AVIAN USE OF RICE BAITED TRAYS ATTACHED TO CAGES WITH LIVE DECOY BLACKBIRDS IN CENTRAL NORTH DAKOTA

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

MASTER OF SCIENCE

ABSTRACT

Winter, Jamison Brian, MS, Natural Resources Management Program, College of Graduate and Interdisciplinary Studies, North Dakota State University, April 2010. Avian Use of Rice Baited Trays Attached to Cages with Live Decoy Blackbirds in Central North Dakota. Major Professor: Dr. William Bleier.

The viability of a management program using DRC-1339 (3-chloro-4-methylanaline hydrochloride) rice bait and live decoy blackbirds to reduce avian depredation on sunflower was assessed. In fall 2007 and 2008, observations were conducted at bait trays attached to decoy traps in central North Dakota. Study participants randomly visited the bait sites for 1-h intervals throughout daylight hours to record numbers, species, and ages (when possible) of blackbirds (targets) and non-blackbirds (non-targets) on the bait trays and nearby baited gravel roadsides. Researchers observed the bait trays for 1011 h and recorded 3,888 birds, representing 25 species, 12 families, and 3 unidentified birds. The red-winged blackbird (*Agelaius phoeniceus*) (n=3,006) was the most common target species, whereas clay-colored sparrows (*Spizella pallida*) (n=12) and savannah sparrows (*Passerculus sandwichensis*) (n=12) were the most numerous non-target species observed on trays. The sparrow family (Emberizidae) was the most prevalent of non-target observations, with 50 individuals representing 8 species and 21 unidentified individual sparrows. Overall risk to non-target species appears minimal, and use by blackbird species was minimal in comparison to the local population. Baited roadsides were used infrequently by blackbirds. Based on this research, use of DRC-1339 rice-baited trays with accompanying live decoys and rice-baited roadsides are not cost-effective methods of reducing blackbird damage to sunflower.

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INTRODUCTION

Agricultural production throughout much of the Midwest is one of the most significant factors in rural economies. The commercial production of a variety of crops, coupled with the reduction of native habitats, has often led to conflicts between humans and wildlife who share the same food resources. These conflicts are particularly noticeable when that resource is of economic value. Croplands can offer an alternative source of food for many species, but crop depredation can lead to substantial economic losses for some producers. Granivorous birds, especially blackbirds (Icteridae), have a negative impact on corn and sunflower production in the northern Great Plains and on rice production in Louisiana, costing producers millions of dollars annually (Wilson et al. 1989, Dolbeer 1990, Linz and Hanzel 1997).

Over the long history of wildlife management, a host of techniques have been employed to manage depredation by blackbirds. Non-lethal methods have included altering farming practices, using mechanical frightening devices, hazing with aircraft, and planting lure plots to reduce losses (Besser 1978, Linz et al. 1993, Hagy et al. 2008). These non-lethal methods have not always produced adequate results (Guarino 1984). As a result, lethal methods using poisons and surfactants have been introduced under some circumstances. Lethal methods have included shooting, spraying toxicants on roosts, and using poisoned baits (Snyder 1961, Handegard 1988, Cummings et al. 1990, Heisterberg et al. 1990). The avicide DRC-1339 (3-chloro-4-methylanaline hydrochloride) continues to be examined for use as an avian toxicant to reduce damage caused by foraging blackbirds (Glahn and Wilson 1992a, b).

The use of pesticides to control pest animal populations has been used for many years (Tome et al. 1991, Barras 1996); however, pesticides are potentially hazardous to non-target species (Schafer 1984, Tome et al. 1991). There are two primary modes of hazards to non-targets, primary and secondary. Primary hazards are a result of direct exposure to a poison, such as consuming poisoned baits. Secondary hazards are indirect and could come from the consumption of poisoned prey items (Schafer 1984). Whether or not a species is at risk can depend on the toxicity of poisons to the species in controlled lab trials (Schafer 1970, Felsenstein et al. 1974, Cunningham et al. 1979, Schafer et al. 1983, Cummings et al. 1992), as well as the abundance, behavior, and ecology of the non-target species specific to baiting regions or sites (Kenyon 1996, Knutsen, 1998, Kostecke 1998). Non-target risks may be reduced because DRC-1339 is somewhat specific to certain families of birds and does not persist in an exposed environment or in biological systems (USDA 1994).

