## Songbird Carcasses Disappear Rapidly from Agricultural Fields

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In field studies of the effects of pesticides on birds, attempts often are made to estimate mortality by searching pesticide-treated areas for dead or moribund animals (Finley 1965, Mills 1973, Flickinger et al. 1980, Bunyan et al. 1981, DeWeese et al. 1983, Overgaard et al. 1983, Balcomb et al. 1984). Similar procedures have been used to study mortality resulting from collisions with motor vehicles and flight obstructions such as television towers (Avery et al. 1980). Body-count estimates of mortality may be biased by scavenging, failure to find carcasses, movement of affected animals outside of study areas, and other factors.

Field researchers cannot continually monitor their study sites. Birds rarely will be found at the onset of paralysis or death after exposure to pesticides. Instead, time is likely to elapse between the death or immobilization of birds and a search. Meanwhile, predators and scavengers can be expected to find and remove a portion of the available prey. I report an attempt to measure the rate of loss of small dead birds from agricultural fields by monitoring carcasses placed to simulate mortality after pesticide application.

I conducted fieldwork in two successive spring plantings (April and May 1981–1982) at the Agricultural Research Center (U.S. Department of Agriculture) in Beltsville, Maryland. This site is a restricted-access preserve that consists of 1,074 ha of agricultural fields and other undeveloped open areas, 340 ha of forest, 499 ha of woodlots (wooded areas ≤40 ha), 2 ponds with a total surface area of 23 ha, and 199 ha in buildings and grounds (V. Miller pers. comm.).

Seventy-eight intact carcasses were placed in corn fields 0–7 days after planting (Table 1). Field surfaces varied in amounts of corn stubble and scattered weeds but were generally clear, and birds were never directly concealed by vegetation or field litter. Twenty-eight birds were monitored in 3 trials in 1981, and 50 birds in 4 trials in 1982. Birds were banded for identification, and the distal wing tips and tail feathers were squared off with scissors to provide a means for identifying feather remains for birds that were eaten. All birds were placed between 0530 and 0630 EST and were revisited at 24-h intervals until carcasses disappeared or for at least 5 days. In trials 6 and 7 in 1982, sites were visited twice during the first 24 h after placement (sunset and sunrise) to determine diurnal and nocturnal disappearance rates.

I used 23 roughly rectangular corn fields (1.7–13.2 ha) as placement sites. Some fields were used twice each year. One to 3 birds were placed randomly in each field, and their locations were marked with small (15 cm) metal stakes and noted on the field map. Carcass density (birds/ha) in corn fields was 0.27 (SD = 0.14) in 1981 and 0.23 (SD = 0.13) in 1982.

Fresh predator or scavenger butcher sites of small birds, mainly passerines, consisting of various amounts of feathers and body parts, are found frequently in some newly planted and insecticide-treated corn fields (Balcomb 1983, Balcomb et al. 1984).

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TABLE 1. Description of field trials.

| Year | Trial no. | Start date | No. of fields | Mean field size[a] (SD) | No. of birds | Species (no. of birds) |
|---|---|---|---|---|---|---|
| 1981 | 1 | 26 April | 4 | 7.1 (2.0) | 8 | *Melospiza melodia* (3)[b] *Passer domesticus* (5)[b] |
| | 2 | 28 April | 4 | 5.6 (1.6) | 8 | *P. domesticus*[b] |
| | 3 | 5 May | 9 | 6.2 (2.7) | 12 | *Agelaius phoeniceus*[c] |
| 1982 | 4 | 14 April | 9 | 6.7 (3.0) | 12 | *A. phoeniceus*[d] |
| | 5 | 25 April | 9 | 6.5 (2.6) | 13 | *A. phoeniceus*[d] |
| | 6 | 12 May | 10 | 6.8 (2.5) | 13 | *A. phoeniceus* (7)[d] *Quiscalus quiscula* (6)[b] |
| | 7 | 25 May | 10 | 6.8 (4.0) | 12 | *A. phoeniceus* (4)[d] *Q. quiscula* (8)[b] |

[a] Hectares.
[b] Males and females.
[c] Females only.
[d] Males only.

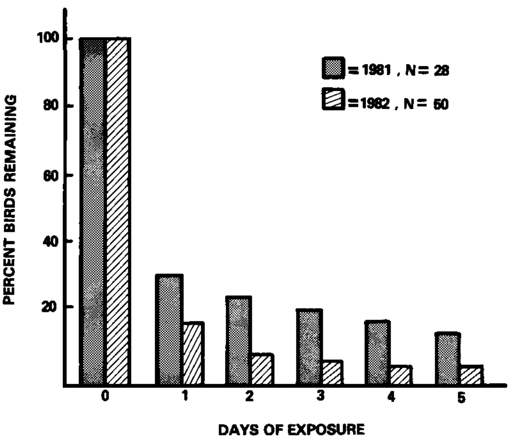


Fig. 1. Disappearance of songbird carcasses from Maryland corn fields, April and May 1981-1982.

