Bird Damage to Sunflower in North Dakota, South Dakota, and Minnesota, 1979–1981

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Abstract

Sunflower-growing areas in North Dakota, South Dakota, and Minnesota were surveyed for bird damage from 1979 through 1981. Individual fields were sampled each year, and bird damage on sample sunflower heads was estimated using a gridded, plastic template. The average bird loss estimates in 1979 and 1980, respectively, were 0.8% (n = 933 fields) and 2.0% (n = 555 fields). In 1979, average damage levels were similar among the three major ecological regions in the three-State survey area. In 1980, however, the average level of bird damage within the combined Drift Plains and Missouri Coteau strata was about 4 times more than the average level elsewhere. Although the overall value of bird damage was estimated at $5.1 million in 1979 and $7.9 million in 1980, only 2.2% of the 1,488 fields surveyed had losses >10%. In 1981, bird damage was more intensively evaluated in 199 fields in four high-damage counties. The estimated overall loss in the four-county area was about $600,000, but only eight (4.0%) fields had losses >10%. Although the percentages of bird damage found during the 3 years of study were similar to those found in 1972 and 1978, the overall seed tonnage loss was greater, probably because of the large increases in sunflower acreage and a corresponding increase in blackbird feeding. Differential shrinkage of damaged versus undamaged portions of heads and possible growth compensation by damaged heads could have biased the survey results, but these could not be quantified.

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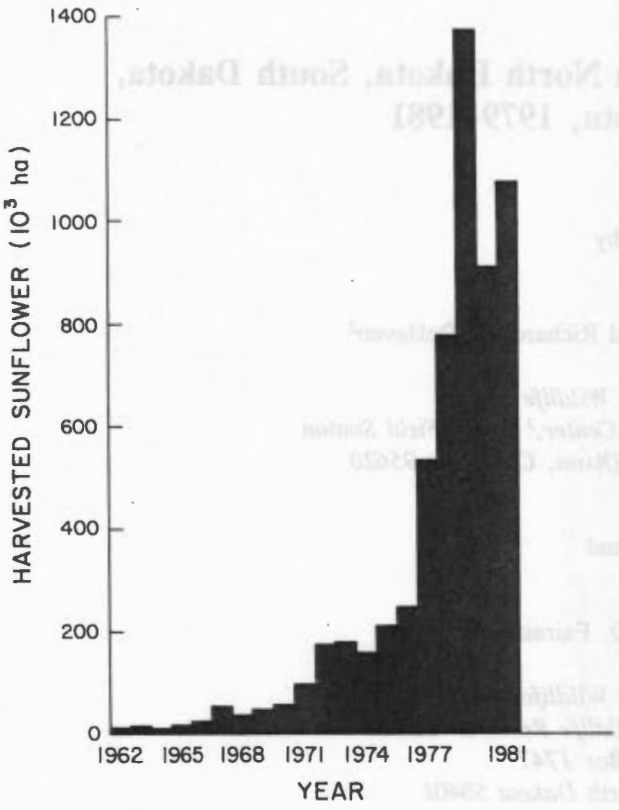

Fig. 1. Harvested sunflower (ha) in North Dakota, 1962–81 (Lilleboe 1979; Crop Reporting Board 1981; North Dakota Crop and Livestock Reporting Service 1983).

The area of cultivated sunflower (*Helianthus annuus*) has expanded greatly in the United States over the last two decades. In North Dakota, the Nation's leading producer of sunflower, the peak harvested area of 773,000 ha in 1978 was about 70 times greater than its average annual harvest during 1962–66 (Fig. 1). The actual tonnage production of sunflower seed in North Dakota increased even more dramatically—by about 110 times—from an annual average of 10,400 t in 1962–66 to 1.1 million t in 1978. The combined area of sunflower harvested in the three most important sunflower-producing States, North Dakota, South Dakota, and Minnesota, peaked in 1979 at 2.16 million ha, a 93% increase from 1978.

One problem faced by sunflower growers in North Dakota, South Dakota, and Minnesota is damage to the ripening seeds by red-winged blackbirds, *Agelaius phoeniceus*, common grackles, *Quiscalus quiscula*, and yellow-headed blackbirds, *Xanthocephalus xanthocephalus* (Besser 1978). The Fish and Wildlife Service (FWS) responded to the problem by initiating a comprehensive research program.

An initial objective of the research by FWS was to determine the extent and severity of blackbird damage to sunflower. In 1972, 11 counties in North Dakota and 7 in Minnesota, representing the areas with most sunflower acreage, were surveyed for bird damage; the overall damage level was about 1.2% (Stone 1973). A subsequent survey conducted during 1978 in 365 fields in 25 North Dakota counties also revealed a 1.2% damage level (Besser and DeHaven, unpublished report). Finally, to better define the areawide distribution and year-to-year variations in bird damage in North Dakota, South Dakota, and Minnesota, an intensive 3-year damage survey was conducted during 1979–81; we report the results here.