Several studies have been conducted to assess the primary and secondary hazards associated with a variety of baiting programs to reduce avian pest species in the northern Great Plains (Linz et al. 1995, Kenyon 1996, Knutsen 1998, Kostecke 1998). However, no such studies have been conducted using elevated bait trays, in particular trays attached to cages containing captive live decoy blackbirds, nor have any of these studies involved ripening sunflower. This field research was developed to determine avian use of rice-baited trays attached to cages containing live decoy blackbirds and avian use of rice-baited roadsides in central North Dakota. The study was conducted during fall migration (August through October) of blackbird species through the study area. The objectives of this study were to; 1) assess the avian use and non-target risks of DRC-1339 rice baits on trays attached to the top of decoy traps; 2) examine the avian use and impact on baited trays of baited roadsides adjacent to those trays; and 3) compare site selection and two unique cage designs for attracting blackbirds.

LITERATURE REVIEW

2.1. Blackbirds:

Blackbird (Icteridae) species nest throughout North Dakota and the majority of the Prairie Pothole Region (PPR). Red-winged blackbirds (*Agelaius phoeniceus*) range from the Atlantic to the Pacific coast of North America, and range as far south as portions of Costa Rica and as far north as southern Alaska and central Canada. Red-winged blackbirds are highly gregarious and will travel, feed, and roost together outside of the breeding season (Orians 1961). Red-winged blackbirds migrate in large groups, usually after the fall molt is complete, which in part is why this particular species causes so much crop damage; a great majority of the depredation is caused by local breeding populations and young of the year (Dolbeer 1978, Besser et al. 1983). Yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) breed throughout much of the western and central portions of North America. Fall migration of yellow-headed blackbirds in the Dakotas takes place between August and late September; however, some individuals may remain into October (SDOU 1991). Common grackles (*Quiscalus quiscula*) are found throughout western and southern portions of Canada to the Atlantic coast, and south to the Gulf of Mexico (Bent 1958). Common grackles migrate through the Dakotas in September and October (Bray et al. 1973).

Blackbird species form communal roosts where large flocks of blackbirds that may be feeding in one or many locations congregate. These roosts are often located in dense cattail (*Typha spp.*) stands that provide some protection from the elements, as well as warmer temperatures above water during cool fall nights.

These roosts are utilized during darkness and often mid-day hours where water can be found as well as protection from predators. Blackbirds start leaving roost sites around sunrise and occasionally travel great distances to feeding sites. Blackbirds may then return to roost sites during mid-day or as late as 1.5 to 2 hours before sunset, although on cloudy days, returns to roosts may be several hours earlier than on clear days (Meanly 1965, Martin 1977, Orians 1961).

2.2. Sunflower Depredation:

Sunflower (*Helianthus annuus*) production in the United States is concentrated in the Dakotas with North Dakota ranked as the number one producing state, contributing approximately 57% of the entire US production (North Dakota Agricultural Statistics Service 2007). The large-scale production of sunflowers in North Dakota began in the late 1960's and coincided with the development of high oil content hybrid sunflower varieties (Cobia and Zimmer 1978). In 1969, 44,500 ha of sunflowers were planted in North Dakota, and by 1977, the acreage had increased to 526,000 ha (Cobia and Zimmer 1978). Sunflower production in North Dakota is concentrated in the Missouri Coteau and Drift Prairie subdivisions (Baltezore et al. 1994).

The Missouri Coteau and Drift Prairie subdivisions of North Dakota are located within the PPR of the United States which is characterized by an abundance of wetlands and cattail marshes (Ralston et al. 2004). Cattails spread across the state and increased in density within wetlands as changes occurred in agriculture; in addition, the decrease in prairie wildfires facilitated the spread (Kantrud 1992).

Blackbirds feed on sunflower seeds and cause significant economic losses to ripening sunflower (and also corn) in central regions of North America (Besser 1985, Dolbeer 1990, Linz et al. 1993, Homan et al. 1994, Cummings et al. 2002, Werner et al. 2005). Sunflower fields in the northern Great Plains are most vulnerable to blackbird damage in late summer when the birds are congregating in large flocks prior to fall migration and during a 2- to 4-week period of dough-stage seed development (Avery and DeHaven 1984, Cummings et al. 1989, Berglund 1994). Although blackbirds tend to feed on corn and sunflower during the milk and dough stage when the kernels are soft and early in ripening, grackles and red-winged blackbird males are known to continue sunflower and corn foraging later into the season due to their larger body and beak size (Dolbeer 1980, Homan et al. 1994). Avery and DeHaven (1984) reported damage chronology as a gradual buildup beginning just after anthesis, followed by a steep rise in damage until about 4 to 5 weeks after anthesis, with damage concentrated in the second to fourth weeks post anthesis (Avery and De Haven 1984).