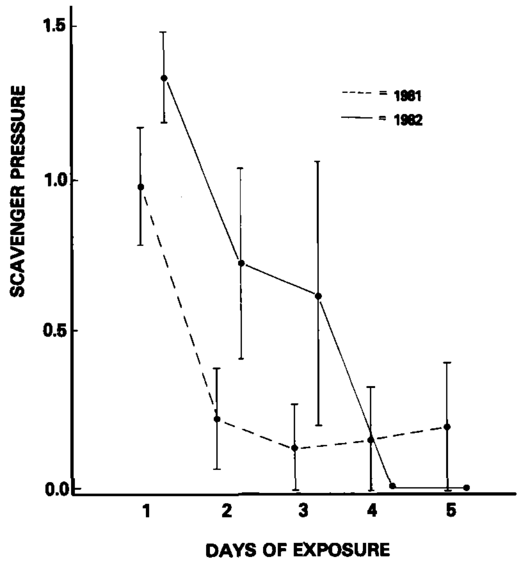


Fig. 2. Scavenger pressure (SP) over a 5-day exposure period. SP values ($\lambda_i$) are shown with their standard errors and are based on pooled results of 1981 ($n$ = 28) and 1982 ($n$ = 50).

Bird remains found in this study were characterized after carcass removal (or after 5 days exposure) as (1) removed with no apparent trace, (2) less than 10 feathers remaining, (3) 10 or more feathers remaining or fewer than 10 feathers plus body tissue or limbs, or (4) slightly eaten or intact. Category 3 was established to identify sites that might suggest to an observer that a mortality had occurred. I was particularly interested in the proportion of carcasses removed with no trace, as this would be a major source of error in estimates of the extent of bird mortality that are based on field-found carcasses and butcher sites.

The time to carcass disappearance may be viewed as a survival period. Survival times, therefore, were analyzed as survival curves using the BMDP-77 Life Table computer program (Brown 1977). This program tests the equality of survival distributions for experimental groups (Mantel 1966, Breslow 1970). The tests are analogues of nonparametric rank tests (Brown 1977). Differences in carcass survival were tested between trials within years and between years (with trials within years pooled). In addition, the program

TABLE 2. Results of carcass disappearance trials. Trials 1-3 were run in 1981 and 4-7 in 1982.

| Trial no. | No. of carcasses monitored | No. remaining at daily checks after placement: Day 1 | Day 2 | Day 3 | Day 4 | Day 5 |
|---|---|---|---|---|---|---|
| 1 | 8 | 3 (37.5%) | 2 (25%) | 2 | 1 (12.5%) | 0 |
| 2 | 8 | 3 (37.5%) | 3 | 2 (25%) | 2 | 2 |
| 3 | 12 | 3 (25%) | 0 | 0 | 0 | 0 |
| 4 | 12 | 3 (25%) | 2 (16.7%) | 2 | 2 | 2 |
| 5 | 13 | 1 (7.7%) | 1 | 0 | 0 | 0 |
| 6 | 13 | 4 (30.8%) | 2 (15.4%) | 2 | 1 (7.7%) | 1 |
| 7 | 12 | 1 (8.3%) | 1 | 1 | 1 | 1 |
| Total | 78 | 18 (23.1%) | 11 (14.1%) | 9 (11.5%) | 7 (9.0%) | 6 (7.7%) |

TABLE 3. Results of BMDP (Brown 1977) statistical comparisons of carcass survival curves within and between years.

| Comparison | Breslow test | df | $P$ | Mantel test | df | $P$ |
|---|---|---|---|---|---|---|
| 1981 (between trials, $n = 3$) | 0.42 | 2 | 0.81 | 0.72 | 2 | 0.70 |
| 1982 (between trials, $n = 4$) | 3.06 | 3 | 0.38 | 1.76 | 3 | 0.62 |
| 1981 vs. 1982 | 2.66 | 1 | 0.10 | 3.76 | 1 | 0.05 |

calculates a hazard function "also called the failure rate, instantaneous death rate or force of mortality" (Brown 1977). In the context of this study, this function is the instantaneous carcass removal rate or scavenger pressure (SP). I used the SP function to analyze the uniformity of carcass loss rates over the 5-day monitoring periods. This function is calculated at the midpoint of each interval (i.e. day in my analysis) of the life table by the formula:

$$\lambda_i = 2q_i/h_i(1 + p_i),$$

with an approximate standard error of

$$SE(\lambda_i) \simeq \lambda_i[1 - (h_i\lambda_i/2)^2/r_iq_i]^{1/2},$$

where $q_i$ (the number removed divided by the number exposed in each interval) is the probability of a carcass disappearing in the ith interval, $p_i$ is the probability of surviving the ith interval (calculated as $1 - q_i$), $h_i$ is the width of the time interval, and $r_i$ is the number of birds exposed during the interval (also see Gross and Clark 1975).