In 1979 and 1980, the primary objective was to estimate the overall level of bird damage in each of the three States. To achieve this, a large number of sunflower fields were sampled using relatively small within-field sample sizes, and thus the resulting estimates of bird damage for individual fields were relatively imprecise. A different sampling strategy was used in 1981 to determine how losses are distributed over an area; such knowledge is more important than an average loss figure when considering the cost-effectiveness of potential damage control techniques. Much more intensive within-field sampling was carried out in four counties in which consistently high levels of bird damage had been recorded earlier.

A secondary objective of the 3-year survey was to determine whether bird damage levels within and among sampled fields were associated with selected physical features of the sunflower plants and the fields, or with proximity of the field to selected habitat types. The methods used and the subsequent results of this aspect of the 3-year study are reported in Part II, "Influence of Environmental Factors on Blackbird Damage to Sunflower."

Methods

Survey Area

In 1979, bird damage was assessed in 52 of the 53 counties in North Dakota, 23 counties in northwestern Minnesota, and 26 counties in northeastern South Dakota (Fig. 2). These counties contained 99.9% of the area planted to sunflower in North Dakota, 86.2% in South Dakota, and 93.1% in Minnesota.

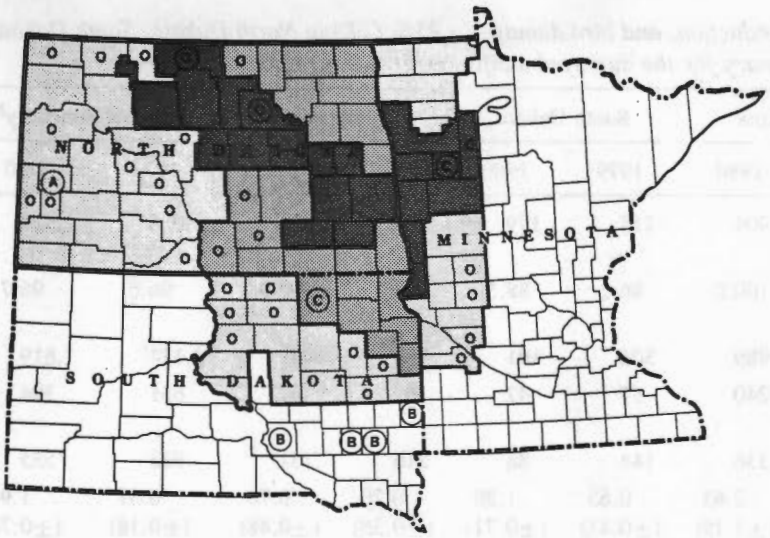

Fig. 2. Counties in North Dakota, South Dakota, and Minnesota sampled during surveys of blackbird damage to sunflower during 1979–81. In 1979, all counties within the outermost solid black line, except for Billings County, North Dakota (A), were surveyed. Also surveyed, but only in 1979, were four counties (B) in South Dakota outside the solid line. In 1980, all counties within the solid black lines were included in one of three damage level strata (distinguished by three intensities of shading). Sampling in 1980 was random, without regard to county boundaries, thus some counties (O) did not contain any sample fields. In 1981, only four counties (C) were surveyed for bird damage.

In 1980, the area sampled included all 53 North Dakota counties, the same 23 counties sampled in Minnesota in 1979, and 22 of the 26 counties sampled in South Dakota in 1979 (Fig. 2). Although fewer counties in South Dakota were surveyed, primarily because of a reduction in available manpower, the percentage of the total available sunflower that was sampled for this State actually increased slightly to 88.5% (Table 1). Virtually all of the area planted to sunflower in North Dakota was surveyed in 1980, while 92.9% of the sunflower area in Minnesota was included.

In 1981, the following areas were sampled: (1) Benson County, North Dakota, (2) Mahnomen County, Minnesota, (3) the eastern two-thirds of Bottineau County, North Dakota (i.e., east of County Road FAS 0517, which passes through Maxbass), and (4) the north-central portion of Brown County, South Dakota, generally northeast of Aberdeen (east of Highway 281, north of Highway 12, and west of Highway 37).

Sampling Design

Survey procedures varied during the 3 years. In 1979, sunflower fields were selected for sampling according to a stratified random design, with each county serving as a stratum. Each county was sampled in proportion to its estimated area planted to sunflower, based on State Crop and Livestock Reporting Service (CLRS) records. First, within each county, the allocated samples were assigned to randomly chosen sections (1.61 km^2) containing sunflower. Within each section, the first sunflower field encountered as the assessor traversed the section perimeter, or the first field observed upon entering the section, became the sample field. Sampling rates were about one field for each 2,500 ha planted in counties in North Dakota and Minnesota and one field for each 1,400 ha in South Dakota counties. However, at least two fields were sampled in each county, regardless of its sunflower acreage. In all, 573 fields were sampled in North Dakota, 216 in Minnesota, and 144 in South Dakota. One 0.6-ha block (76.2 × 76.2 m) of sunflower was randomly chosen in each randomly selected field. Within each block, four subsamples were randomly chosen, each consisting of a group of 5 consecutive, harvestable sunflower heads within one row; that is, 20 sunflower heads per field.