Several blackbird species are abundant summer residents and migrants in central and southern regions of North America (Meanley 1971, Dolbeer 1978, Werner et al. 2005). North Dakota is part of the major migration corridor for the red-winged blackbird, (Linz and Hanzel 1997), and also provides prime habitat for breeding blackbirds; North Dakota's breeding blackbird population was estimated at more than 2.3 million pairs in 1990 (Nelms et al. 1994). All blackbirds are gregarious, especially during the non-breeding season, and when they descend on a crop field, the results can be devastating for the grower (Avery and Cummings

2003). Blackbird densities in North Dakota reach their peak in August and September when sunflowers reach maturity (Peer et al. 2003). During the time frame of sunflower maturation, trees and shelterbelts in North Dakota may be used by blackbirds for resting and loafing during the day (Besser 1978, Otis and Kilburn 1988), however, their general preference is to choose cattail-choked wetlands for roosting during this fall period (Linz and Hanzel 1997). Red-winged blackbirds, common grackles, and yellow-headed blackbirds aggregate in large flocks that feed on agricultural crops (Werner et al. 2005). Fall blackbird roosts in cattail marshes can harbor as many as 0.5 million birds, and flocks of blackbirds feeding in sunflower fields have numbered as many as 100,000 birds (Besser et al. 1979). Cummings et al. (1989) observed that blackbird flocks feeding in sunflower fields in North Dakota included 80% red-winged blackbirds, 11% common grackles, and 9% yellow-headed blackbirds; the species composition of blackbirds in surrounding roosts was similar to that of birds observed in sunflower fields. The majority of depredation losses in sunflower have been attributed to blackbirds, although several species of birds and mammals also use sunflower as a food source (Linz and Hanzel 1997). The opportunistic nature of blackbirds enables them to exploit a variety feeding situations created by numerous agricultural crops.

Sunflowers are an ideal source of food for blackbirds because the seeds contain proteins and fats necessary for growth, molt, fat storage, and weight maintenance prior to fall migration (Besser 1978). Homan et al. (1994) found that sunflower seeds were a major source of food for both male red-winged blackbirds and common grackles in north central North Dakota from August through October.

Analysis of esophageal contents of red-winged blackbirds collected in late summer and fall showed that 93% of males and 86% of females had consumed sunflower as part of their diet and that these seeds comprised 69% and 57% of the male and female diets, respectively (Linz et al. 1984). Red-winged blackbirds, whose late-summer migrating populations can number some 75 million (Peer et al. 2003), cause approximately 50% of the damage, while yellow-headed blackbirds and common grackles account for the remainder of the loss (Homan et al., 1994).

Sunflowers are an important economic resource in the northern Great Plains and particularly in North Dakota, South Dakota and Kansas, the three largest sunflower-producing states in the US (National Agricultural Statistics Service, 2007). The 2007 sunflower crop in North Dakota was harvested at over 1.51 billion pounds and had a total production value of $307,435,000 (National Agricultural Statistics Service, 2008). The annual cost of blackbird damage to sunflower crops in North Dakota has been estimated at $4 to $11 million (Hothem et al. 1988, Linz et al. 1993, Linz and Hanzel, 1997, Peer et al. 2003). Blackbird damage to sunflower is highly variable, with a number of producers receiving little damage and some producers suffering severe damage and significant economic losses (Hothem et al. 1988, Guarino and Cummings 1984, Lamey and Luecke 1993, Peer et al. 2003). Guarino and Cummings (1984) noted that while statewide-damage estimates from 1979 to 1983 showed that fewer than 5% of fields suffered damage in excess of 10%, fields adjacent to blackbird roosts received from two to four times more damage than fields at greater distances from roost sites. Furthermore, in a 1980 study, Hothem et al. (1988) showed that the average loss in Stutsman County, North Dakota, was estimated at 21% compared to a state average of less than 2%.

