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Abstract

In the Prairie Pothole Region of North Dakota and South Dakota, blackbirds (Icteridae) gather by the thousands in large premigratory roosts in late summer and early fall. Wetlands dominated by cattails (*Typha* spp.) provide ideal roosting habitat for these aggregations. Sunflower fields near large roosts can receive substantial damage. To eliminate potential roosting sites, Wildlife Services of the U.S. Department of Agriculture has implemented a cattail management program that aerially sprays dense cattail stands with the herbicide glyphosate [N-(phosphonomethyl) glycine]. The continued viability of the program depends on a positive benefit-cost ratio and minimal environmental impacts. In this paper, we discuss the economics and ecological implications of cattail management in the northern Great Plains.

Introduction

Bird Damage to Sunflower. The potential for blackbird (Icteridae) damage probably limits sunflower acreage in North Dakota, South Dakota, and Minnesota. Blackbird species that damage sunflower, in order of importance, are the red-winged blackbird (*Agelaius phoeniceus* L.), common grackle (*Quiscalus quiscula* L.), and yellow-headed blackbird (*Xanthocephalus xanthocephalus* Bonaporte). After nesting season ends in July, the three species aggregate in large night roosts in wetlands with expansive stands of cattail (*Typha* spp.), which provide shelter. Blackbirds begin to damage sunflower at the beginning of seed-set (anthesis) in August. The greatest amount of damage occurs during the first 2½ weeks of

anthesis (Cummings et al., 1989), but damage will continue until harvest in October. Sunflower kernels are sought because they are a high-calorie food that meets the energy demands of annual feather replacement and the premigratory drive for fat accumulation.

Peer et al. (2003) developed a bioenergetic model to estimate annual sunflower consumption by males and females of the three major blackbird species. The model assumed that all species fed on sunflower in proportion to dietary contents of specimens collected while returning to roost in August and September. Including the hull weight, which is discarded by birds but counted in the market price, male red-winged blackbirds (RWBL) ate 346 g of sunflower, followed by male common grackles (COGR) (334 g), male yellow-headed blackbirds (YHBL) (310 g), female COGR (288 g), female RWBL (210 g), and female YHBL (174 g). Multiplied by the total blackbird population in the northern Great Plains region during late summer and fall (75 million comprising 52% RWBL, 25% COGR, 23% YHBL), the amount of sunflower eaten and destroyed per season was about 21 million kg or ~US$5.4 million (at US$0.26/kg sunflower market price). The damage estimated by the bioenergetic model approximated empirical estimates of damage from field assessments. These assessments, done in 1979 and 1980, showed that blackbirds damaged 20 million kg (0.87% of total production) and 30 million kg (2.65% of production) for those years, respectively (Hothem et al., 1988).

Usually, bird damage is clumped around cattail-dominated wetlands, whose abundance of vegetation provides excellent roosting and loafing cover (Otis and Kilburn, 1988). By disrupting this link between roosting habitat and bird damage, Wildlife Services expects to reduce the impact of blackbird damage on sunflower production. In 1991, Wildlife Services initiated a statewide operational cattail management program in North Dakota and South Dakota. The objectives were to reduce and maintain blackbird damage to <5% for individual producers, while keeping the benefit-cost ratio of the program above 1:1. Success of the cattail management program will depend not only on a positive benefit-cost ratio but on the scientific approach used to ensure the integrity of ecological processes in treated wetlands. In this paper, we address these two tenets by reviewing the existing literature.

Biology of Cattails. Historically, vegetation in semipermanent wetlands of the northern Great Plains consisted of several species of bulrush (*Scirpus* spp.) and sparse stands of common cattail (*Typha latifolia* L.), an indigenous species (Kantrud, 1986). By the 1970s, narrow-leaved cattail (*T. angustifolia* L.), which had been introduced in the U.S., invaded this region. The two cattail species hybridized to produce *T.* x *glauca* Godron, a robust plant that forms dense homogenous stands, unlike the sparse stands typical of common cattail (Weller, 1975; Davis and van der Valk, 1978). The hybrid is more tolerant of continuous inundation and seasonal draw-downs than the native species and can quickly colonize a wetland, out-competing and excluding other wetland plant species.