In 1980, the three-State area was stratified into areas of low, medium, and high expected bird damage, on the basis of the results of the 1979 survey (Fig. 2). To achieve the greatest overall sampling efficiency, the number of fields sampled within each stratum was determined using the strata sizes (estimated area planted to sunflower) and estimated variances from the 1979 data (Mendenhall et al. 1971). Because variance tends to increase as loss increases, more samples (fields) were included as the estimated stratum damage increased. Within each stratum, fields were selected for sampling completely at random, without regard for county boundaries. As a result, only 69 (70%) of the counties included within the strata boundaries actually contained sample fields. For each county that was to contain one or more sample fields, a number of random sections, generally about 2–3 times more than the number of fields desired, were chosen and marked on a county map. This map was then sent to the county's

Table 1. *Estimated sunflower acreage, production, and bird damage (±95% C.I.) in North Dakota, South Dakota, and Minnesota, and a summary for the surveyed sunflower-growing region, 1979–80.*

	North Dakota		South Dakota		Minnesota		Regional summary[b]	
Category[a]	1979	1980	1979	1980	1979	1980	1979	1980
Sunflower (10^3 ha) in survey area	1,366	904	215	179	507	335	2,088	1,418
Available sunflower area surveyed (%)	99.9	100.0	86.2	88.5	93.1	92.9	96.6	96.7
Total production (10^3 t)	2,078	989	306	191	789	439	3,174[c]	1,619
Total value of harvested sunflower ($\$10^6$)[d]	407	240	57	47	167	107	631	394
No. of fields surveyed	573	336	144	88	216	131	933	555
Average (%) damage per seed head	0.87 (±0.23)	2.65 (±1.19)	0.63 (±0.41)	1.30 (±0.71)	0.70 (±0.35)	0.70 (±0.48)	0.81 (±0.18)	1.96 (±0.74)
Total bird damage (10^3 t)	18.3 (±4.8)	26.9 (±11.9)	1.9 (±1.3)	2.5 (±1.4)	5.6 (±2.8)	3.1 (±2.1)	25.8 (±5.7)	32.4[c] (±12.1)
Average bird damage (kg/ha)	13.4	29.8	9.1	14.0	10.9	9.2	12.3	22.8
Total value of bird damage ($\$10^6$)	3.6 (±0.9)	6.5 (±2.9)	0.4 (±0.2)	0.6 (±0.3)	1.2 (±0.6)	0.8 (±0.5)	5.1 (±1.1)	7.9 (±2.9)
Average value of bird damage ($/ha)	2.63	7.22	1.68	3.43	2.32	2.26	2.44	5.57

[a] Data pertain to surveyed area only; not extrapolated for areas not surveyed (Minnesota Agricultural Statistics Service 1981, 1982; South Dakota Crop and Livestock Reporting Service 1981–83; North Dakota Crop and Livestock Reporting Service 1981–83).
[b] Summary for sunflower-growing region, ignoring State boundaries.
[c] Rounding error.
[d] Based on data from Crop Reporting Board (1980, 1983).

Agricultural Stabilization and Conservation Service (ASCS) office for determining the marked sections that actually contained sunflower in 1980. For each section containing sunflower, the ASCS provided a photocopy of an aerial photograph of the section, with the boundaries of the sunflower fields delineated. From the fields delineated on the photographs, the number needed for sampling was randomly chosen. The sampling rate in 1980 was about one field for each 2,560 ha, which resulted in 336 sample fields in North Dakota, 131 in Minnesota, and 88 in South Dakota. Within each selected sunflower field, two randomly selected 0.6-ha blocks (76.2 × 76.2 m) were chosen. As in 1979, within each block four subsamples of five heads each were chosen. Forty heads per field were thus examined.

In 1981, 50 sample fields were randomly chosen from within each of the four surveyed counties using cluster sampling procedures (Mendenhall et al. 1971). Sampling frames of sunflower fields (based on records of 1981 grower planting intentions) were provided by county ASCS offices, and the overall sampling rate was one field for each 410 ha of sunflower. The location of 50 subsamples within each field was determined by using a systematic–random design. First, each field was divided into four sections, each containing an equal number of rows. One row was then selected at random from the first section; the row in the same relative position within each of the other three field sections was also identified. The total length of the four selected rows was then divided by 50 to derive a uniform subsampling interval (i.e., distance, in paces, between the first heads of consecutive subsamples). The location of the first subsample was always selected from the first sample row, a random distance in paces between the field edge and the subsample interval. The remaining 49 subsamples were then located at uniform intervals. Each subsample comprised 5 consecutive harvestable heads along the row, resulting in a total of 250 heads examined per field.

Measuring Damage to Sunflower Heads

Sample sunflower fields were surveyed for bird damage as near the time of harvest as possible. To accomplish this, the average maturity of fields was determined during early September to estimate their probable harvest periods. Then, to monitor the status of the sample fields as the predicted harvest periods approached, the areas were checked, and individual growers were questioned. When a sample field was found to be much less mature than the average field in an area, its assessment, whenever possible, was delayed. Sample fields were assessed for bird damage on 24 September–15 October 1979; 17 September–16 November 1980; and 13 September–3 November 1981.

