Pgs. 63-75 in Proceedings of the Sunflower Research Workshop,
(January 8-9, 1990, Fargo, ND)

WETLAND HABITAT MANAGEMENT: A NEW APPROACH FOR REDUCING BLACKBIRD DAMAGE TO SUNFLOWER

GEORGE M. LINZ AND DAVID L. BERGMAN

USDA/APHIS/S&T, North Dakota Field Station,
Denver Wildlife Research Center, Fargo, ND 58105

In the north-central states blackbirds begin to roost in July in wetlands dominated by dense stands of cattail (*Typha* spp.). Often these roosts are located near sunflower fields (Otis and Kilburn 1988). Frightening and dispersal techniques are available to reduce the sunflower damage caused by blackbirds (Dyer and Ward 1977). These techniques, however, have limitations of cost, logistics, or limited effectiveness. CPT (3-chloro-4-methylbenzenamine) has shown some promise as an avicide (Cummings and Schafer 1989, J. Heisterberg, unpub. data) but registration by the Environmental Protection Agency (EPA) for use in the near future is unlikely (Linz et al. 1988). Thus, new management techniques for reducing blackbird damage to sunflower are needed.

The U. S. Fish and Wildlife Service (USFWS) and Canadian Wildlife Service have identified the loss and degradation of habitat as the major waterfowl management problem in North America (United States Fish and Wildl. Serv. and Canadian Wildl. Serv. 1986). Breeding marsh birds respond positively to the creation of wetlands with interspersed emergent vegetation and water (Weller and Spatcher 1965, Nelson and Dietz 1966, Buele 1979, Murkin 1979). Therefore, various federal and state wildlife agencies (e.g., USFWS, Wisconsin Department of Nat. Res.) have removed or reduced dense cattails stands by using herbicides, mechanical destruction, burning, grazing, water level manipulation, and combinations of these techniques (Beule 1979, Murkin 1979, Murkin and Ward 1980, Kantrud 1986, Schultz 1987, Solberg 1989).

To our knowledge, no data have been published on the use of these modified wetlands by roosting blackbirds. Dispersing or reducing blackbird populations by altering their roosting habitat (i. e. cattail) may reduce damage to sunflower. To begin to determine the feasibility of this notion, we aerially sprayed 4 cattail marshes with the Rodeo formulation of glyphosate (Isopropylamine salt of N-phosphonomethyl) (Rodeo is a registered trademark of Monsanto Company, St. Louis, MO. The U.S. Department of Agriculture does not endorse any product used in this study). Rodeo is a post-emergent, nonselective herbicide registered for use in aquatic environments (Monsanto 1985a). We also began to develop a data base on the immediate and long term effects of glyphosate on the abundance and diversity of organisms in marsh ecosystems.

Long-term benefits of this research include (1) a management tool for eliminating blackbird roosts located near sunflower fields and thereby reducing or dispersing damage, (2) a method of moving blackbirds into alternate roosts, and (3) a method of enhancing habitat for marsh breeding birds, especially waterfowl. Here, we present our

initial findings to stimulate discussion on managing wetland habitat for reducing blackbird damage to sunflower.

K. Higgins provided valuable advice during the planning phase of this study. W. Bleier and D. Otis assisted in the field. D. Hanson, Product Development Specialist for the Monsanto Company, was instrumental in providing a substantial amount of Rodeo used in this study. R. Marquart and D. Wakefield applied the herbicide. We especially thank R. Blegen, R. Morken, L. Pederson, P. Steffan, and B. Wall for granting permission to conduct this experiment on their property. W. Bleier, J. Homan, L. Linz, and D. Otis commented on earlier drafts.

Study Area

During August and September 1989, Blegen's Marsh, Command Roost, Rose Lake, and Wall's Marsh located in Nelson and Ramsey Counties, North Dakota, were aerially sprayed with Rodeo herbicide (Fig. 1). Blegen's Marsh, Command Roost, and Wall's Marsh are Class IV (semipermanent) marshes with cattails covering >95% of the wetland area (Cover Type 1) (classification system of Stewart and Kantrud 1971). By mid-August, Blegen's and Wall's Marshes were nearly dry with only small, shallow, pools of water (<12 cm) remaining. Command Roost was bordered on the northern edge by a road ditch filled with 61-152 cm of water. There were shallow pools of water (<24 cm) scattered throughout the marsh. Rose Lake is a 46 ha (114 ac) permanent lake (Class V) with an inlet composed of 16 ha (40 ac) which is surrounded by a fringe of cattail about 10-110 m wide on the northeast corner (Cover Type III) (Fig. 2). Aerial and ground photos were taken of each marsh prior to or just after treatment.

Methods

The amount of Rodeo sprayed on the marshes ranged from 5.8 l/ha (0.6 gal/ac) to the maximum recommended application rate of 7.0 l/ha (0.75 gal/ac) (Monsanto 1985b) (Table 1). The herbicide was mixed in a 46.8 l/ha (5.0 gal/ac) solution, containing 0.19 l/ha (0.02 gal/ac) surfactant (Activator 90, Trademark of Loveland Industries, Inc., Greeley, CO.), 0.9 l/ha (0.1 gal) drift retardant, and sufficient water to bring the solution to final volume. For maximum efficacy, Monsanto (1985b) recommends that no significant precipitation contact the treated plants for 6 hours after treatment. Weather conditions at the time of treatment and during the 24 hours following the treatment were obtained from the Devils Lake, North Dakota, National Weather Service (Table 2).