Cattails are found in several habitats, including wetlands, fens, margins of ponds and lakes, roadside ditches, irrigation canals, and backwater areas of rivers and streams. Water depths >76 cm usually preclude the formation of dense stands of hybrid cattail. Cattail stands produce an enormous quantity of litter; and established stands will grow on soils with high amounts of organic matter. An extensive rhizome system helps with the maintenance and expansion of existing stands; whereas, seed dispersal is responsible for invasion and colonization of new sites. Each cattail inflorescence may have >100,000 fruits. The spike-

like inflorescence bursts at maturity, releasing the fruits, which if wind-aided can spread widely over the landscape. Each fruit has bristly hairs that enhance wind dispersal. When the fruit comes in contact with water, the pericarp opens rapidly, releasing the seed.

Environmental Effects of Glyphosate. Glyphosate [N-(phosphonomethyl) glycine], formulated under various commercial brand names, is the product most commonly used to chemically manage cattails. Glyphosate is a nonselective, nonresidual, postemergence herbicide registered in the United States by the Environmental Protection Agency. Once applied to the foliage, glyphosate is translocated throughout the plant. It inhibits protein synthesis by blocking the shikimic acid pathway (Cole, 1985), a metabolic pathway missing in animals. Therefore, glyphosate is considered practically nontoxic to aquatic invertebrates (Buhl and Faerber, 1989; Henry et al., 1994), fish (Folmar et al., 1979), algae, and submerged macrophytes (Maule and Wright, 1984). Glyphosate loses its phytotoxicity on contact with water and dissipates rapidly by (1) adhering to suspended soil particles and bottom sediment, (2) microbial degradation, and (3) photolysis (Bronstad and Friestad, 1985). Glyphosate does not bioaccumulate in fish, but applications in lentic waters, where low levels of dissolved oxygen or high temperatures may exist, may be hazardous to fry (Folmar et al., 1979).

Applications of glyphosate are made using a linear pattern consisting of 15-m treated strips alternating with 6-m bands of living untreated cattails. Mats of floating dead cattails may exist for two to three years after treatment, but their presence will vary among wetlands because rates of decomposition are influenced by physical, chemical, and biological processes unique to each wetland (Davis and van der Valk, 1978). Eventually, the treated strips become open-water areas. Treatment effects can last for >6 years in wetlands with stable water depths >30 cm (Merendino and Smith, 1991).

Experiments conducted by Linz et al. (1999) showed that dissolved oxygen (D.O.) concentrations were not suppressed in wetlands that had received prior applications of glyphosate. The authors hypothesized that the newly formed open areas in the treated wetlands allowed for greater amounts of wave action and wind spray, which increased the surface area for oxygen absorption at the air-water interface. This, in turn, may have helped move D.O. down the water column, offsetting any reduction in D.O. from rapid decomposition of dead cattail (Cole, 1985). Large mats of duckweed (*Lemna* spp.) often formed on the water surface a year after treatment, suggesting that these floating macrophytes benefited from increased sunlight (previously absorbed by the cattail canopy) and perhaps from decreased competition for plant nutrients, such as nitrate and phosphate (Linz et al., 1997).

Invertebrate densities were either similar or greater in glyphosate-treated wetlands than untreated wetlands (Linz et al., 1999). Grazing and predacious invertebrates were probably able to sustain or enhance their numbers in treated wetlands because of the increased availability of foods and nutrients residing in the decomposing vegetation and algae. Because the density of aquatic invertebrates is a major determinant of waterfowl use (Murkin and Kadlec, 1986), it was not surprising that waterfowl increased their use of treated wetlands (Solberg and Higgins, 1993; Linz et al., 1997). The flourishing populations of invertebrates in the newly opened wetlands were exploited mainly by dabbling ducks and their broods (Solberg and Higgins, 1993).

Discussion

Current Status of the Program. Wildlife Services has sprayed 17,910 ha of cattails since the inception of the program 13 years ago (Ryan Wimberly 2004, USDA Wildlife Services, Bismarck, ND, unpublished data). The average number of hectares treated annually in North Dakota (1,378 ha) represents <1% of the total estimated area of cattail stands growing yearly in North Dakota, ~225,000 ha (Ralston et al., 2004). The minimum size of wetlands for entry into the program has been reduced to 4 ha. The treatments are applied by helicopter with a mounted boom. Because helicopters have fewer problems with offsite spray drift compared to fixed-wing aircraft, Wildlife Services has pushed for earlier dates of treatment. If glyphosate applications are made during cattail's more active period of growth (e.g., mid-July or early August), the stands can be flattened in the same year of treatment, potentially providing within-year protection from blackbird damage.