First, two measurements were made with a measuring tape on each assessed sunflower head: (1) the average (from two perpendicular measurements) diameter of the seed surface of the head, and (2) the average (from two perpendicular measurements) diameter of any undeveloped (without filled achenes) center portion of the head. From these measurements, the surface area of harvestable seed available before any damage occurred was calculated. Next, the area (in square centimeters) of seed missing from the head because of either bird or wind damage was also estimated, using a gridded, clear plastic template (Dolbeer 1975). If any indicators of bird damage were present, such as seed hulls in the head bowl or on the ground, torn bracts, or bird droppings, then the loss of all the seed from that particular head was attributed to birds, even if part of the damage appeared to be caused by wind.

Estimating Sunflower Crop Loss

For 1979, the percentage of seed lost to birds on each subsample of five heads was determined by dividing the total area (in square centimeters) of bird damage by the total area of harvestable seed potentially available for the five heads. The percentage loss for each 0.6-ha block was then estimated by averaging its four subsample percentage loss estimates. From the losses for blocks, the estimated losses and associated variances for each county and State were then calculated following procedures for stratified random sampling (Mendenhall et al. 1971).

For 1980, the percentage losses for each of the two 0.6-ha blocks were determined in the same way as for 1979; the two values for each field were then averaged to estimate that field's loss. From the field losses, the stratum and State losses were calculated as in 1979.

For 1981, percentage loss estimates for the five-head subsamples were determined as in 1979 and 1980. The 50 resulting subsample values per field were then averaged to estimate the field losses. The average field losses, weighted by field size (in hectares), were then used to calculate percentage losses and their associated variances for each of the four counties.

Results and Discussion

Bird Damage—1979

In 1979, 2,161,000 ha of sunflowers, worth about $631 million, were harvested in the three-State survey area (Fig. 3). Bird damage was recorded in 94 of the 101 counties, but overall loss was >5% in only three: Mahnomen, Minnesota—5.1%; Moody, South Dakota—5.1%; and Emmons, North Dakota—5.6%. The overall percentage loss for the survey area was 0.81%. This loss is equivalent to 25,800 t, worth about $5.1 million, or about $2.45/harvested ha (Table 1). Because it had by far the greatest production, North Dakota also had the greatest estimated dollar loss—about $3.6 million, or $2.63/ha.

Although sampling effort in individual fields was minimal, the estimated losses for the sampled blocks may provide a general indication of the range of bird damage that occurred among fields; 83.3% of the blocks had <1.0% damage, 15.2% had between 1.0% and 10.0%, and 1.5% received >10.0% bird damage. The average estimated bird loss exceeded $5.00/harvested ha in only 11 counties (Table 2).

Bird Damage—1980

The estimated percentage loss to birds for the three-State area in 1980 was 1.96% (Table 1), an increase of 142% over 1979. However, the estimated absolute loss and dollar loss from birds in 1980 were only about 26% and 55% greater than the respective estimates for 1979, because of changes in production and seed value. Total sunflower production in the survey area decreased by 49% from 1979 to 1980, attributable to declines of 32% in the area of harvested sunflower and 25% in the average yield. Partially offsetting this decline in production was a 23% increase in the average value of the seed in 1980. The net result was that the sunflower harvested in the survey area in 1980 was valued at $399 million, a reduction of about 37% from 1979.

Initially we thought that the increased level of bird damage may have been related to the extended length of the 1980 survey, because the final assessment was not completed until about a month later than in 1979. However, during both years more than 90% of the fields were

