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PROGRESS ON MANAGING CATTAIL MARSHES WITH RODEO® HERBICIDE TO DISPERSE ROOSTING BLACKBIRDS

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ABSTRACT: In August and September 1989 and 1990, we aerially sprayed 8 cattail (*Typha* spp.) marshes with Rodeo® herbicide to begin evaluating its use for fragmenting dense cattail stands used by roosting blackbirds (Icterinae). Treated marshes were effectively eliminated as roost sites for blackbirds. After 2 years, cattail densities in 4 marshes treated with Rodeo® at 5.8 - 7.0 L/ha were 87% lower than pretreatment densities ($P = 0.0001$). In 1990, we treated 4 marshes with Rodeo® at 4.7 L/ha. One year later, 6% of the cattails survived in the sprayed areas. Of 7 groups of "indicator birds," only marsh wren (*Cistothorus palustris*) and rail (sora, *Porzana Carolina* and Virginia rail, *Rallus limicola*) populations were adversely affected by cattail fragmentation. These preliminary results led to an increased research effort to develop marsh management techniques aimed at eliminating blackbird roosts.

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INTRODUCTION

In 1979 and 1980, Hothem et al. (1988) documented blackbirds (Icterinae) damage millions of dollars of the sunflower crop in North Dakota, South Dakota, and Minnesota. Recent surveys of sunflower growers indicate blackbird damage to sunflower remains a major production problem in North Dakota (North Dakota Agricultural Statistics Service 1990a, Lamey et al. 1992). In 1989 producers requesting assistance from the U. S. Department of Agriculture, Animal and Plant Health Inspection Service, North Dakota Animal Damage Control reported blackbirds damaged 17.7% of their crop (North Dakota Agricultural Statistics Service 1990a). Average loss per producer was $6,295. Lamey et al. 1992 reported 91 of 652 surveyed sunflower growers suffered bird damage losses greater than 10%.

Researchers have developed many techniques for reducing sunflower damage caused by blackbirds (Dyer and Ward 1977, Knittle et al. 1988, Bomford and O'Brien 1990). However, in practice, many growers have rejected these techniques because of cost, logistics, or limited effectiveness (North Dakota Agricultural Statistics Service 1990a). Thus, new management techniques for dispersing and reducing blackbird damage to sunflower are needed.

In the north-central United States, blackbirds begin roosting in dense cattail (*Typha* spp.) marshes during July. Otis and Kilburn (1988) reported the presence of a marsh is the most important environmental factor influencing levels of sunflower damage by blackbirds. Dispersing congregations of blackbirds by altering their roosting habitat (i.e., cattails) may in turn disperse or reduce damage to surrounding sunflower fields.

Wildlife agencies combat dense cattail stands by using herbicides, mechanical destruction, burning, grazing, water level manipulation, and combinations of these techniques to improve waterfowl habitat (Beule 1979, Murkin 1979, Murkin and Ward 1980, Kantrud 1986, Schultz 1987, Solberg 1989). To our knowledge, only Linz et al. (1991) have reported on the response of roosting blackbirds to fragmented cattail marshes.

In 1989 we began studying the use of Rodeo® Aquatic Herbicide (registered trademark of Monsanto Company, St. Louis, MO) for fragmenting cattail marshes. Rodeo® is a postemergent, nonselective chemical, containing the active ingredient isopropylamine salt of glyphosate (N-phosphonomethyl) glycine. The U. S. Department of Agriculture does not endorse Rodeo® or any other product used in this study. Our objectives were to evaluate Rodeo® for fragmenting dense cattail marshes used by fall roosting blackbirds and assess the response of breeding and migrating bird populations to fragmented marshes. We update information on 4 marshes treated in 1989 (Linz et al. 1991) and report data from 4 marshes treated in 1990.

STUDY AREA AND METHODS

Test Sites

We treated 4 cattail marshes in Benson and Nelson Counties, North Dakota during August and September 1989. In August 1990 4 marshes in Nelson County were sprayed. These counties are in the prairie pothole region, which is characterized by up to 62 wetlands per km^2 (Stewart 1975). This area receives 77% of its annual precipitation between April and September (North Dakota Agricultural Statistics 1990b). Long-term average annual precipitation and temperature in Devils Lake, a city in the center of the study area, are 42 cm and 3.8°C, respectively. Of about 420,700 ha of tillable land in Benson and Nelson Counties, 52% were planted to wheat, 14% to barley, and 11% to sunflower in 1990 (North Dakota Agricultural Statistics 1991b).