After a roost was selected for treatment, the blackbird population was estimated by counting the birds as they departed the roost at sunrise (Meanley 1965), at least 2 times within 7-day pre- and 7-day posttreatment periods. The species composition of the bird population was determined 1 time pre- and 1 time posttreatment, by identifying randomly selected birds as they entered the roost in the evening (Dolbeer et al. 1978). An index of nontarget bird populations was obtained between 0800-1100 hours for each marsh at least 2 times during the pre- and posttreatment periods, by walking around the periphery of the wetland and recording all birds observed in the marsh and within 50 m of the marsh (Linz et al. 1989).

The size, location, and seed type (oil or confectionery) of all sunflower fields located within a 3.2 km (2 mi) radius of each marsh were recorded. If part of a field was within this area, its entirety was included in the survey. The numbers of blackbirds feeding in these fields were visually estimated between 0900-1200 hours at least 2 days during the pre- and posttreatment periods.

Each wetland was divided into 2 strata of equal width. Each stratum was then divided into 15 m wide strips and 70% of the strips were randomly selected for treatment (Fig. 2). To gauge efficacy of the treatment on cattail, we counted the number of live (green) cattail stems within 20 0.5-m^2 quadrats systematically placed along 4 randomly selected strips to be treated. We obtained a posttreatment estimate of the number of live cattails in these quadrats in Blegen's marsh before freezing temperatures killed the cattails. A paired-t test was used to assess differences in number of green cattail stems between pre- and posttreatment. Depth of water in the quadrats was determined by averaging the water depths at the four corners of the plot.

Results

Blegen's Marsh

Mean live (green) cattail density in the 20 0.5-m^2 quadrats was 8.9 ± 1.6 (SE) before treatment and 2.2 ± 0.8 (SE) 26 days (10 September) after treatment (P = 0.0002). None of the 20 quadrats contained water during the study. We estimated that 11,000 and 14,500 blackbirds were using the roost pre- and posttreatment, respectively (Fig. 3). The species composition remained about the same pre- and posttreatment with about 33% of the population being male red-winged blackbirds (*Ageliaus phoeniceus*); 31% a combination of female redwings, female yellow-headed blackbirds (*Xanthocephalus xanthocephalus*), and brown-headed cowbirds (*Molothrus ater*); 16% male yellowheads; and 15% common grackles (*Quiscalus quiscula*) (Fig. 4). There were 376 ha (929 ac) of sunflower, comprised of 5 oil-seed and 5 confectionery variety fields, within 3.2 km (2 mi) of Blegen's Marsh. We noted an average of 170 and 350 blackbirds feeding in each field during the pre- and posttreatment periods, respectively (Fig. 5). The maximum number of nontarget birds recorded in the marsh during the pretreatment period was 324 compared to 249 following the treatment. In particular, there were fewer ducks, sandpipers and wrens following the spray (Table 3).

Command Roost

Mean cattail density in the quadrats was 11.4 ± 2.1 (SE). The mean water depth in the quadrats was 6.4 ± 2.9 (SE) cm. Although freezing temperatures precluded a quantitative assessment of efficacy, streaks of brown cattail were evident after 2 weeks. We estimated that an average of 14,000 blackbirds were using the roost during the pre- and posttreatment periods (Fig. 3). The species composition remained about the same before and after the spray with the majority being male redwings (46%) and the combined category of female redwings-female yellowheads-cowbirds (34%) (Fig. 4). There were 294 ha (726 ac) of sunflower, comprised of 7 oil-seed fields and 1 confectionery field, within 3.2 km of Command Roost. There were more birds in each field during the pretreatment period (x = 850) than the posttreatment period (x = 525) (Fig. 5). The maximum numbers of nontarget birds recorded during the pre- and

posttreatment censuses were 136 and 55, respectively. Most of this decrease was due to fewer flycatchers, swallows, and wrens (Table 4).

Rose Lake

Mean cattail density in the 20 quadrats was 11.5 ± 1.9 (SE). Mean water depth in the quadrats was 23.7 ± 6.8 (SE) cm. R. Marquart flew over Rose Lake on 9 September and noted definite brown streaks where he had applied the herbicide (pers. commun.), indicating that the cattails were injured or killed. We estimated that about 71,000 blackbirds were using the roost pre- and posttreatment (Fig. 3). The species composition remained about the same before and after the treatment with about 42% of the population male yellow-headed blackbirds, 30% male redwings, and 22% female redwings-female yellowheads-cowbirds (Fig. 4). There were 2 oil and 2 confectionery variety sunflower fields totaling about 220 ha (543 ac), within 3.2 km (2 mi) of Rose Lake. There were more birds feeding in the sunflower fields surrounding the marsh during the posttreatment period ($\bar{x}$ = 1650) than during the pretreatment period ($\bar{x}$ = 1070) (Fig. 5). We noted 532 nontarget birds using the marsh during the pretreatment period and 647 birds during the posttreatment period. Most of this increase was due to more ducks, rails, coots, and swallows using the lake (Table 5).