Cost-Benefit Analysis. The cost of the program is completely covered by Wildlife Services. In 2003, the total cost for treating one hectare was US$96; this included the glyphosate (4.7 L/ha), surfactant, drift retardant, and pilot services. Since 1995, the cost per hectare has decreased nearly 30% (Linz et al., 1995). Assuming daily sunflower consumption by one blackbird is 0.009 kg/day (Peer et al., 2003), each bird will take 0.27 kg over a damage period lasting about 30 days. Using a five-year (1993-97) market price for sunflower of US$0.26/kg, a single bird will damage about US$0.07 of sunflower, annually. Thus, an average of 1,376 blackbirds/ha is needed to reach a 1:1 cost-benefit ratio (i.e., application cost at US$96.33 ha ÷ bird damage at US$0.07). However, if sunflower is rotated within the locality of the treated wetland and the wetland maintains stable water depths for four years, only 344 birds/ha would be needed to reach a 1:1 cost-benefit ratio.

Cattail-dominated wetlands harboring >344 blackbirds/ha are relatively common, and roosts containing >1,000 blackbirds/ha are located each year in sunflower growing areas of the northern Great Plains (Linz et al., 1991). Using linear regression analyses, Linz et al. (1995) discovered positive relationships between (1) blackbird density and hectares of live cattails and (2) sunflower production loss and blackbird numbers. These relationships indicated that fragmentation of cattails might disperse blackbirds and reduce sunflower damage, at least locally. Dispersal of blackbird roosts over larger areas might result in more growers receiving slightly damaged heads; however, the damaged heads can compensate for early damage by producing heavier achenes (Sedgwick et al., 1986).

Nontarget Effects of Cattail Reduction. Fragmentation of cattails can impact use by wetland-dependent species, particularly those requiring dense vegetation for breeding or winter cover. Breeding populations of marsh wrens (*Cistothorus palustris* Wilson), sora (*Porzana Carolina* L.), YHBL, and RWBL were reduced after cattail reduction (Linz et al., 1996). Krapu et al. (1979) noted that mallards, a species that typically nests in uplands, will also nest on elevated sites within cattail-dominated wetlands. Muskrats (*Ondatra zibethicus* L.) eat cattail rhizomes and build their lodges with cattail stems. The huts are sometimes used as platform nests by waterfowl and other bird groups. Other species of wildlife use residual cattail vegetation for winter cover, including important game species, such as ring-necked

pheasants (*Phasianus colchicus* L.) and white-tailed deer (*Odocoileus virginianus* Zimmermann).

The negative effects of a rapid reduction in cattail density may be lessened by staggering treatments within and among wetland complexes. By staggering treatments, several successional stages of emergent vegetation would be created. We recommend a mosaic of roughly equal amounts of open water, live emergent vegetation, and floating mats of dead vegetation to maximize avian diversity in treated wetlands. This combination could provide visual isolation and vertical nesting substrate for breeding pairs of passerines, concealment for broods, substrate for aquatic invertebrates, and nesting platforms for waterbirds (Linz et al., 1997). At the same time, large roosts of blackbirds would be prevented.

Management Implications. There is often serious disagreement among agricultural and wildlife groups on the proper management strategies to solve wildlife conflicts with agriculture. However, in this case, cattail management seems to reduce blackbird damage (thereby satisfying agriculture issues [Linz et al., 1995]), while increasing waterfowl use and production, thus meeting some of the goals of the wildlife community. The argument could be made that cattail management returns wetlands of the northern Great Plains to natural physiognomies that existed prior to the invasion of narrow-leaved cattail, and therefore should be beneficial to native species of animals and plants. It might be difficult, however, to obtain the ideal ratio of open water and emergent vegetation that would enhance numbers of all species, because of local and regional environmental factors.

Of course, many other issues besides avian diversity are involved and further complicate the implementation of a cattail management program. For example, some wetlands have multiple owners, are owned by absentee landowners, or are owned or controlled by resource agencies. Some growers argue that managing cattails on selected wetlands merely shifts the problem to others. The former can managed through better communication and access among participating agencies and landowners; whereas, the latter issue will always accompany any large scale management program.

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