Seven of the 8 test marshes were selected because blackbirds were using them as roost sites. The other marsh was a potential roost site. We analyzed aerial photos of 7 test marshes, using the feature mapping function of a geographic information system (MicroImages, Inc., Lincoln, NE), to determine size, and areal coverage of vegetation and water. Blegens (10.9 ha), Command (5.8 ha), Command West (2.1 ha), Elmers (15 ha; estimated from topographic maps), Kellys (2.0 ha), and Wall-89 (6.6 ha) are Class IV marshes (semipermanent; classification system of Stewart and Kantrud 1971) with uniform stands of cattails. Rose is a permanent lake (Class V) with an inlet (3.2 ha) surrounded by a 10-110 m fringe of cattail. Marquart's Ditch is a shallow narrow waterway (1.2 ha), featuring a heavy stand of cattails and phragmites (*Phragmites* spp.).

Table 1. Cattail density and water depth (mm) in 0.5-m quadrats placed in 8 marshes treated with Rodeo® herbicide. Marshes located in Benson and Nelson Counties, North Dakota.

	Cattail Densities						Water Depth					
	1989		1990		1991		1989		1990		1991	
Wetland	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Blegens[a]	8.9	7.2	1.0	2.6	1.2	2.0	0.0	—	7.7	12.1	32.2	49.4
Command[b]	11.4	9.4	0.2	1.1	1.6	4.5	6.0	11.7	55.9	45.5	206.3	174.9
Rose Lake[c]	11.5	8.5	0.2	0.7	0.0	—	21.0	27.2	0.0	—	0.0	—
Wall-89[d]	7.2	8.5	1.2	2.7	2.5	5.3	1.1	4.1	7.8	13.6	202.1	165.8
Mean SD	9.8	2.1	0.6	0.5	1.3	1.0	7.0	9.7	17.8	25.6	110.2	109.4
Command West[e]			7.8	4.5	0.1	0.3			20.9	10.4	417.6	194.8
Elmers[e]			9.4	2.6	1.6	4.3			0.7	1.5	11.2	23.6
Kellys[e]			6.9	3.4	0.3	1.0			0.0	—	241.3	189.0
Marquart's Ditch[e]			7.7	4.7	0.0	—			0.0	—	59.6	64.3
Mean SD			8.0	1.0	0.5	0.7			5.4	10.3	182.4	185.4

[a]Treated on 15 August 1989 with 5.8 L/ha (2.5 qt/A) Rodeo.
[b]Treated on 29 August 1989 with 6.8 L/ha (2.9 qt/A) Rodeo.
[c]Treated on 29 August 1989 with 7.0 L/ha (3.0 qt/A) Rodeo.
[d]Treated on 9 September 1989 with 6.8 L/ha (2.9 qt/A) Rodeo.
[e]Treated on 28-29 August 1990 with 4.7 L/ha (2.0 qt/A) Rodeo.

Application

In 1989 each marsh was divided into 2 strata of equal width. Each stratum was partitioned into 15 m wide strips and 70% of the strips were randomly selected for treatment (Linz et al. 1991). A fixed-winged agricultural spray aircraft was used to apply Rodeo® at 5.8-7.0 L/ha (1.0 L Rodeo® contains 0.48 kg glyphosate). The herbicide was mixed in a 46.8 L/ha (5 gal/A) solution, containing about 0.23 L/ha (0.1 qt/A) of surfactant (Activator 90, Trademark of Loveland Industries, Inc., Greeley, CO.), 0.4 - 0.6 L/ha (0.25 qt/A) of drift retardant (Chem-trol, Trademark of Loveland Industries, Inc., Greeley, CO.), and sufficient water to bring the solution to final volume.