Wall's Marsh

Mean cattail density in the 20 quadrats was 15.2 ± 2.4 (SE). Water depth averaged 1.3 ± 1.1 (SE) cm in the quadrats. An average of 2,000 blackbirds were using the roost pretreatment and 4,500 posttreatment (Fig. 3). There was a noticeable difference in the species composition between the pre- and posttreatment periods. Male redwings represented 8% and 51% of the population during the pre- and posttreatment periods, respectively, while male yellowheads made up 40% of the population during pretreatment and <1% posttreatment. The other species and sex groups remained about the same (Fig. 4). There were 470 ha (1161 ac) of sunflower, comprised of 3 oil and 7 confectionery variety fields, within 3.2 km (2 mi) of Wall's Marsh. We recorded an average of 825 and 1,300 blackbirds in each field during the pre- and posttreatment period, respectively (Fig. 5). The maximum number of nontarget birds recorded during the pre- and posttreatment was about the same. In decreasing order, wrens, sandpipers, sparrows, and ducks were the most abundant birds in this marsh (Table 6).

Discussion

Evaluation of Applications

Solberg (1989) used the maximum application rate of Rodeo on 23 semipermanent wetlands in northeastern South Dakota in July and August 1985-86. He killed nearly 100% of the cattail in the treated portions of the marsh. Wetlands with at least 30 cm of water remained free of cattail for at least 3 years. On the other hand, cattails regenerated the following year in dry marshes.

In this study, preliminary evaluation of 4 marshes treated with Rodeo at near maximum rates indicated that good cattail control may be achieved. Starting in mid-summer

1990, our test marshes will be assessed annually for regrowth of cattail and number of roosting blackbirds.

Seasonal migration of birds begins in August and September in North Dakota. Therefore, it is difficult to attribute changes in bird populations to a single event, such as an application of herbicide, during this time. The number and species composition of the blackbird roosting populations did not appear to vary between pre- and posttreatment periods in Blegen's Marsh, Command Roost, and Rose Lake. Whereas, during these periods the number and species composition of blackbirds varyed in Wall's marsh. The posttreatment increase in blackbird numbers in Wall's Marsh was probably due to an influx of birds seeking refuge from the aerial hazers (Handegard 1988) who were chasing birds trying to roost at Rose Lake. The change in species composition coincides with the emigration of yellow-headed blackbirds (Twedt et al. 1989).

No obvious acute treatment effects on either target or nontarget birds were seen in the marshes or surrounding sunflower fields. The lower number of birds seen in Blegen's Marsh after the treatment was probably due to the evaporation of a shallow pool of water. It is likely that observed differences between pre- and posttreatment numbers of nontarget birds recorded were weather related. The wind and rain associated with passing weather fronts reduces the activity of the passerine birds and introduces an observer bias. To overcome possible bias, we recommend that censuses only be conducted when the wind is <10 mph and there is no precipitation.

Starting in 1990, censuses of target and nontarget birds using treated wetlands will be conducted during the breeding (spring) and postbreeding (summer) seasons to assess long-term effects of altering the wetland on bird populations, especially blackbirds and waterfowl. Further, because of concern by wetland managers that glyphosate may be detrimental to invertebrates which are an important food source of nestlings and fledglings (Dale Henry, USFWS, pers. commun.), we plan to conduct studies addressing this issue.

Censusing blackbirds in sunflower fields provides a valuable index of their numbers and activity patterns. However, statistically valid sunflower damage assessments are needed to test the hypothesis that reducing blackbird roosting habitat (i.e., cattail) will disperse or reduce sunflower damage by blackbirds. Starting in 1990, we plan to conduct damage assessments in Nelson County to develop historical data on damage patterns that will be used for evaluating the effect of altering blackbird roosting habitat on blackbird damage.

Economics of Using Rodeo

Cost of aerial application of Rodeo, using the 7.0 l/ha (0.75 gal/ac) rate, is about $198.00/ha ($80.00/ac). Eighty-eight percent of this cost is for the herbicide. If managing wetland vegetation proves effective in dispersing blackbirds and thereby reducing sunflower loss, a positive cost:benefit ratio may be obtained where blackbirds historically damage sunflower and when application costs are amortized over a number of years. For example, Command Roost is 9 ha (22 ac) and averaged about 12,000 blackbirds for 30 days. If each bird consumed 24 g (0.84 ounce) of food each day (J. Mah, unpubl. data) of which 50% was sunflower (Linz et al. 1984), this population

consumed 4,286 kg/30 days (9,450 lbs) of sunflower at a cost of $945.00 (@0.10/lb). It would cost $1,760 to treat the entire marsh with Rodeo. Assuming that the treatment is 100% effective, in less than 2 years, the grower would recoup his cost for treating the marsh. Additionally, the sunflower grower will have enhanced the recreational value of the wetland by improving the habitat for marsh birds, especially waterfowl (Solberg 1989).

Unfortunately, as blackbirds follow their traditional migration route through the sunflower growing regions of North Dakota, South Dakota, and Minnesota they consume the most nutritious food available, namely sunflower (Linz et al. 1984). Therefore, we expect that some sunflower damage will occur after blackbird roosting habitat is reduced. However, we speculate that the damage may be more evenly distributed, with few growers suffering large losses. Since sunflower plants suffering minor early damage (up to 15%) compensate by producing heavier seeds (Sedgwick et al. 1986), total damage may be reduced.

