceptions were the Red-eyed Vireo (locally common) and Yellow Warbler (common). Of those species not differing greatly in their seasonal losses, only the American Coot and Clay-colored Sparrow were observed regularly at the tower site They were common in 1972 when suitable habitat existed for them, but were seen only infrequently in 1973 when water levels were lower and brushy areas used by the sparrows were destroyed by grazing cows.

Seasonal variation in the species composition of tower kills has been noted by others (e.g., Caldwell and Wallace 1966, Stoddard and Norris 1967) In

Michigan, Caldwell and Wallace found 24 species distributed unequally by season and suggested different spring and fall migration routes as a possible explanation. In our study, this possibility was examined by rank correlations between tower losses and field observations made during the migration seasons of 1972 and 1973. All passerine species seen in the field or killed at the tower were included in the analysis. Many nonpasserine species, particularly waterfowl and shorebirds, were seen by the hundreds in the field but appeared in the kill only rarely. Thus, all nonpasserines were excluded from this analysis because it was known *a priori* that no positive correlation existed.

There was a significant ($p<0.001$) correlation between total field observations and tower losses in the spring but not in the fall. When analyses were made on vireos and warblers combined, and on fringillids, significant ($p<0.005$) correlations were obtained in both spring and fall. These results indicate that the variations in the composition of the kill reflected corresponding seasonal differences in the local abundance of certain groups of passerine migrants. These differences may have been due to different spring and fall migration routes, as suggested by Caldwell and Wallace (1966).

Several exceptions to the relationship between field counts and tower kill were evident. The Yellow and Yellow-rumped Warblers were observed in the field more often in the spring but appeared much more often in the fall kill. Species such as the American Goldfinch and Chestnut-collared Longspur, which generally migrate diurnally, were very abundant in the field but were almost totally absent from the kill. Others, such as the Mourning Warbler and Grasshopper and Lincoln's Sparrows, which are difficult to observe in the field, appeared in the kill in greater relative numbers than they were observed during field surveys.

Previous investigators have reported on the relationship between tower kills and field observations of migrants. Graber (1968) found no correlation between fall field counts and tower kills when all species were considered; however, when comparisons were limited to closely related species (e.g., *Dendroica* warblers), correlations were significant. Weise (1971), using fall mist net data instead of field observations, reported similar results. Our findings are in agreement and indicate that tower kills do provide a reliable index of the relative abundance of certain species of migrants through a given area.

The cause of certain species suffering greater mortality at towers in one season or the other probably involves a combination of factors. In addition to those discussed here, other variables such as weather, different heights of migration in spring and fall (Bellrose and Graber 1963), and interspecific differences in the effects of tower lights on migrants must also be considered.

Summary

BEGINNING IN SEPTEMBER 1971, bird mortality was monitored during five seasons of migration at the 366-m transmitting tower of the U.S. Coast Guard's Omega Navigation Station, LaMoure, North Dakota In summary, the findings were: (1) Throughout the study, 937 birds of 102 species were found dead or injured at the site. Based on a stratified random sampling system, the average estimated seasonal mortality in 1972 and 1973 was about 1075. (2) The composition of the losses varied seasonally — warblers and vireos dominating the fall kills and wrens, icterids and fringillids the spring kills. Birds displaying greater spring than fall losses were primarily species that breed abundantly in southeastern North Dakota. (3) Rank correlation analysis showed that the abundance in the field of vireos and warblers and of fringillids was correlated positively with their occurrence in the tower kill in both spring and fall

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Avian Mortality at Man-Made Structures: An Annotated Bibliography by Michael Avery, Paul F. Springer, and Nancy S. Dailey, contains 853 entries directly concerned with bird losses at man-made structures, primarily taken from U.S. journals and periodicals; *American Birds* being the greatest source of citations (230). These were mostly contained in regional reports and contained number of individuals and species killed during spring and autumn migrations, or migration records obtained from kill incidents with otherwise few details. This is a publication of the Biological Services Program and is available from the office of the Superintendent of Documents, U.S. Government Printing Office.