BIRD MORTALITY AT A GLASSED-IN WALKWAY IN WASHINGTON STATE

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Many studies have dealt with the spectacular bird losses during migration that occur in the eastern United States at airport ceilometers (Spofford 1949, Howell et al. 1954, Johnston 1955, Johnston and Haines 1957), TV towers (Tordoff and Mengel 1956, Brewer and Ellis 1958, Kemper 1958, 1964, Kemper et al. 1966, Stoddard and Norris 1967, Graber 1968, Taylor and Anderson 1973) and tall buildings (Overing 1936, 1937, 1938a, 1938b, Pough 1948). From these have come an increased knowledge of the biology of migratory species and, in certain cases, suggestions leading to a decrease in the number of birds killed (Tordoff and Mengel 1956, Cahalane 1966).

Less consideration has been given to the mortality associated with lower structures whose individual impacts are small but when taken together may equal the destruction from the sources mentioned above. Perhaps most important are structures with large windows, particularly if sky and vegetation can be seen clearly on the opposite side.

The present paper examines mortality associated with a glassed-in walkway on the campus of Washington State University in Pullman, Washington, between 20 May 1968 and 30 June 1974. A partial deterrent to mortality in the form of silhouettes of raptorial birds placed on the windows beginning 15 March 1970 also is discussed.

THE WALKWAY AND SURROUNDING AREA

The city of Pullman is built on hilly topography in the Palouse wheat country of southeastern Washington. The city and campus provide an island of trees within this largely open area.

The walkway is a structure 21.8 m long, 15.3 m high and 3.8 m wide connecting Science and Heald Halls at four levels. Windows enclose the three upper floors but leave a breezeway 3.3 m high at the ground level. Thus, the total area of one side of the structure is about 261 m^2. Of this, 139 m^2 is glass, the remainder being concrete and steel. Interior incandescent lights are spaced along each level but are probably of little consequence to the birds because the lights are usually turned off at all hours and burn only dimly when on.

The walkway and buildings are on a southwest facing slope. The walkway runs approximately east to west with the ground in the immediate vicinity sloping gently to the south. However, about 30 meters to the south the slope drops away sharply and at a similar distance to the north the slope turns up. A portion of the area on either side of

the walkway is planted with trees and shrubs. A bird approaching from the south would see trees and sky through the glass and one from the north would see open sky.

COMPOSITION OF KILL

Over the 73 months of the study 266 birds of 41 species and 15 families were recorded (Table 1). The most common species were Pine Siskin (19.9%), Dark-eyed Junco (7.1%), American Robin (4.9%) and House Sparrow (4.9%). Families most heavily represented were Fringillidae (48.9%), Parulidae (22.6%) and Turdidae (8.3%). Of the latter family only three (1.1% of the total kill) were thrushes of the genus *Catharus*.

These results differ markedly from those obtained in the eastern United States where mortality occurred at ceilometers, TV towers and tall buildings (Table 2). In those studies warblers, and often vireos and catharid thrushes, made up the largest portion of the kill and finches were sparsely represented. Several factors probably contribute to these differences.

One is the distribution of the kills over the 24-hour day. The glassed-in walkway is invisible to birds during both day and night and, thus, resulted in mortality at all hours. Partly for this reason, nocturnal migrants (ex. warblers, vireos, catharid thrushes) form a smaller fraction of the kill and diurnal migrants such as robins, waxwings and cardueline finches contribute a larger portion than in previous studies. The latter taxa made up 4.9%, 3.8% and 32.7%, respectively, of the total kill at the walkway in contrast to earlier studies where their combined presence was in each case less than one percent.

This shift away from an exclusively nocturnal kill is probably accentuated by the effective height of the walkway compared to that of the other agents. Most earlier reports considered structures and lights that reach 500 feet or more into the air and well above surrounding buildings. The walkway, by contrast, is much lower and does not project above the buildings in the vicinity. Because nocturnal migrants generally fly high (Bellrose 1971), the mortality to these species is doubtless reduced. A similar reduction would not be expected for diurnal species because their activities center closer to the ground.

Another factor affecting the relative abundance of the species obtained is the seasonal timing and duration of the studies. Most previous work was limited to the early portion of the fall migratory period or even to a single large kill on one night of that period (Table 2). As pointed out by Stoddard and Norris (1967), finches tend to migrate late and, therefore, probably were underrepresented in these studies. Their own data based upon daily sampling throughout the year at a Florida TV tower give a higher percentage of finches than in all but

Table 1. Mortality at the glassed-in walkway before and after installation of silhouettes of raptorial birds.