Since the herbicide is the most expensive component of the application cost, research on ways of reducing the amount of Rodeo needed to control cattail is warranted. The Crop and Weed Science Department (CWS), North Dakota State University, has conducted some research using Rodeo on small plots of cattail along drainage ditches (Cal Messersmith, pers. commun.). They found that cattails were effectively controlled at both 5.3 l/ha (0.56 gal/ac) and 7.0 l/ha (0.75 gal/ac) application rates for at least 2 growing seasons. In 1990, CWS, in cooperation with the Denver Wildlife Research Center, will begin testing various application rates of Rodeo on small plots of cattails, which can be precisely evaluated, and larger cattail marshes historically used by blackbirds.

Literature Cited

Beule, J. D. 1979. Control and management of cattails in southeastern Wisconsin wetlands. Dept. Natural Res. Tech. Bull. 112. 41pp.

Cummings, J. L. and E. W. Schafer, Jr. 1989. Evaluation of a DRC-1347 (CPT) aerial spray application for reducing a roosting blackbird population. Proc. Sunflower Res. Workshop. Fargo, North Dakota. Pp. 26-27.

Dolbeer, R. A., P. P. Woronecki, A. R. Stickley, Jr., and S. B. White. 1978. Agricultural impact of a winter population of blackbirds and starlings. Wilson Bull. 90:31-44.

Dyer, M. I. and P. Ward. 1977. Management of pest situations. Pp. 267-300 *in* Granivorous birds in ecosystems. J. Pinowski and S.C. Kendeigh (ed.). Cambridge Univ. Press, Cambridge. 431pp.

Handegard, L. L. 1988. Using aircraft for controlling blackbird/sunflower depredation. Proc. Vertebr. Pest Conf. 13:293-294.

Kantrud, H.A. 1986. Effects of vegetation manipulation of breeding waterfowl in prairie wetlands - a literature review. U.S. Fish Wildl. Serv., Fish Wildl. Tech. Rep. 3. 15pp.

Linz, G. M., D. L. Vakoch, J. F. Cassel, and R. B. Carlson. 1984. Food of red-winged blackbirds, *Agelaius phoeniceus*, in sunflower fields and corn fields. Canadian Field-Naturalist. 98:38-44.

Linz, G. M., D. F. Mott, and E. W. Schafer, Jr. 1988. Progress of the development of an avian toxicant (CPT). Proc. Sunflower Res. Workshop. Bismarck, North Dakota. Pp. 3-4.

Linz, G. M., M. L. Avery, J. F. Besser, J. B. Bourassa, J. L. Cummings, J. E. Davis, Jr., R. A. Dolbeer, R. M. Engeman, C. E. Knittle, D. F. Mott, D. L. Otis, and E. W. Schafer, Jr. 1989. Treatment of two blackbird roosts in North Dakota with a simulated CPT-Avicide formulation. Denver Wildl. Res. Ctr. Bird Section Res. Rep. 435. 57pp.

Meanley, B. 1965. The roosting behavior of the red-winged blackbird in the Southern United States. Wilson Bull. 77:217-228.

Monsanto. 1985a. Technical bulletin for rodeo herbicide. Monsanto Agr. Prod. Co. Tech. Bull. 2pp.

Monsanto. 1985b. Rodeo herbicide for aquatic vegetation management. Monsanto Agr. Prod. Co. Tech. Man. 20pp.

Murkin, H. R. 1979. Response by waterfowl and blackbirds to an experimentally manipulated cattail marsh. M.S. Thesis, McGill Univ. 97pp.

Murkin. H. R. and P. Ward. 1980. Early spring cutting to control cattail in a northern marsh. Wildl. Soc. Bull. 8:254-256.

Nelson, N. F. and R. H. Dietz. 1966. Cattail control methods in Utah. Utah Dep. Fish Game Publ. 66-2. 31pp.

Otis, D. L. and C. M. Kilburn. 1988. Influence of environmental factors on blackbird damage to sunflower. U.S. Fish and Wildl. Tech. Rep. 16. 11pp.

Schultz, B. D. 1987. Biotic responses of Typha-monodominant semipermanent wetlands to cattle grazing. M.S. Thesis, South Dakota State Univ., Brookings. 92pp.

Sedgwick, J. A., J. L. Oldemeyer, and E. L. Swenson. 1986. Shrinkage and growth compensation in common sunflowers: refining estimates of damage. J. Wildl. Manage. 50:513-520.

Solberg, K. L. 1989. Chemical treatment of monodominant cattail stands in semipermanent wetlands: duck, invertebrate, and vegetation response. M.S. Thesis, South Dakota State Univ., Brookings. 105pp.

Stewart, R. E. and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Bureau Sport Fish and Wildl. Resour. Publ. 92. 57pp.

Twedt, D. J., W. J. Bleier, and G. M. Linz. 1989. Diet, molt and geographic variation of yellow-headed blackbirds (*Xanthocephalus xanthocephalus*). Final Rpt., North Dakota State Univ., Fargo. 197pp.

United States Fish and Wildlife Service and Canadian Wildlife Service. 1986. North American Waterfowl Management Plan. United States Department of Interior and Environment Canada. 19pp.