2.3. Past Management Strategies:

Numerous methods have been used to control blackbird damage to sunflowers (Linz and Hanzel 1997). Both lethal and non-lethal techniques have been developed to reduce blackbird depredation in sunflower fields. Non-lethal techniques are usually intended to decrease the availability or attractiveness of the crop to blackbirds or to disperse birds such that damage is not concentrated in any given area. Synchronized planting of crops, avoidance of planting in vulnerable areas, and use of blackbird resistant varieties of sunflower have been offered as preventative measures to reduce blackbird damage in sunflowers (Fox and Linz 1983, Guarino 1984, Mah and Nuechterlein 1991, Linz et al. 1993). Chemical frightening agents, mechanical devices, broadcasting of taped blackbird distress calls, propane cannon explosions, discharging firearms towards flocks of blackbirds, and airplane hazing have been used to disperse feeding flocks of blackbirds, but these techniques have had mixed success (Besser et al. 1984, Conover 1984, Jaeger et al. 1984, Linz et al. 1993, Linz and Hanzel 1997, Handegard 1988). Fragmentation of dense cattail marshes with herbicide has been used to remove roosting substrate, thus preventing large roosts of blackbirds from forming, and resulting in reduced sunflower damage in local areas (Linz et al. 1993, 1995b).

A blackbird hazing program was developed using a single Piper Super Cub (PA-18), pilot, and gunner per district, where blackbirds were harassed out of sunflower fields with low flying PA-18s, supplemented by shooting with a 12-gauge shotgun (Bergman et al. 1997, Handegard 1988). Visual strategies of management have been implemented and are often inexpensive, and they tend to be effective, if only for short periods. Typical examples of visual repellents include balloons (Shirota et al. 1983, Mott 1985), plastic flagging, and Mylar streamers (Bruggers et al. 1986, Dolbeer et al. 1986). Functionally, visual repellents cause startle responses, as do aposematic colors such as red, orange and silver (Reidinger and Mason 1983, Lipcius et al. 1980). Startle responses are also associated with predator cues like hawk silhouettes, eyespots, and raptor models (Conover 1982, Inglis 1980, Inglis et al. 1983). However, startle responses eventually diminish, generally within a few days or weeks as a function of several variables, including weather conditions, bird numbers, and the availability of nearby unprotected foods (Feare et al. 1986).

A variety of auditory management strategies are available and include both passive and active management strategies. Propane cannons are commonly used for the control of bird depredation and nuisance problems (Linz et al. 1993). Propane cannons have been placed around fields and are simple to operate, use inexpensive bottled propane gas, and produce a sound similar to that of a shotgun with an advantage that the cannons allow the timing of explosions to be controlled (Bergman et al. 1997, Knittle and Porter 1988). Provided that units are moved every few days, cannons can be effective when one is placed for every 10 acres of crop. Repellency is enhanced when shooting is implemented concurrently, or when other measures are taken to slow birds' habituation to noise (Slater 1980, Inglis

1984). A variety of other sonic frightening devices, including electronic noise systems, synthetic bird calls, and pyrotechnics, are sometimes used in addition to cannons (Aubin 1990, Feare et al. 1986). Three types of pyrotechnics have been offered as an alternative technique for reducing blackbird damage. Cracker shells are explosive charges fired from a 12-gauge shotgun. The charge travels up to 250 yards down range and explodes with a loud sound. Bird bangers are pyrotechnics that are launched with a hand-held pistol. Each cartridge is ignited with a .22 caliber blank. Bird bangers travel down range 120-145 feet and explode upon reaching maximum distance. Screamer sirens are also launched from a hand-held pistol. Screamer sirens travel down range 180-240 feet and scream the entire distance traveled (Bergman et al. 1997). These strategies can be effective against loafing and roosting birds (Blokpoel 1976). However, they have little utility against feeding birds in agricultural settings and are not any more effective than propane cannons alone (Feare et al. 1986). Repellency efficiency is variable, and depends on the persistence and skill of the operator, the attractiveness of the crop, the number of birds present, and the availability of alternative food sources (Mott 1978, Mott and Timbrook 1986, Salmon and Conte 1981).