SPECIES	20 MAY 1968-15 MARCH 1970		16 MARCH 1970-30 JUNE 1974	
	No. killed	No./year	No. killed	No./year
Mourning Dove	6	3.0	0	0.0
Belted Kingfisher	1	0.5	0	0.0
Common Flicker	0	0.0	1	0.2
Hammond's Flycatcher	1	0.5	0	0.0
Red-breasted Nuthatch	5	2.5	2	0.5
Brown Creeper	0	0.0	1	0.2
House Wren	0	0.0	1	0.2
American Robin	9	4.5	4	1.0
Varied Thrush	1	0.5	4	1.0
Hermit Thrush	0	0.0	1	0.2
Swainson's Thrush	1	0.5	1	0.2
Townsend's Solitaire	1	0.5	0	0.0
Golden-crowned Kinglet	0	0.0	1	0.2
Ruby-crowned Kinglet	1	0.5	0	0.0
Bohemian Waxwing	8	4.0	0	0.0
Cedar Waxwing	1	0.5	1	0.2
Warbling Vireo	0	0.0	2	0.5
Black-and-white Warbler	0	0.0	1	0.2
Orange-crowned Warbler	8	4.0	3	0.8
Nashville Warbler	5	2.5	1	0.2
Yellow Warbler	9	4.5	1	0.2
Yellow-rumped Warbler	3	1.5	3	0.8
Townsend's Warbler	2	1.0	2	0.5
MacGillivray's Warbler	8	4.0	4	1.0
Wilson's Warbler	7	3.5	3	0.8
House Sparrow	8	4.0	5	1.3
Western Tanager	5	2.5	4	1.0
Black-headed Grosbeak	1	0.5	1	0.2
Lazuli Bunting	4	2.0	2	0.5
Evening Grosbeak	6	3.0	2	0.5
Cassin's Finch	1	0.5	0	0.0
House Finch	9	4.5	3	0.8
Pine Siskin	28	14.0	25	6.6
American Goldfinch	0	0.0	4	1.0
Red Crossbill	1	0.5	7	1.8
White-winged Crossbill	1	0.5	0	0.0
Dark-eyed Junco	7	3.5	12	3.0
Chipping Sparrow	3	1.5	1	0.2
White-crowned Sparrow	4	2.0	6	1.5
Fox Sparrow	0	0.0	1	0.2
Lincoln's Sparrow	0	0.0	1	0.2
TOTALS	155	77.5	111	27.7

Table 2. Frequency of occurrence (%) of four avian families in kills. The percent catharid thrushes is given in parentheses where this figure differs from that for the entire family.

Location	Reference	Turdidae	Vireonidae	Parulidae	Fringillidae	Date	Cause of Mortality
Minnesota	1	31.2	10.6	30.1	1.1	10 Sep	TV tower
Wisconsin	1	6.2	32.9	52.0	1.4	10 Sep	TV tower
New York	2	1.0	7.8	86.4	1.0	10 Sep	Tall bldg.
District of Columbia	3	0.1	32.1	61.0	1.5	Aug-Nov	Tall bldg.
Kansas	4	1.8	14.9	53.8	17.4	Sep-Oct	TV tower
Illinois	5	4.9	6.6	69.5	7.8	Fall and spring	TV tower
Illinois	6	25.6	9.7	44.3	6.3	Sep	TV tower
Tennessee	2	1.6	38.7	44.8	0.4	10 Sep	Ceilometer
Georgia	7	14.4	15.4	54.1	7.1	8 Oct	Ceilometer
Florida	8	5.3(5.0)	23.2	43.6	11.6	Jan-Dec	TV tower
Florida	9	0.6	2.7	84.5	1.4	Aug-Dec	TV tower
Washington	10	8.3(1.1)	0.8	22.6	48.9	Jan-Dec	Glassed-in walkway

References cited above:

1. Kemper et al. (1966)
2. Spofford (1949)
3. Overing (1936, 1937, 1938b)
4. Tordoff and Mengel (1956)
5. Brewer and Ellis (1958)
6. Graber (1968)
7. Johnston (1955), Johnston and Haines (1957)
8. Stoddard and Norris (1967)
9. Taylor and Anderson (1973)
10. This study

one previous study. The large proportion of finches obtained in our work is partly a result of inclusion of these late migrants.

Finally, it seems likely that our results reflect, in part, regional differences in occurrence of the various species. For example, warblers and vireos have a lower abundance and diversity in the West than in the East (Chapman 1917, Robbins and Van Velzen 1969) and finches seem to be the reverse with cardueline finches being especially low in the Southeast (Robbins et al. 1966).