In August 1990 4 cattail marshes were sprayed with Rodeo® at a rate of 4.7 L/ha. The solution used in 1990 contained a different surfactant (Valent X-77 Spreader, Trademark of Valent, U.S.A. Corporation, Walnut Creek, CA) and the drift retardant was increased to 0.59 L/ha. The pilot was instructed to spray about 70 - 90% of these marshes. No measurable precipitation contacted the treated plants for at least 6 hr after treatment, as recommended by Monsanto (1985).

Determining Efficacy

In 1989, we counted the number of live (green) cattail stems and measured depth of water within 20 quadrats (0.5-m on a side) systematically placed along 4 randomly selected strips designated for treatment in each marsh. We placed 10 quadrats along 2 treated strips in each marsh sprayed in 1990. All quadrats were permanently marked with numbered stakes so they could be reassessed in July and August of subsequent years.

Bird Censuses

Blackbirds roosting in the test marshes in August 1989 were counted twice within 7 days before treatment and twice within 7 days after treatment as they departed the roost at sunrise (Meanley 1965). The pre- and posttreatment counts were averaged for 1989 and compared to the population estimates obtained in mid-August 1990 and 1991.

After the blackbirds departed the marsh, we walked around the periphery of 7 test marshes and recorded all birds seen or heard in and around (<50 m) the marsh. In 1989, a population index of all bird species in each marsh was obtained between 0800-1100 hr at least 2 times within 7 days pretreatment and 2 times within 7 days posttreatment. Populations of birds in the marshes treated in 1989 did not change between pre- and posttreatment censuses (Linz et al. 1991). Therefore, pre- and posttreatment numbers were averaged to oblain the population size of each group of birds in August 1989.

In 1990, all birds using the marshes treated in 1989 were counted between sunrise-1030 hr one time during the periods 7-13 June, 24 July-6 August, and 20-23 August. We censused 3 of 4 marshes treated in August 1990 one time within 7 days prior to treatment. In 1991, birds were censused during 12-20 June, 9-13 July, and 20-22 August. For marshes treated in 1990, we only report and compare data collected in August 1990 and 1991.

Populations of 7 groups of birds, commonly seen in cattail marshes, were chosen as indicators of possible detrimental or beneficial effects due to vegetation changes. Briefly, rails (sora, *Porzana Carolina* and Virginia rail, *Rallus limicola*) forage and nest on the ground in dense vegetation; marsh wrens (*Cistothorus palustris*) forage and nest in dense emergent vegetation; ducks (Anatinae) and ducklings prefer an interspersion of vegetation and open areas of water for

cover and foraging; and shorebirds (Charadriidae, Scolopacidae, and Reurvirostridae) normally feed in shallow water in open areas of marshes. We counted breeding male red-winged blackbirds (*Agelaius phoeniceus*) and yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) in June 1990 and 1991. Territorial redwings were seen near the marsh edge; whereas, male yellowheads were seen in central zones of marshes (Stewart 1975).

Statistical Analyses

For those marshes treated in 1989, a randomized complete block ANOVA, treating marshes as blocks, was used to assess differences among years in number of live cattail stems and water depth in the quadrats (McClave and Dietrich 1982:404-434). Tukey's (HSD) was used to separate the means; $P < 0.05$ was accepted as significant. Only quadrats containing at least 1 live cattail before treatment were included in the analysis. The Kruskal-Wallis test was used to determine if the numbers of birds within each taxonomic group differed among years (Conover 1980:229-233, SAS 1988:713-726).

For marshes treated in 1990, a paired-t test was used to assess difference between years in number of live cattail stems and depth of water found within the quadrats. Wilcoxon 2-sample test was used to determine if the numbers of birds within each taxonomic group differed between 1990 and 1991 (Conover 1980:215-227). We set the alpha level *a priori* at 0.1 for the nonparametric tests to reduce the chances of making a Type II error (i.e., falsely assuming no treatment effect on the indicator bird populations; Tacha et al. 1982).

RESULTS

Efficacy

Live cattail density in marshes treated in 1989 differed significantly between pretreatment and posttreatment years ($P = 0.0001$; Table 1). In 1991, cattail densities in the quadrats were 87% lower than pretreatment densities. Analyses of aerial photos taken in July 1991, indicated that live cattails covered only 0.4% of Rose Lake, compared with 31% of Command, 12% of Blegens, and 23% of Wall-89.