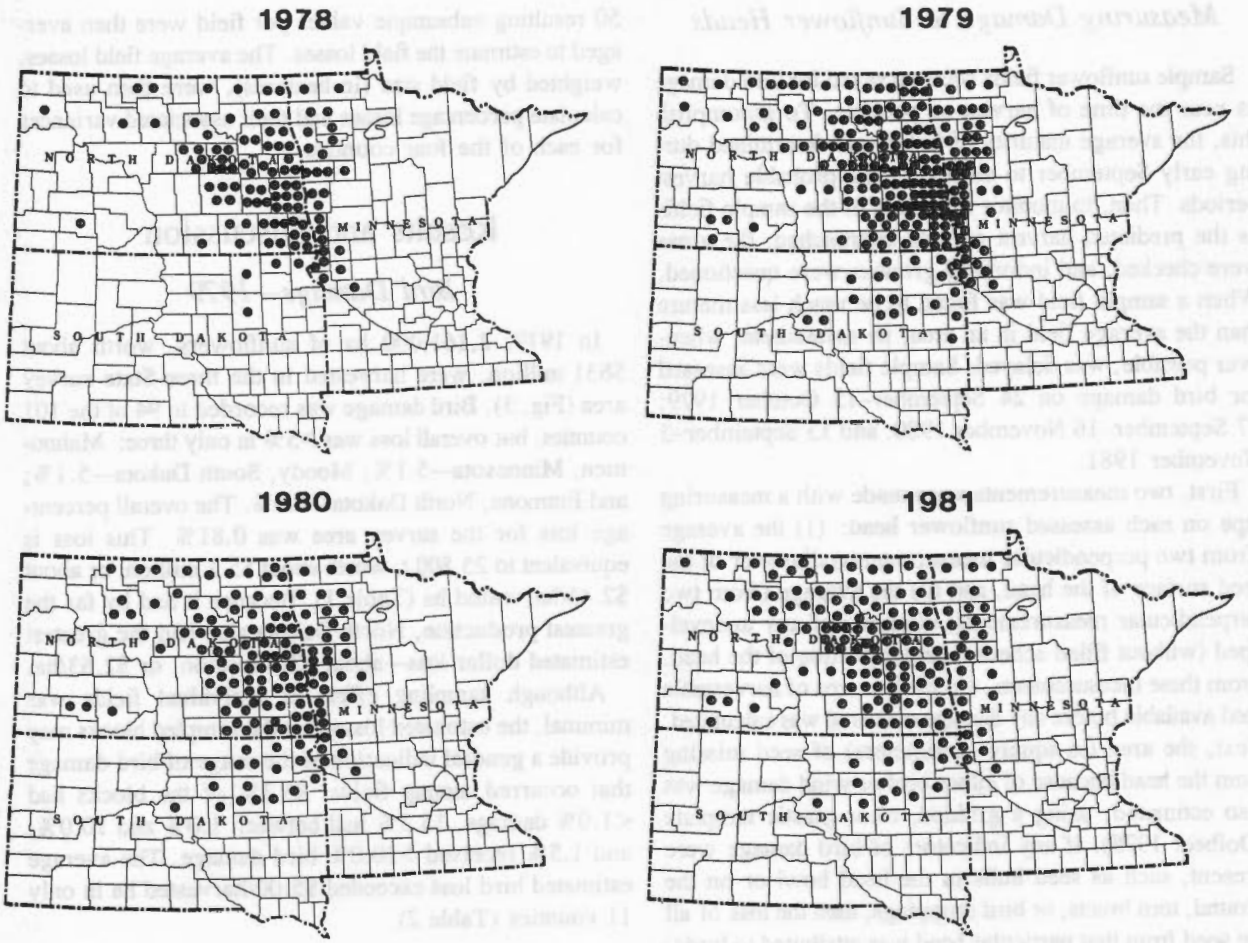

Fig. 3. Approximate harvested sunflower (● = 10,000 ha) per county in North Dakota, South Dakota, and Minnesota, 1978–81 (Minnesota Agricultural Statistics Service 1981, 1982; North Dakota Crop and Livestock Reporting Service 1981, 1982, 1983; South Dakota Crop and Livestock Reporting Service 1981, 1982, 1983).

assessed between 17 September and 16 October. Only 31 (6%) of the 555 fields in 1980 were surveyed during November, and the average estimated loss for those fields was actually lower than the average loss in 1979. Therefore, the later assessments in 1980 were not a factor in the greater average levels of damage recorded compared with 1979.

North Dakota had the highest average percentage bird damage in 1980 (Table 1). The 2.65% loss meant that birds destroyed about 27,000 t of sunflower, worth about $6.5 million. The percentage loss to birds in South Dakota was nearly twice that recorded in 1979, but it was still only about half that of North Dakota in 1980. The percentage loss to birds in Minnesota in 1980 was about the same as in 1979. However, the value of seed lost to birds—$0.8 million—was about 33% lower than it was in 1979.

Despite the use of a stratification scheme, the variance of the percentage loss estimate for North Dakota in 1980 was relatively large, especially compared with that in 1979 (Table 1). This reduced precision resulted mostly from an unexpectedly high average level of bird damage (21%) encountered in the 10 fields sampled in Stutsman County. That county was placed in the "moderate" damage stratum, based on the relatively low average level of bird damage (0.3%, $n = 37$) found there in 1979. However, 8 of the 10 fields sampled in 1980 received high (>10%) and variable (13–43%) bird damage. This greatly increased the standard errors and confidence intervals for the moderate damage stratum and the State as a whole.

Table 2. *Estimated average sunflower loss (cost per harvested ha) to bird damage in the most heavily damaged counties in North Dakota, South Dakota, and Minnesota, 1978–80.*[a]

State and county	1979 ($)	1980 ($)
North Dakota		
Benson	9.76	16.33
Bottineau	4.05	6.57
Eddy	4.65	12.58
Emmons	16.98	N.S.[b]
Grant	9.44	0.30
McHenry	15.86	5.61
Pierce	11.49	3.51
Ramsey	2.03	5.56
Sheridan	10.70	5.14
Stutsman	0.99	65.58
South Dakota		
Brookings	0.59	7.09
Brown	4.45	9.39
Hanson	5.19	N.S.
McCook	5.58	N.S.
Moody	17.32	N.S.
Roberts	2.13	8.87
Minnesota		
Mahnomen	17.99	2.89
Roseau	0.62	5.09
Traverse	5.96	0.25

[a] Only those counties with an average loss >$5.00/harvested ha (about $2.00/acre) in either 1979 or 1980 are included. All other counties surveyed in 1979 and 1980 (Fig. 2) had <$5.00/ha loss in both years.
[b] N.S. = not sampled.