The initial disappearance of songbird carcasses was rapid (Fig. 1). In the 7 trials, losses 24 h after placement ranged from 62 to 92%; the mean loss at 24 h was 75% (SD = 12.4) (Table 2). In trial 3, all birds were gone 48 h after placement, and in trial 5 all birds had disappeared by 72 h. Overall, by the end of the 5-day monitoring period, 72 of 78 carcasses (92.3%) had been removed by scavengers. Mean survival time was 1.6 (SD = 1.9) days in 1981 and 0.9 (SD = 1.1) days in 1982.

The rate of carcass disappearance, as indicated by the scavenger-pressure function, was not uniform during the 5-day exposure period (Fig. 2). Carcass losses were markedly greater during the first 24-h period (1981: SP = 1.03; 1982: SP = 1.39) than on subsequent days (Fig. 2).

In trials 6 and 7 birds were monitored just before sunset and just after sunrise during the first day of exposure to determine differences in diurnal and nocturnal losses. In trial 6, 38% (5/13) of the birds were gone at sunset and 4 of the remaining 8 (50%) had disappeared by sunrise. For trial 7, 67% (8/12) were gone at sunset with 3 of the 4 (75%) remaining missing at sunrise. In pooled trials 6 and 7, 52% (13/25) had disappeared by sunset and 58% (7/12) of those remaining were gone at sunrise; this difference was not statistically significant ($\chi^2 = 1.00$, df = 1, $0.3 < P < 0.4$). These data suggest that diurnal and nocturnal scavenging at the study site was of similar intensity. Scavenger pressures (±SE) calculated for day and night removal likewise did not indicate significant differences (trial 6: SP day = 1.0 ± 0.31, SP night = 0.67 ± 0.31; trial 7: SP day = 1.0 ± 0.31, SP night = 1.2 ± 0.55; trials 6 and 7 pooled: SP day = 0.70 ± 0.18, SP night = 0.82 ± 0.28).

Evaluation of all residual evidence indicated that the majority of birds were scavenged without leaving readily observable remains. Over the 7 trials, a mean of 58.2% (SD = 20.6) were removed without a trace, 27.3% (SD = 20.7) showed remains of 10 feathers or more, and 8.2% (SD = 9.6) were untouched or were only slightly eaten. Most (15/21) of those carcass sites categorized as having more than 10 feathers (or <10 feathers plus body parts) consisted of extensive "feather piles" that indicated clear scavenger or predator activity. Searches following carcass disappearance showed that feathers and other body parts were always found within approximately 5 m of the original placement sites; in no instance were there indications that carcasses were moved to other locations in the fields. Rather, they appeared to be removed entirely from the general field area when they were not consumed at the placement site.

Carcass loss rates (scavenging pressure; Fig. 2) were greatest during the first 24 h of exposure, and most birds disappeared during this interval (Table 2). This pattern might occur if scavengers maintained regular hunting territories or search routes that covered most of the field areas studied. Carcasses located outside of predator/scavenger territories probably disappear at slower rates than those within.

I found that carcass survival was not different between successive trials within years, suggesting that scavenger pressure was relatively uniform during the spring monitoring period (Table 3). The rates of disappearance were different between years. The larger size and greater color contrast (with soil colors) of the birds used in 1982 (Table 1) may have made them more conspicuous. This would account for their more rapid disappearance, but these factors were not compared simultaneously in the trials and, hence, the hypothesis cannot be tested. Alternatively, there may have been more scavengers present in 1982.

Clearly, songbird carcasses may disappear rapidly from agricultural fields at the time of spring planting. Other studies have reported both faster (Crawford 1971) and much slower (Fowle 1965) removal rates in other habitats than I found in corn fields. Quantitative studies of avian mortality that depend on recovery of dead birds should monitor scavenger activity. Searches should follow immediately mortality events if a large proportion of the affected birds are to be detected.

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## Changes in Plasma Prolactin Associated With Laying and Hatch in the Spotted Sandpiper

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Among captive galliform and anseriform birds, plasma prolactin (Prl) levels tend to rise during laying, peak during incubation, and decline rapidly at hatch (Etches et al. 1979, Burke and Dennison 1980, Bedrak et al. 1981, Dittami 1981, Lea et al. 1981, Proudman and Opel 1981, Goldsmith 1982, Hall and Goldsmith 1983, Wentworth et al. 1983). While the role of Prl as a regulator of avian incubation has been discussed widely, it is not clear whether Prl induces incubation, incubation behavior causes a rise in Prl, both, or neither (reviewed in Goldsmith 1983). In Spotted Sandpipers (*Actitis macularia*), where incubation is biparental but males perform the greater share, Prl levels increase significantly in both sexes