In 1991, water covered 64% of Rose Lake, 16% of Command, 30% of Blegens and 33% of Wall-89. Overall, water depths in these marshes increased from 7.0 mm in 1989 to 110.2 mm in 1991 ($P = 0.0001$). Average water depths within Command, Blegens, and Wall-89 increased from 2.4 mm in 1989 to 146.9 mm in 1991 (Table 1). In contrast, water depth in Rose Lake decreased from 21.0 to 0 mm between 1989 and 1990-91. A combination of low water levels and cattle grazing probably contributed to the near total loss of cattails in Rose Lake.

Live cattail densities in those marshes treated in 1990 with 4.7 L/ha of Rodeo® were significantly lower in 1991 ($P = 0.0001$; Table 1). After 1 year, 6% of the cattails survived in the sprayed strips. Water depths within the 4 marshes treated in 1990 increased from 5.5 mm in 1990 to 182.5 mm in 1991 ($P = 0.0001$; Table 1). In 1991, live cattails covered 3% of Command West and 14% of Kellys. Open water covered 16% of Command West and 15% of Kellys.

Blackbird Numbers

Fragmenting the dense cattail stands effectively eliminated the use of the test marshes by roosting blackbirds. In August 1989 a median of 12,720 (range = 3,180-68,390) blackbirds were using the 4 marshes treated in 1989 (Table 2). No blackbirds were observed in these marshes in late summer 1990 and a median of 12 (range = 0 - 429) were seen in 1991. No new roosts were found within 5 km of Wall-89 and Rose Lake in late summer 1990 and 1991. In 1990, a new roost, harboring 16,900 blackbirds, formed in a cattail marsh within 500 m of Command. This marsh was treated in late August 1990. In 1991 a roost of about 5,500 birds formed in a marsh adjacent to Command. We did not look for new roosts in the area surrounding Blegens. Command West, Elmers, and Marquart's Ditch harbored a median of 16,875 blackbirds in 1990 and 2 in 1991. The small numbers of blackbirds using Wall-89 and Marquart's Ditch in 1991 were roosting in small patches of unsprayed cattails.

Table 2. Numbers of blackbirds roosting in 8 cattail marshes treated with Rodeo® herbicide in 1989. Marshes located in Benson and Nelson Counties, North Dakota.

	Number of Blackbirds		
Wetland	1989	1990	1991
Blegens[a]	13,120	0	25
Command[b]	12,320	0	0
Rose Lake[c]	68,390	0	0
Wall-89[d]	3,180	0	429
Median	12,720	0	12
Command West[e]		16,875	4
Elmers[e]		21,655	0
Kellys[e]		0	0
Marquart's Ditch[e]		4,080	400
Median[f]		16,875	2

[a]Treated on 15 August 1989 with 5.8 L/ha (2.5 qt/A) Rodeo.
[b]Treated on 29 August 1989 with 6.8 L/ha (2.9 qt/A) Rodeo.
[c]Treated on 29 August 1989 with 7.0 L/ha (3.0 qt/A) Rodeo.
[d]Treated on 9 September 1989 with 6.8 L/ha (2.9 qt/A) Rodeo.
[e]Treated on 28--29 August 1990 with 4.7 L/ha (2.0 qt/A) Rodeo.
[f]Does not include Kellys.

Bird Populations

Bird counts on the 4 marshes treated in 1989 showed marsh wren and rail numbers decreased significantly after treatment (Table 3). For example, marsh wrens decreased from a median of 30 (range = 20 - 34.5) birds in August 1989 to a median of 1 (range = 0-5) bird in August 1991.

Bird counts in August 1991 on 3 marshes treated in 1990 also indicated marsh wrens were adversely effected by the reduction of cattails in the marshes ($Z = 1.75$, $P = 0.08$). The numbers of adult ducks ($Z = 0.93$, $P = 0.35$), ducklings ($Z = 1.29$, $P = 0.20$), rails did not differ between years ($Z = 0.24$, $P = 0.81$).

Table 3. Numbers of birds observed in 4 cattail marshes treated with Rodeo® herbicide in August 1989. Marshes located in Benson and Nelson Counties, North Dakota.