SEASONAL VARIATION OF KILL

Examination of the seasonal distribution of the kill (Figure 1) shows that most of the mortality occurred during the annual migratory periods and especially during fall migration. Species largely confined to these periods include most of the warblers and the White-crowned Sparrow. Certain species, however, were associated with other seasons. For example, Bohemian Waxwings, Evening Grosbeaks and Red Crossbills were killed primarily in winter when they sometimes occurred in large flocks in the region. Still others, such as the Lazuli Bunting, House Finch and

Chipping Sparrow, were obtained principally in the summer and may have been drawn from local breeding populations. Mortality at the walkway during summer and winter appears to make up a larger fraction of the total kill than is found during similar periods at TV towers, tall buildings and ceilometers. This is suggested by comparison with data from several studies but especially with those from the Florida TV tower studied extensively by Stoddard and Norris (1967). Mortality at the tower fell below three percent of the total annual kill during each of three summer (May, June, July) and three winter (December, January, February) months, although large numbers of birds probably occurred in the area at both of these seasons. In contrast, mortality at the walkway dropped to this level during only two months and these were both in winter (January, February) when few birds remain in Pullman. The apparent explanation for this difference is, as noted earli-

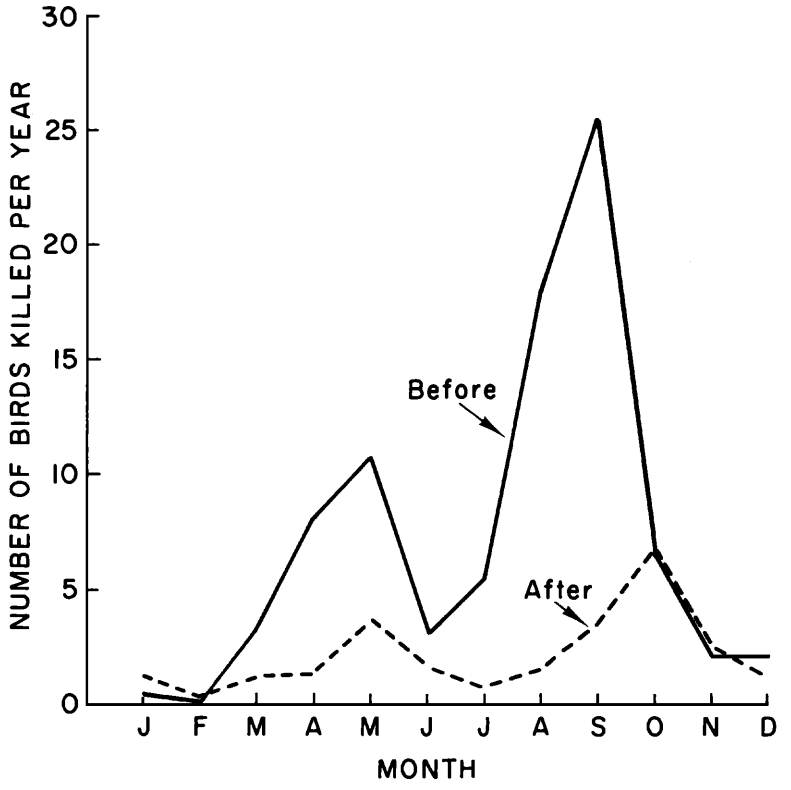

Figure 1. Seasonal variation in mortality at the glassed-in walkway before and after installation of silhouettes of raptorial birds.

er, that birds are killed at the walkway at all hours and thus at all seasons, whereas the other agents cause mortality only at night and thus almost exclusively during migration.

THE SILHOUETTES

On 15 March 1970, about two years after the first birds were collected, lifesize silhouettes of raptorial birds sitting in profile or flying were placed on windows on each level of the walkway. Initially twelve silhouettes were located on each side of the structure but in the four years that followed some were lost and at the end only half the original number remained.

Mortality before and after installation of the silhouettes is given for each species in Table 1 and for each month in Figure 1. The numbers of birds killed per year before and after installation (Table 1) were approximated by dividing the total kill for each period by the nearest whole number of years. The errors introduced by this method are small and biased in the direction of reduced annual mortality in the former period and increased mortality in the latter. Subsequent to placement of the silhouettes total mortality decreased to approximately one-third the former rate. Nearly three-fourths of the species shared in this reduction and every species with a mortality rate of one or more per year in the former period showed a decline after the silhouettes were in place. Only three species, Varied Thrush, American Goldfinch and Red Crossbill, experienced an increase to one or more killed per year. There is little question, then, that the silhouettes were effective deterrents to mortality, but it is uncertain whether the raptorial shape of these figures was important or if the same results would have been obtained using any object of similar size regardless of shape.