When sunflower crops must be planted near cattail marshes, blackbird resistant varieties of sunflowers have been suggested, which have concave-shaped heads which make feeding more difficult for blackbirds (Mah and Nuechterlein 1991); however, these varieties are not commercially available. Proper weed control or early harvests of sunflower fields are practices that may reduce depredation losses to commercial fields (Kopp et al. 1980, Birch et al

1982). Other non-lethal methods such as the use of methylanthranilate or Bird Shield™ have also been employed, but have been shown to be ineffective in reducing bird damage to ripening rice and sunflower (Werner et al. 2005). Dispersing damage rather than eliminating it has been proposed as an effective management tool because compensatory growth in sunflowers can make up for minor bird damage (a loss of less than 15% of seeds) that occurs during the first 2 weeks of seed formation (Sedgwick et al. 1986). Avoidance of problem areas when planting vulnerable crops, synchronized plantings, crop diversification, lure plots, and blackbird resistant varieties have been offered as preventive measure to reduce blackbird damage (Fox and Linz 1983, Guarino 1984, Mah and Nuechterlein 1991, Linz et al. 1993). Hagy et al. (2008) showed that Wildlife Conservation Sunflower Plots (Lure plots) had greater damage than nearby commercial crops, thereby, likely reducing damage to commercial fields.

In 1991, a cattail management program was initiated that consisted of chemically controlling cattail-choked wetlands to remove primary blackbird roosts and is still a primary non-lethal blackbird management tool (Bergman et al. 1997).

Fragmentation of dense cattail marshes with herbicide removes roosting substrate and prevents large roosts of blackbirds from forming; the result is a reduction of sunflower damage in local areas (Linz et al. 1993, 1995b). Beginning in the 1960's, control of depredating blackbirds via lethal methods has been researched for the protection of commercial crops. Lethal control is directed toward population reduction and has been considered for use on depredating flocks of blackbirds in the fall, wintering populations, and pre –breeding populations in the spring. By targeting depredating flocks of birds in the fall, the costs and benefits for control are focused upon the birds doing the actual damage. However, blackbirds are difficult to lure away from ripening crops to bait on the ground (Cummings et al. 1990). Cracked corn treated with strychnine did not reduce corn damage in a study by Snyder (1961). The use of DRC-2698 treated corn and sunflower did not reduce damage to commercial sunflower fields. Lethal control of blackbirds has also been attempted and has included spraying surfactants and toxicants on roosts. Surfactants are wetting agent solutions that have been used to reduce populations within roosts, but are not species specific. Surfactants cause body temperatures to drop to lethal levels under cool environmental conditions when feathers are wet and sufficient body heat cannot be retained (Lefebvre and Seubert 1970, Weatherhead et al. 1980). An avicide called CPT (DRC-1347) has been tested experimentally for use as a contact toxicant that can be aerially applied to roosting blackbirds (Heisterberg et al. 1990).

Many or all of these management strategies have limitations of efficacy, cost, and logistics (Besser 1978, 1985, Linz et al. 1993). More recently, research on blackbird damage control has focused on the use of an avicide, DRC-1339, to reduce spring blackbird populations in the northern Great Plains (Barras 1996, Kenyon 1996, Knutsen 1998).

2.4. DRC-1339:

DRC-1339 was developed by the U.S. Fish and Wildlife Service in the 1960's, and is a water soluble, crystalline solid that easily degrades in sunlight or heat. Normal environmental conditions can result in 46% loss of DRC-1339 in 2%

treated rice mixtures over a time period of 48 h (DeCino and Cunningham 1964, Cummings et al. 1992). DRC-1339 is a slow acting avicide which has a high toxicity to avian pest species and low to moderate toxicity to most mammals and non-target birds (USDA 1994). DRC-1339 is considered a selective pesticide, as bait type, dilution rate of treated bait to untreated bait and bait location can be manipulated to target specific pest species (Knittle et al. 1990). Starlings, blackbirds and corvids are all susceptible to the toxic effects of DRC-1339 at doses of less than 4.0 mg/kg (Schafer 1979). LD_{50} values for blackbirds range from 1.0 to 3.2 mg/kg (DeCino et al. 1966, Knittle 1989).