	June			July			August			
	1990	1991		1990	1991		1989	1990	1991	
Taxon	Median	Median	P[a]	Median	Median	P[a]	Median	Median	Median	P[b]
Anatinae[c]										
(Adults)	37.0	15.5	0.56	45.5	11.5	0.19	19.2	58.5	31.0	0.70
(Ducklings)	0.0	0.0		10.5	10.0	0.88	1.0	4.5	5.0	0.94
Charadriidae[d]										
Recurvirostridae[d]										
Scolopacidae[d]	4.5	6.0	0.66	23.0	31.5	0.88	32.0	49.0	9.5	0.49
Rallidae[e]	1.0	0.0	0.07	3.0	1.0	0.55	4.0	3.0	0.0	0.08
Troglodytidae[f]	37.5	2.0	0.03	20.5	1.5	0.03	30.0	8.0	1.0	0.02
Red-winged blackbirds[g]	9.0	4.5	0.38							
Yellow-headed blackbirds[g]	4.5	11.0	0.24							

[a]Wilcoxon 2-sample test.
[b]Kruskal-Wallis test.
[c]Ducks.
[d]Broadly defined as shorebirds.
[e]Soras (*Porzana carolina*) and Virginia rails (*Rallus limicola*).
[f]Marsh wrens (*Cistothorus palustris*).
[g]Breeding males.

DISCUSSION

Efficacy of Spray Applications

Under the environmental conditions of northeastern North Dakota, Rodeo® herbicide applied at 5.8 - 7.0 L/ha in August effectively controls cattails for at least 2 years. Rodeo® applied at 4.7 L/ha significantly reduced cattail density after 1 year. Comes and Kelly (1989) found glyphosate applied at 3.4 kg/ha (equivalent to 7.0 L/ha Rodeo®) in mid-September was optimum for controlling cattails in a seasonal flowing drainage ditch in central Washington. In August 1985 and July 1986, Solberg (1989) aerially applied Rodeo® at 7.0 to 8.8 L/ha on cattail marshes in South Dakota and achieved nearly 100% control of cattails. Cattails regenerate quickly on mud-flats and shallow water (<30 cm) marshes (Solberg 1989, Merendino and Smith 1991); whereas, wetlands with at least 30 cm of water will remain free of cattail for several years (K. Higgins, pers. commun., U.S. Fish and Wildlife, Brookings, South Dakota). In 1990, we observed small, dense patches of immature cattails (<8 cm tall) growing where spikes of mature seeds had fallen into shallow water. In addition, dense stands of taller (<30 cm) seedling cattails grew in areas of the marshes where mud flats were created by water evaporation. In Wall-89 these patches of cattails reached 120 to 150 cm tall in 1991 but did not flower.

Cattails killed in 1989, were still present in September 1991, but the majority had fallen into the water. Mason and Bryant (1975) reported dead cattail (*Typha angustifolia*) shoots collapse after 2 years and take an additional 2 years to decompose completely. Burning the dead cattails in the fall or spring following treatment may be an effective way of rapidly creating openings in treated marshes. Additionally, reducing the amount of litter in the marsh may lessen any adverse effects on water quality caused by the decomposition of large amounts of vegetation. We will continue annually to assess the regrowth of cattails in the treated marshes, until the cattails reach pretreatment densities.

Bird Populations

This study indicates fragmenting solid stands of cattails with herbicide reduces their use by fall-migrating blackbirds. We speculate that dispersing blackbirds may dissipate and reduce sunflower damage. However, studies are needed to quantify sunflower damage patterns before formulating specific management recommendations.

Populations of marsh wrens and rails appear to decrease with the eradication of cattails, probably because these birds require dense emergent vegetation for foraging and nesting. We expect these populations of birds will begin to rebound as cattails repopulate the marsh. Numbers of ducks and shorebirds did not differ between pretreatment and posttreatment counts. However, their numbers are probably correlated with water levels and cattail densities. Generally, marshes with dense stands of tall emergents are used less by waterfowl than marshes with interspersions of open water and emergent vegetation (Kantrud 1986). Normal water levels coupled with broken stands of emergent vegetation should increase the number of adult and young waterfowl using the test marshes

(Kaminski and Prince 1981, Murkin et al. 1982). Marshes with high water levels or those that are dry probably would not harbor many shorebirds.