Variation in the number of silhouettes during the latter part of the study apparently had little effect upon mortality. From 1970 through 1973, when the number of silhouettes was declining, the annual mortality rate remained nearly constant at 29, 22, 28, and 25 for the respective years.

Figure 1 shows an apparent shift in the peak of fall migration after the silhouettes were installed. It seems likely that most of this difference was due to chance and to annual differences in migration and not to any intrinsic effect of the silhouettes. Pine Siskins, for example, occur in the area in large numbers only sporadically and not in every year, yet they make up over 30% of the total fall (August through October) kill. The chance occurrence of siskin flocks greatly influenced the position of the peaks of migration shown in Figure 1 and omission of data for this species moves the peaks much closer together.

However, some of the difference in timing of migratory peaks may be related to the direct effect of the silhouettes. Warblers, which make

up 32% of the total fall kill, showed an 80% decline in mortality rate after placement of the silhouettes, whereas the overall decrease is only about 64% and the decrease for fringillids is only 51%. Such differences in decline of mortality rates suggest differing sensitivities of the various taxa to the silhouettes between night and day. The disproportionate decline in numbers of warblers killed contributes to the observed shift toward a later peak of migration because warblers migrate earlier than most other species.

SPECIES ACCOUNTS

Several birds obtained at the walkway represent new early or late dates for migration in southeastern Washington and one is the first record at any season for the region. These records are summarized below. Asterisks mark records documented by specimens in Conner Museum.

Southeastern Washington is defined as the entire southeastern corner of the state, an area of about 41,000 km^2, bordered on the north by the Spokane and Columbia rivers, on the west by the Columbia River, on the south by Oregon and on the east by Idaho. This is the same area treated earlier by Hudson and Yocom (1954) and references below to previous records for the region are from this source except when noted.

Hammond's Flycatcher *(Empidonax hammondii).* A female obtained on 16 May 1969 is the earliest known spring record for the region.

Black-and-white Warbler *(Mniotilta varia).* One male obtained on 30 May 1973* (Conner Museum No. 73-215). There are only two previous records for the region (Hudson and Yocom 1954, Biddulph 1967).

Nashville Warbler *(Vermivora ruficapilla).* Heretofore known only as an uncommon spring migrant. Five fall records obtained as follows: 2* and 9* September 1968, 14* and 29 August 1969, 6* September 1971.

Yellow Warbler *(Dendroica petechia).* One on 27 August 1969 is the latest fall record for the region.

Townsend's Warbler *(D. townsendi).* One on 23 September 1968 is the latest fall record for the region.

Macgillivray's Warbler *(Oporornis tolmiei).* Three birds were later than existing fall records: 23* and 24* September 1968 and 28 September 1970.

Wilson's Warbler *(Wilsonia pusilla).* All fall records have previously been from 3 to 15 September. Five birds were obtained on earlier dates: 19 and 20 August 1968; 8, 10* and 25 August 1969.

White-winged Crossbill *(Loxia leucoptera).* A male obtained on 2 January 1970* is the first record for the region (Conner Museum No. 70-29).

Lincoln's Sparrow *(Melospiza lincolnii).* One on 25 May 1970 is only the second spring record for the region.

SUMMARY

Mortality at a glassed-in walkway between two buildings on the campus of Washington State University in Pullman, Washington, was studied

from 20 May 1968 to 30 June 1974. The kill consisted of 266 individuals of 41 species and 15 families. Fringillids were heavily represented (48.9% of kill) and warblers contributed a smaller fraction (22.6%). These results differ from those obtained from kills at ceilometers, TV towers and tall buildings in the eastern United States where warblers usually contribute a larger fraction and finches a much smaller portion. These differences are probably a result of increased diurnal and decreased nocturnal sampling by the walkway. The timing of the study and regional differences in family abundance also may have played a role.

Greatest mortality occurred during the fall and spring migratory periods but significant numbers were killed at other times as well. New early and late dates for migration of several species were obtained. A White-winged Crossbill specimen provided a new species record for southeastern Washington.

Silhouettes of raptorial birds placed on the windows on 15 March 1970 resulted in a decrease in mortality to one-third the previous rate.

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Sketch by Tim Manolis