The random sampling of two 0.6-ha blocks of sunflower per field was designed to produce more precise estimates of bird damage for individual fields than in 1979, when only one block was sampled per field (D. Otis, personal communication). In 1980, 76% of the fields had <1.0% losses to birds, 21% had losses between 1.0% and 10.0%, and 3.4% had >10.0% losses. Although the percentage of fields with >10% damage was more than double that in 1979, only 12 counties had losses to birds >$5.00/harvested ha (Table 2), compared with 11 in 1979.

Bird Damage—1981

The estimated loss to birds in Benson County, North Dakota, was about 1,700 t of seed or 2.4% of the crop in the county (Table 3). This loss was worth about $400,000, or nearly $10.00/harvested ha. These bird damage estimates had large confidence intervals, primarily because one sample field in the county had an extremely high level of bird damage (35%). Although birds destroyed about 34.5 t of seed worth about $8,000 in this field, each of the other 49 fields sampled within the county had <10% losses worth <$650 per field.

In the sampled area of Bottineau County, North Dakota, the estimated value of the 590 t of seed lost to birds was about $139,000 (Table 3), or nearly as much as was lost in 1980 in the entire county. Of the four fields in Bottineau County that received >10% losses, one 65-ha field with 10.5% loss accounted for 36% of the total dollar loss recorded for all the sample fields. Another field had a higher percentage loss (19%), but because its production was relatively low, it made up only 10% of the total dollar loss.

In the portion of Brown County, South Dakota, surveyed in 1981, about 2.4% of the sunflower crop was lost to birds (Table 3), indicating a loss of 141 t, worth about $34,000. The average loss to birds was $7.50/ha, compared with $9.40/ha in 1980 when the entire county was sampled. Of the 49 fields assessed, 30 (61%) had losses <1.0%, and only 3 (6%) had >10% bird damage. However, a 65-ha field with an extremely high yield and a loss to birds of 8.8% had the greatest overall loss of seed (11.4 t) in the county.

Of the four counties surveyed, Mahnomen County, Minnesota, had the lowest estimated percentage bird damage (1.5%; Table 3). This loss was equivalent to 117 t, worth about $28,500. Of the 50 sample fields, 27 (54%) had bird damage <1.0%, whereas the remainder had no more than 8.5%.

Overall, the distribution of damage among the 199 fields sampled in the four counties was highly skewed (Fig. 4), with 77% of the fields having damage levels <2%. However, because the four counties sampled were historically high-damage areas, it was not surprising that a greater percentage of their fields (4%) had >10% bird damage in 1981 than in either of the previous years.

Bird Damage Trends, 1962–1981

During 1962–79, increases in the area harvested (Fig. 1), the yield, and the price paid for the harvested seed dramatically increased the total value of the sunflower crop in the three-State survey area. In North Dakota, for example, the total value of the harvested crop increased by about 300 times, from an average of $1.1 million per year in 1962–66 (Lilleboe 1979) to $337 million in 1979 (North Dakota CLRS 1981). Thus, although the overall estimated percentage bird damage in

Table 3. *Estimated sunflower acreage, production, and bird damage (±95% C.I.) in counties sampled in North Dakota, South Dakota, and Minnesota during 1981.*

Category[a]	Benson, N.Dak.	Bottineau, N.Dak.	Brown, S.Dak.	Mahnomen, Minn.	Summary[b]
Total fields sampled	50	50	49	50	199
Total sunflower harvested (ha) in surveyed area	40,348	29,138	4,506	7,123	81,115
County's harvested sunflower surveyed (%)	100	64	19	100	
Total production (10^3 t) in surveyed area	55.3	33.6	5.6	8.9	103.4
Total value of harvested sunflower ($ million)[c]	13.1	7.9	1.3	2.2	24.5
Average (%) damage per seed head[d]	2.40 (±2.74)	1.81 (±1.12)	2.38 (±1.33)	1.49 (±0.57)	—
Total bird damage (t)[e]	1,682.6 (±1,920.9)	588.5 (±364.1)	140.9 (±78.8)	117.4 (±44.9)	2,529.4
Average bird damage (kg/ha)	41.7	20.2	31.3	16.5	31.2
Total value of bird damage ($)	396,906 (±453,145)	138,817 (±85,900)	33,869 (±18,927)	28,464 (±10,890)	598,056
Average value of bird damage ($/ha)	9.84	4.76	7.50	4.00	7.37

[a] All estimates for Bottineau and Brown counties pertain only to the area surveyed for damage.
[b] Regional totals and averages, ignoring county boundaries.
[c] From Crop Reporting Board (1983) values.
[d] Based on average, weighted by field size.
[e] Based on average g/cm^2 surface area of seeds per county and weighted by field size.