Weller, M. W. and C. E. Spatcher. 1965. Role of habitat in the distribution and abundance of marsh birds. Iowa Agric. Home Econ. Exp. Stn. Spec. Rep. 43. 31pp.

Table 1. Description of wetlands in North Dakota treated with Rodeo[1] herbicide during August and September 1989.

Name of Wetland	Location Township, Range, Section	Wetland Type	Cover[2] Type	Date Treated	Total Area (ha) of Cattail (ac)[3]	Area of (ha) Cattail Treated (ac)[3]	Rate (l/ha) of Application (qt/ac)
Blegen's Marsh	T155N, R67W, S14SW	Semipermanent	I[4]	15 August	15 (37)	15 (27)	5.8 (2.5)
Command Roost	T150N, R60W, S1NC	Semipermanent	I	29 August	9 (22)	6 (15)	6.8 (2.9)
Rose Lake	T153N, R59W, S25NE	Permanent	III[5]	29 August	4 (10)	3 (7)	7.0 (3.0)
Wall's Marsh	T153N, R59W, S26WE	Semipermanent	I	9 September	4 (10)	3 (7)	6.8 (2.9)

[1]Rodeo is a registered trademark of Monsanto Company, St. Louis, Missouri.

[2]Classification of Stewart and Kantrud (1971).

[3]Rounded to the nearest whole number.

[4]Cattails (*Typha* spp) covering > 95% of wetland area.

[5]Cattails covering < 95% of the wetland area and peripheral band of cattails averaging > 2 m in width.

Table 2. Weather conditions during the 24 hours following treatment of 4 cattail marshes with Rodeo herbicide in 1989.

Name of Wetland	Date Treated	Time Treated	Wind at Treatment (km/h)	Temperature Range (°C)	Amount of Precipitation (cm)
Blegen's Marsh	15 August	0900	< 8	8-26	0.0
Command Roost	29 August	1900	<10	10-22	0.5
Rose Lake	29 August	2000	< 8	10-22	0.5
Wall's Marsh	9 September	0800	24-32	1-16	0.0

Table 3. Maximum numbers of nontarget birds observed at Blegen's Roost, Benson County, North Dakota pre- (11, 12, 14 August) and posttreatment (16, 17 August) with Rodeo[1] herbicide.

Taxa (Common Name)	Maximum Number Recorded During Pretreatment Period	Maximum Number Recorded During Posttreatment Period
Ardeidae	2	3
Anatinae	26	19
Accipitridae	3	4
Falconidae	2	0
Rallidae	11	4
Recurvirostridae	0	1
Charadriidae	8	2
Scolopacidae	75	37
Columbidae	13	7
Tyrannidae	7	5
Hirundinidae	122	131
Troglodytidae	38	26
Parulinae	1	1
Emberizinae	6	0
Icterinae[2]	3	2
Fringillidae	7	7
TOTAL	324	249

[1]Rodeo is a registered trademark of Monsanto
[2]Meadowlarks

Table 4. Maximum numbers of nontarget birds observed at Command Roost, Nelson County, North Dakota pre- (22, 23, 27 August) and posttreatment (31 August and 1 September) with Rodeo[1] herbicide.

Taxa (Common Name)	Maximum Number Recorded During Pretreatment Period	Maximum Number Recorded During Posttreatment Period
Podicipedidae	1	0
Ardeidae	0	20
Anatinae	20	14
Accipitridae	1	3
Rallidae	5	4
Scolopacidae	13	3
Laridae	0	5
Columbidae	2	0
Tyrannidae	10	0
Hirundinidae	17	2
Troglodytidae	38	18
Parulinae	5	2
Emberizinae	16	2
Fringillidae	6	2
TOTAL	134	75

[1]Rodeo is a registered trademark of Monsanto

Table 5. Maximum numbers of nontarget birds observed at Rose Lake Roost, Nelson County, North Dakota pre- (26, 28, 29 August) and posttreatment (30, 31 August and 1 September) with Rodeo[1] herbicide.

Taxa (Common Name)	Maximum Number Recorded During Pretreatment Period	Maximum Number Recorded During Posttreatment Period
Podicipedidae	4	3
Phalacrocoracidae	9	2
Ardeidae	14	1
Anatinae	215	356
Accipitridae	4	1
Falconidae	2	0
Rallidae	127	146
Charadriidae	1	2
Scolopacidae	46	32
Laridae	43	10
Columbidae	6	5
Tyrannidae	7	5
Hirundinidae	23	51
Troglodytidae	17	23
Parulinae	3	2
Emberizinae	9	4
Icterinae[2]	1	2
Fringillidae	1	2
TOTAL	532	647

[1]Rodeo is a registered trademark of Monsanto
[2]Meadowlarks

Table 6. Maximum numbers of nontarget birds observed at Wall's Marsh, Nelson County, North Dakota pre- (5-7 September) and posttreatment (11-13 September) with Rodeo[1] herbicide.