Economics of Using Rodeo®

If managing cattail marshes proves effective in dispersing blackbirds, individual growers may substantially reduce sunflower losses. Rodeo® may be cost-beneficial, especially if costs are amortized over a number of years. For example, if a 10 ha (25 A) cattail marsh harbors 20,000 blackbirds and each bird eats 14 g (1/2 ounce) sunflower per day (a conservative estimate, Besser 1979), this flock will eat 280 kg/day (617 lb/day) at a cost of $61.70/day (@ $0.10 lb). Over 30 days, the birds may damage 8,400 kg (18,518 lb) of sunflower at a cost of $1,852.00. Cost of aerially applying Rodeo®, using 5.8 L/ha (2.5 qt/A), is about $151.00/ha ($61.00/A). Most of the cost (88%) is for the herbicide. The cost of treating 70 to 100% of a 10 ha marsh with 5.8 L/ha Rodeo® is $1,057 - $1,510. If the treatment is effective (i.e., a blackbird roost does not form), individual growers may recoup their costs for treating the marsh in 1 year. Additionally, the sunflower grower may enhance the value of the marsh by improving the habitat for marsh birds, especially waterfowl (Kantrud 1986, Solberg 1989).

Preliminary Recommendations

The USDA-APHIS, North Dakota Animal Damage Control has received funding for demonstrating the use of Rodeo® for controlling cattails used by roosting blackbirds (Louis Huffman, North Dakota Animal Damage Control, Bismarck, ND, pers. commun.). Therefore, we advance the following (*albeit* preliminary) recommendations: 1.) For maximum cost-effectiveness, limit treatment to cattail marshes containing water and traditionally harboring large numbers of birds. The water will slow regrowth of cattails by inhibiting reproduction by seeds. 2.) Apply Rodeo® at 5.8 L/ha (2.5 qt/A). Under normal growing conditions, this rate should be adequate to kill the majority of the cattails (Cal Messersmith, Department of Crop and Weed Science, North Dakota State University, pers. commun.). (A 100 gal tank solution contains 12.5 gal Rodeo®, 2 qt surfactant, 5 qt drift retardant, and sufficient water to bring to final volume). 3.) At least 70% of the cattail should be killed by alternately spraying 15 m (50 ft) wide strips and skipping about 6.4 m (21 ft) between strips. Data gathered to date indicate that birds will not roost in marshes with narrow strips of live cattail. 4.) Although we have evidence that Rodeo® applications sprayed from mid-July to early September effectively kills cattails, ideally treatments should be made from August until first frost. This timing will (1) maximize herbicide efficacy, (2) decrease the possibility of spray drift damaging small grain crops, and (3) avoid most young waterfowl broods.

Concurrent and Future Research

In 1990-91, Henry (1992) conducted field and laboratory studies on the response of aquatic invertebrates to Rodeo® herbicide. She found no difference in the number of invertebrates surviving in untreated and treated marshes. Laboratory experiments corroborated the field tests.

In 1992, scientists from North Dakota State University and Denver Wildlife Research Center will (1) gather data on the efficacy of managing blackbird roosting sites for dispersing and reducing sunflower damage, (2) assess the effects of using Rodeo® on marsh water quality, aquatic invertebrate populations, breeding bird populations, and winter cover for gallinaceous birds, and (3) continue to evaluate the response of cattails to various application rates of Rodeo®.

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LITERATURE CITED

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

BESSER, J. F. 1979. Capability of red-winged blackbirds to damage ripening sunflower. Bird Damage Res. Rep. No. 113. Denver Wildl. Res. Ctr. 4 pp.

BOMFORD, M., and P. H. O'BRIEN. 1990. Sonic deterrents in animal damage control: A review of device tests and effectiveness. Wildl. Soc. Bull. 18:411422.

COMES, R. D., and A. D. KELLEY. 1989. Control of common cattail with postemergence herbicides. J. Aquat. Plant Manage. 27:20-23.

CONOVER, W. J. 1980. Practical Nonparametric statistics. Second ed. John Wiley & Sons Publ., New York, N.Y. 493 pp.

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. 431 pp.