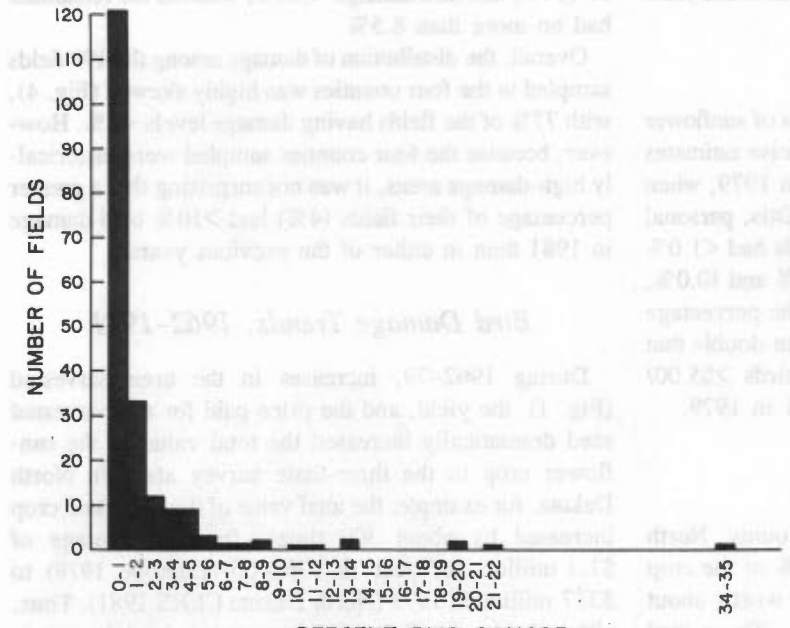

Fig. 4. Distribution of levels of bird damage estimated for Benson and Bottineau counties, North Dakota; Mahnomen County, Minnesota; and Brown County, South Dakota; in 1981.

the present study appears similar to that observed in 1972 (Stone 1973), both the absolute loss of sunflower to birds and the value of that loss have increased substantially. For example, in North Dakota, the value of bird damage increased by about 22-fold, from $0.3 million in 1972 (Henne et al. 1979) to $6.5 million in 1980.

We could not correlate this increase in bird damage, at least in North Dakota, with an increase in the number of breeding blackbirds. Likewise, Stehn and de Becker (1982) were unable to correlate numbers of breeding blackbirds with corn damage in Ohio. Besser (unpublished report) estimated that, for all species combined, breeding blackbirds in North Dakota increased by about 14% from 1967 (Stewart and Kantrud 1972) to 1981–82. However, he also concluded that the breeding population of red-winged blackbirds, the species generally considered the most destructive of sunflower (Besser 1978), had actually declined by 29% over the same period. The breeding populations of common grackles and yellow-headed blackbirds increased during the period, but because both species are less involved in sunflower damage than red-winged blackbirds (Besser et al. 1984), it is unlikely that these increases were sufficient to offset the decline in the red-winged blackbird population.

We suggest that the large increase in absolute bird damage to sunflower has been the result of blackbirds increasing their use of the crop. Mott et al. (1972) reported that the most common cultivated crops found in the gizzards of red-winged blackbirds collected in Brown County, South Dakota, between 16 August and 25 September 1959–65, were corn, millet, oats, and wheat, in descending order of occurrence and volume. More recently, Linz et al. (1983) collected red-winged blackbirds at a roosting area in Cass County, North Dakota, during 12–25 August 1981 and found cultivated sunflower in 63% of the esophagi. Sunflower made up 67% of the total weight of food items in the males and 21% in the females. Corn, the second most common food, made up 11% and 8% of the diets of males and females, respectively. The increased abundance of cultivated sunflower has apparently allowed it to supplant corn and the other grains as the primary food of red-winged blackbirds in late summer and fall.

Physiographic Distribution of Bird Damage

The sunflower-growing area of North Dakota, South Dakota, and Minnesota lies within two major topographic regions: the Central Lowland and the Great Plains (Bluemle 1977). It is in the Central Lowland that 94–95% of the sunflower produced in these three States was grown in 1979 and 1980. Within the Central Lowland are three strata: the Agassiz Plain (or Red River Valley), the Drift (or glaciated) Plain, and the Missouri Coteau (Bluemle 1977). The Drift Plain and the Missouri Coteau (Drift–Coteau; Fig. 5) together contain the "highest number of water areas per square mile of any region in the U.S.A." (Besser 1978), and these areas provide habitat that attracts both breeding and migrating blackbirds. It would not be surprising, therefore, if bird damage to sunflowers was greater in these two strata.

In 1979, the combined counties of the Drift–Coteau accounted for about half the sunflower produced within the entire three-State survey region. The distribution of damage among the strata was fairly uniform, with the average percentage bird damage in the Drift–Coteau being 0.9%, compared with 0.7% for the Great Plains and 0.6% for the Agassiz Plain. Further evidence of this relative uniformity of damage was the distribution of heavily damaged fields among the strata. Eight (1.8%) fields sampled within the Drift–Coteau had >10% bird damage, whereas five (1.2%) fields in the Agassiz Plain and one (1.4%) in the Great Plains had >10% bird damage.