Taxa (Common Name)	Maximum Number Recorded During Pretreatment Period	Maximum Number Recorded During Posttreatment Period
Anserinae	0	4
Anatinae	0	15
Accipitridae	1	1
Falconidae	0	1
Rallidae	2	0
Scolopacidae	20	27
Charadriidae	0	1
Columbidae	9	6
Picidae	1	0
Tyrannidae	7	5
Hirundinidae	12	3
Troglodytidae	36	33
Parulinae	7	4
Emberizinae	22	22
Icterinae[2]	1	1
Fringillidae	2	0
TOTAL	120	123

[1]Rodeo is a registered trademark of Monsanto
[2]Meadowlarks

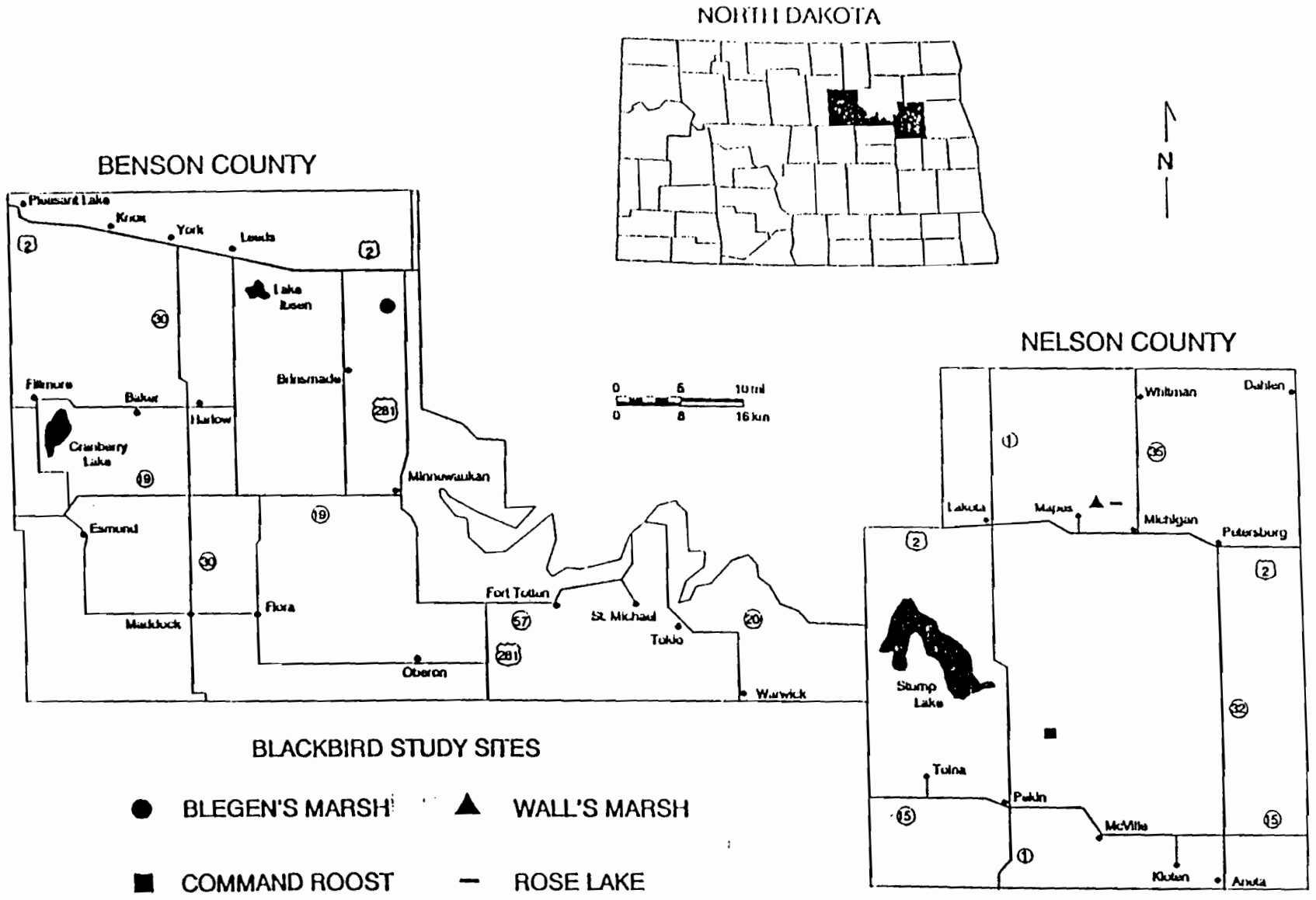

Fig. 1. Locations of wetlands treated with Rodeo formulation of glyphosate during August and September 1989.