HENRY, C. J. 1992. Effects of rodeo herbicide on aquatic invertebrates and fathead minnow. M.S. Thesis, South Dakota State Univ., Brookings. 63 pp.

HOTHEM, R. L., R. W. DEHAVEN, and S. D. FAIRAIZL. 1988. Bird damage to sunflower in North Dakota, South Dakota, and Minnesota, 1979-1981. U.S. Fish Wildl. Serv. Tech. Rep. 15. 11 pp.

KAMINSKI, R. M., and H. H. PRINCE. 1981. Dabbling duck and aquatic macroinvertebrate responses to manipulated wetland habitat. J. Wildl. Manage. 45:1-15.

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. 15 pp.

KNITTLE, C. E., J. L. CUMMINGS, G. M. LINZ, and J. F. BESSER. 1988. An evaluation of modified 4-aminopyridine baits for protecting sunflower from blackbird damage. Proc. Vertebr. Pest Conf. 13:248-253.

LAMEY, H. A., D. K. McBRIDE, R. K. ZOLLINGER, J. L. LUECKE, M. P. MCMULLEN, and D. R. BERGLUND. 1992. 1990 sunflower grower survey of pest problems and pesticide use in North Dakota. North Dakota State Univ. Extension Service. Ext. Report No. 9., Fargo, ND. 12 pp.

LINZ, G. M., D. L BERGMAN, S. T. SWANSON, and W. J. BLEIER. 1991. Managing cattail marshes with glyphosate to reduce blackbird populations: 1990 up-

date. Proc. Sunflower Res. Workshop. Fargo, North Dakota, pp. 76-85.
MASON, C. R, and R. J. BRYANT. 1975. Production, nutrient content, and decomposition of *Phragmites communis* Trin. and *Typha angustifolia* L. J. Ecol. 63:71-95.
McCLAVE, J. T., and F. H. DIETRICH, II. 1982. Statistics. Dellen Publ. Co., San Francisco, California. 766 pp.
MEANLEY, B. 1965. The roosting behavior of the red-winged blackbird in the Southern United States. Wilson Bull. 77:217-228.
MERENDINO, M. T., and L. M. SMITH. 1991. Influence of drawdown date and reflood depth on wetland vegetation establishment. Wildl. Soc. Bull. 19:143-150.
MONSANTO. 1985. Rodeo herbicide for aquatic vegetation management. Monsanto Agr. Prod. Co. Tech. Man. 20 pp.
MURKIN, H. R. 1979. Response by waterfowl and blackbirds to an experimentally manipulated cattail marsh. M.S. Thesis, McGill Univ. 97 pp.
MURKIN, H. R., and P. WARD. 1980. Early spring cutting to control cattail in a northern marsh. Wildl. Soc. Bull. 8:254-256.
MURKIN, H. R., R. M. KAMINSKI, and R. D. TTTMAN. 1982. Responses by dabbling ducks and aquatic invertebrates to an experimentally manipulated cattail marsh. Can. J. Zool. 60:2324-2332.
NORTH DAKOTA AGRICULTURAL STATISTICS SERVICE. 1990a. Blackbird evaluation survey. Cooperative Extension Newsletter, Fargo, ND. 2 pp.
NORTH DAKOTA AGRICULTURAL STATISTICS SERVICE. 1990b. North Dakota agricultural statistics 1990. Agricultural Statistics No. 59. North Dakota State Univ., Fargo, ND. 102 pp.
OTIS, D. L., and C. M. KBLBURN. 1988. Influence of environmental factors on blackbird damage to sunflower. U.S. Fish and Wildl. Tech. Rep. 16.11 pp.
SAS INSTITUTE, INC. 1988. SAS user's guide: statistics. 6.03 ed. SAS Institute, Inc., Cary, N.C. 1028 pp.
SCHULTZ, B. D. 1987. Biotic responses of Typha-monodominant semipermanent wetlands to cattle grazing. M.S. Thesis, South Dakota State Univ., Brookings. 92 pp.
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. 105 pp.
STEWART, R. E. 1975. Breeding birds of North Dakota. Tri-College Center Environ. Studies, Fargo. 295 pp.
STEWART, R. E., and H. A. KANTRUD. 1971. Classifica-