In 1980, the area planted to sunflower decreased by about 32% throughout the three-State area, but production in the Drift–Coteau still composed 50% of the total in the survey area. However, the average percentage bird damage more than tripled to 3.1% within the Drift–Coteau, whereas damage in the Agassiz Plain remained about the same (0.7%) as in 1979. Although the sample was comparatively small, the 14 fields surveyed within the Great Plains had overall bird damage <0.1%. Also, 18 of the 19 fields with damage >10% in 1980 were within the Drift–Coteau, whereas only one was within the Agassiz Plain. Eight of the fields with >10% loss were in Stutsman County, a county which contains more than 40 water basins per square kilometer (Besser 1978).

Although the cause of the large increase in percentage loss within the Drift–Coteau in 1980 is unknown, the high level of bird damage in Stutsman County was a major contributor. Apparently conditions were such that Stutsman County attracted far more blackbirds and for a longer time in 1980 than in 1979.

Factors Affecting Bird Damage Estimates

Two potentially important sources of error in estimating bird damage were identified during a study in North Dakota during 1981–82 (Guarino 1984; Sedgwick et al. 1986). First, sunflower heads that were assessed for bird damage just before harvest averaged 28% more shrinkage on the bird-damaged areas than on the undamaged areas

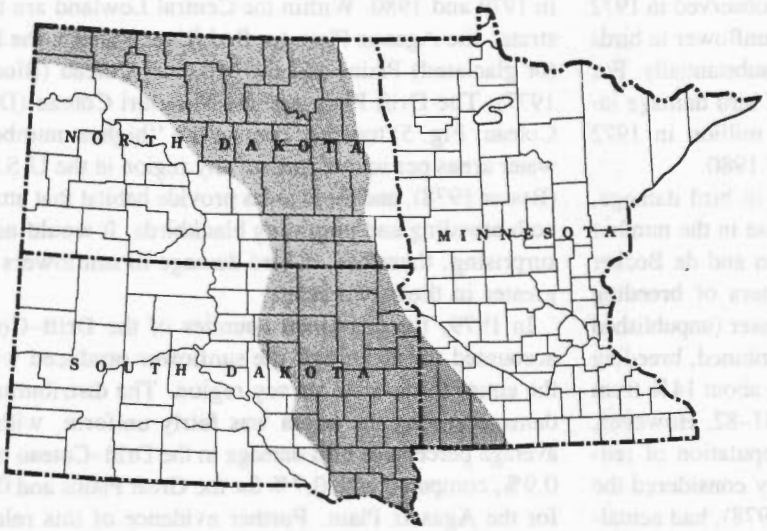

Fig. 5. The combined Drift Plain and Missouri Coteau regions (*shaded*) of North Dakota and South Dakota. The area with sunflower to the east of this area is the Agassiz Plain, and the region to the west is the Great Plains (Barari 1971; Ojakangas and Matsch 1982).

as the heads dried in the fields. The result was a tendency, when estimating bird damage, to underestimate losses, with the bias being extremely variable depending on the timing of the bird damage. As the time interval between bird damage and the damage assessment increased, so did the shrinkage differential and thus the underestimate of damage.

A second potential error in estimating bird damage can be caused by growth compensation, which may result in overestimating total bird damage. Individual sunflower plants were found to compensate for low-to-moderate levels of bird damage (up to 15%) by redirecting their growth to the remaining seeds (Sedgwick et al. 1986). As with shrinkage, the degree of growth compensation varies greatly, depending primarily on the growth stage at which the damage occurs; generally, the earlier the damage, the greater the compensation. Sunflowers were found to compensate completely for early damage up to 15%.

The net effect that differential shrinkage and growth compensation had on our estimates of bird damage is unclear. Because we were not aware of these potential biases before conducting the study, we did not collect sufficient data to properly evaluate the timing of the damage—the critical factor in evaluating these biases. In general, however, it seems that true losses were probably underestimated in heavily damaged fields but were frequently overestimated in lightly damaged ones.

Conclusions

In North Dakota, South Dakota, and Minnesota, the area planted to sunflower, the overall production, and the value of the crop increased dramatically during 1962–81. Recently, the total overall loss of sunflower seed caused by birds—primarily blackbirds—has also increased substantially, although the average percentage loss has not changed significantly. The increase in overall loss is more likely due to the increased use of sunflower as a food source by blackbirds than to any increase in blackbird numbers. This increased use resulted in estimated losses to birds of $5–$8 million a year in 1979–80.

Although $5–$8 million is a large monetary loss, only 1.6% of the individual fields assessed during the 3-year survey had estimated losses of >10%. Thus, we found that damage to sunflowers was not uniformly distributed. Instead, as with other agricultural crops damaged by birds, although most sunflower growers suffered little or no loss, a small percentage had substantial losses.

The average percentage losses in 1979 were fairly uniform throughout the various topographic regions of the three-State survey area. However, in 1980, overall losses were at least 4 times higher, and more fields were found with losses of >10%, in the Drift–Coteau regions than in the remaining areas. The Drift–Coteau regions have a large number of permanent water features that can provide nesting and migrating blackbirds with suitable habitat

close to an abundant food supply, resulting in increased sunflower damage in the area.

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