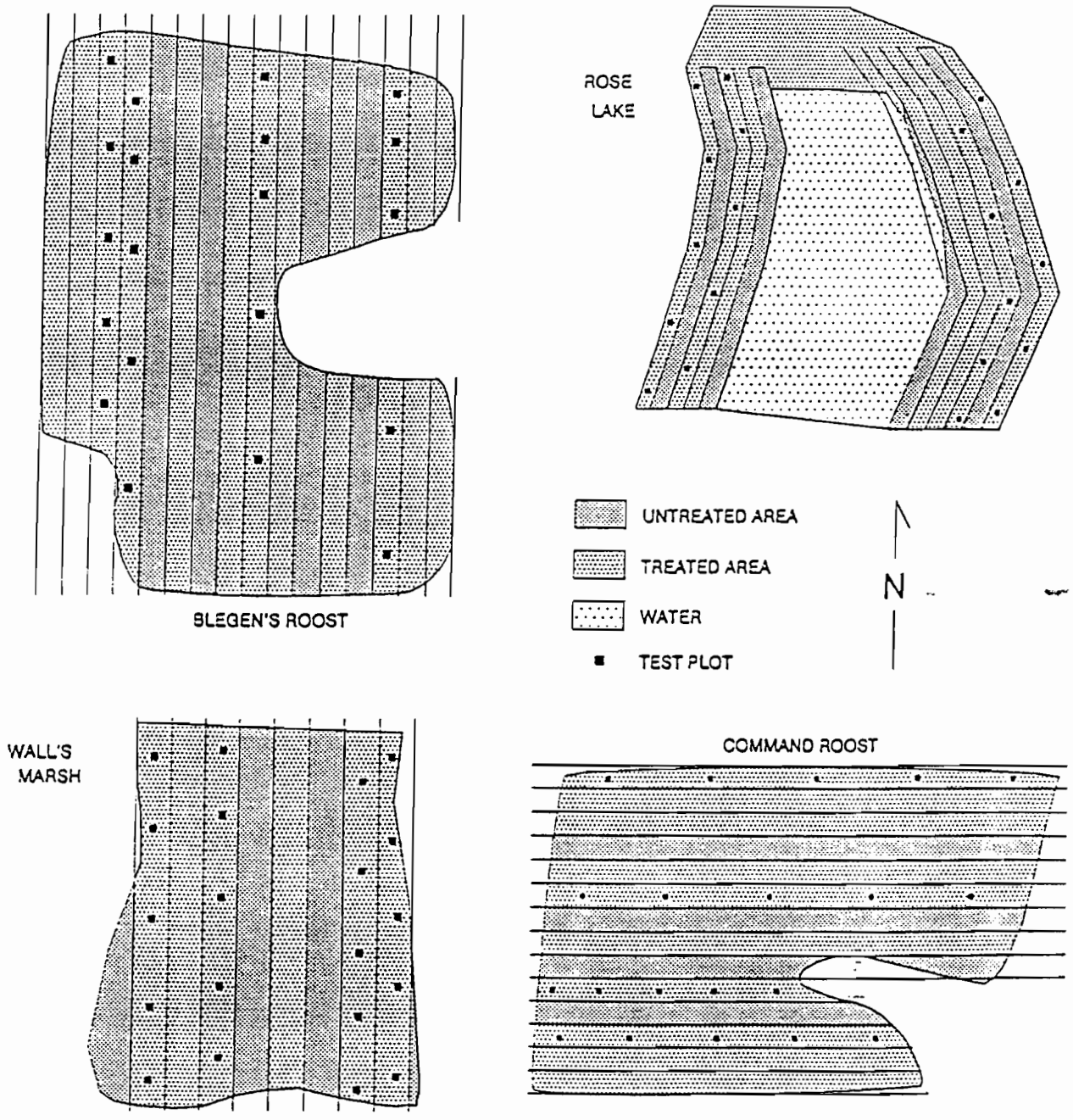

Fig. 2. Schematic diagram of 4 wetlands treated with Rodeo herbicide showing treated and untreated 15-m wide strips and location of 0.5-m² quadrats.

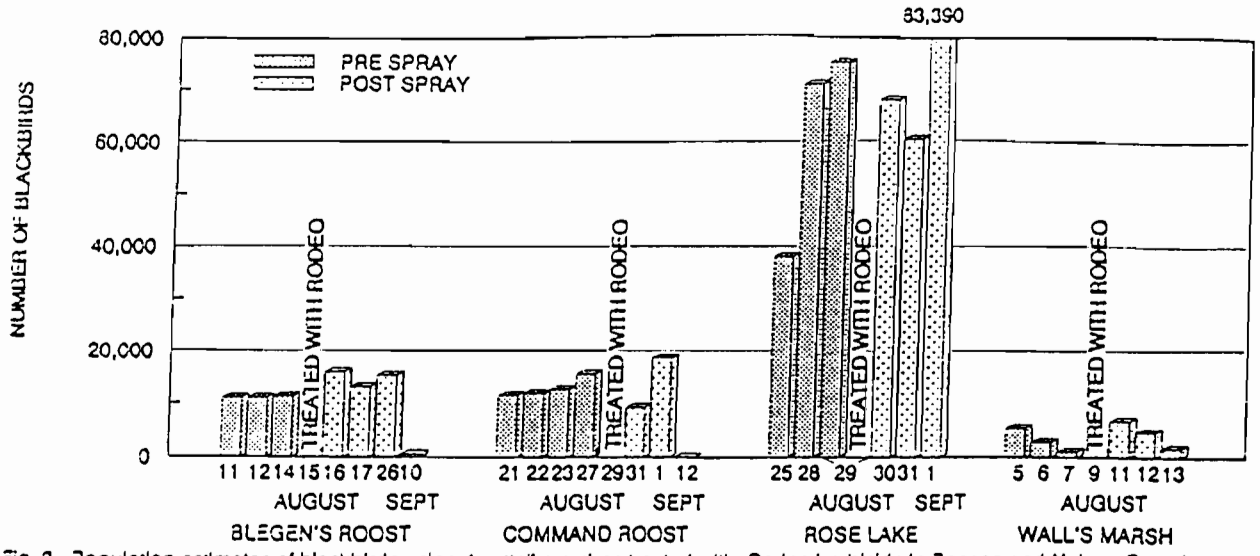

Fig. 3. Population estimates of blackbirds using 4 cattail marshes treated with Rodeo herbicide in Benson and Nelson Counties, North Dakota in August and September 1989.

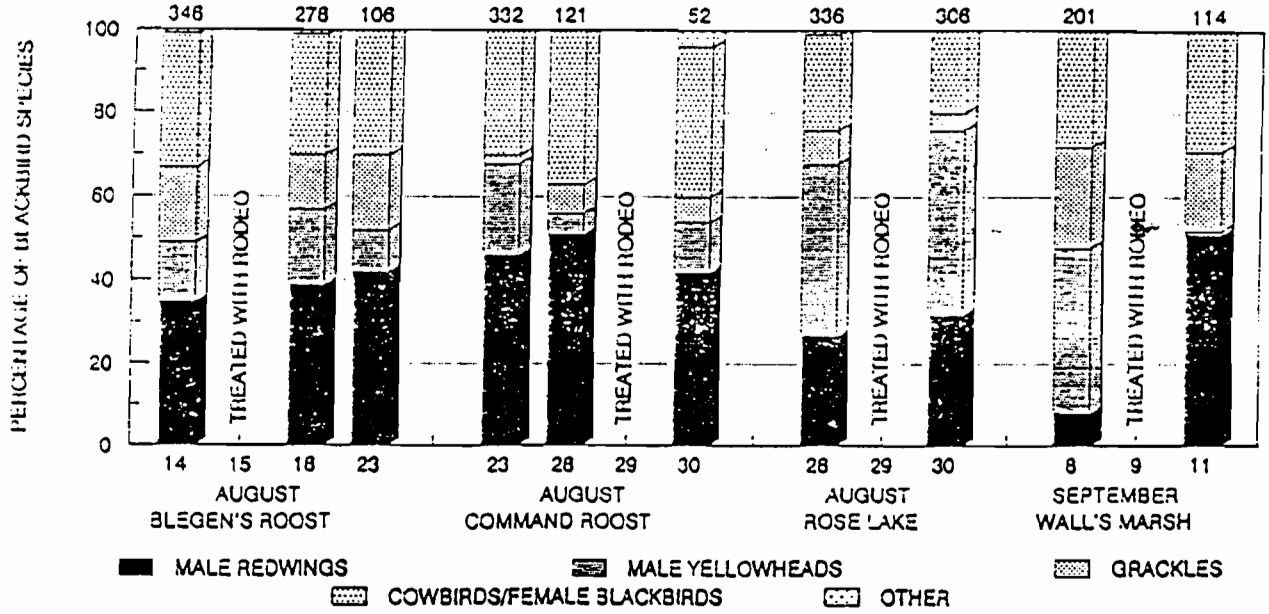

Fig. 4. Species composition of blackbird populations roosting in 4 cattail marshes treated with Rodeo herbicide in Benson and Nelson Counties, North Dakota in August and September 1989. Numbers above bars are the numbers of blackbirds observed.

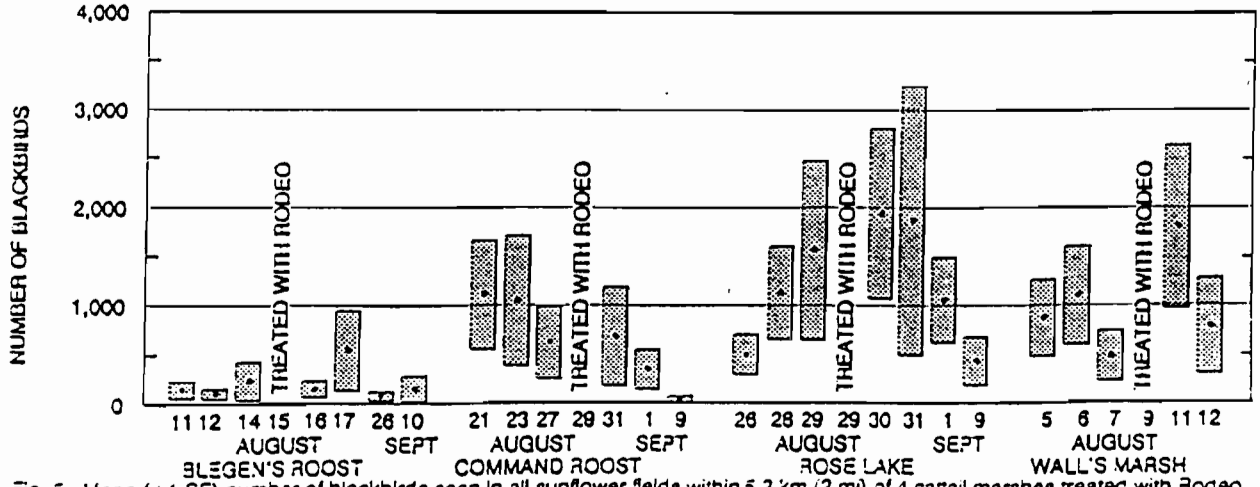

Fig. 5. Mean (±1 SE) number of blackbirds seen in all sunflower fields within 5.2 km (2 mi) of 4 cattail marshes treated with Rodeo herbicide during August and September 1989.