DRC-1339 was formulated as an avicide to control starlings in livestock and poultry feedlots (DeCino and Cunningham 1964). DRC-1339 was later approved for use as a restricted use pesticide to be used only by trained personnel in the former Animal Damage Control program administered by the USDA Animal and Plant Health Inspection Service (APHIS) (USDA 1994). Chemical formulations applied to various grains are often used to control blackbird populations (Knittle et al. 1988, Glahn and Wilson 1992). DRC-1339 products are approved in 23 states for various uses, including control of European starlings, blackbirds, rock pigeons (*Columba livia*), and American crows (*Corvus brachyrhynchos*) at feedlots; European starlings, rock pigeons, and American crows in structures, blackbirds, rock pigeons, and common grackles at staging areas, predatory gulls along coastal nesting areas, and American crows, common ravens (*Corvus corax*) and black-billed magpies (*Pica hudsonia*), in livestock production areas (USDA 1994).

Utilization of DRC-1339 as an avicide continues because it is highly toxic to certain families of birds that are targeted as agricultural pests. The mechanism of avian toxicity is related to renal failure, uremic poisoning and congestion of major organs, but the exact mechanism is unknown (Mull et al. 1972, Mull and Giri 1972, Felsenstein et al. 1974). The effects in non-sensitive species include depression of central nervous system, muscular weakness and methemoglobinemia (Felsenstein et al. 1974). Use of DRC-1339 is restricted to trained personnel in the Wildlife Services program of the United States Department of Agriculture (USDA 1994).

2.5. Non-target Toxicity of DRC-1339:

Non-targeted birds and mammals may be exposed to DRC-1339 in baited areas either through primary consumption of treated baits or through secondary consumption of poisoned birds (Schafer 1984, Glahn and Wilson 1992b, Cummings et al. 1992, USDA 1994). The toxic effects of DRC-1339 have been studied in a variety of birds including waterfowl, galliformes, passerines, columbiformes, and raptors (DeCino et al. 1966, Schafer 1970, 1979, Knittle 1989, USDA 1994). Toxicological studies have been conducted to ascertain acute and chronic lethal doses for some avian and mammalian species that have potential for exposure to DRC-1339 (Schafer 1970, 1979, USDA 1994). Acutely toxic doses are usually reported as $LD_{50's}$, the dose of poison required to kill one half of the subjects in toxicity tests. Generally mammals are less susceptible than birds to toxic effects of DRC-1339. The LD_{50} values of most mammals are at least 100mg/kg or higher, with most birds being under 100mg/kg (USDA 1994).

Of the avian species tested, toxic effects of DRC-1339 were most notable in galliforms, columbiforms, and most passerines (except sparrows (Emberizidae) and finches (Fringillidae)), where low levels of DRC-1339 caused mortality, and often at or below the toxic level for target species (<3.2 mg/kg). The American crow, American robin (*Turdus migratorius*), northern cardinal (*Cardinalis cardinalis*), blue jay (*Cyanocitta cristata*), curve-billed thrasher (*Toxostoma curvirostre*), and mourning dove (*Zenaida macroura*) have LD_{50} values at or below 3.2 mg/kg. The ring-necked pheasant (*Phasianus colchicus*), northern bobwhite (*Colinus virginianus*), domestic chicken (*Gallus domesticus*), black-billed magpie, common ground dove (*Columbina passerina*), and white-winged dove (*Zenaida asiatica*) have values between 4.2 and 10.0 mg/kg. Meadowlark species (*Sturnella spp.*) do not have a listed LD_{50}, but in a field study of the effectiveness and non-target risks associated with the use of 1% DRC-1339 pellet baits (Starlicide), Knittle et al. (1980) observed that a flock of 16 eastern meadowlark's (*Sturnella magna*) were routinely observed feeding at a bait site during pretreatment, but disappeared after treatment began and 1 eastern meadowlark was found dead near the bait site. Eleven northern cardinals, 2 white-throated sparrows (*Zonotrichia albicollis*) and 1 blue jay were also found dead at bait sites and reportedly died from DRC-1339 poisoning (Knittle et al. 1980).

Some species of waterfowl have been evaluated for susceptibility to DRC-1339, but inconsistent results have been reported. LD_{50} values for mallard (*Anas platyrhynchos*) have been reported as low as 10.0 and as high as 128.0 mg/kg (Schafer 1979). A similar range has been reported for the blue-winged teal (*Anas *discors*). The northern pintail (*Anas acuta*) has been reported to be susceptible at greater than 32.0 mg/kg. Although some larger birds such as waterfowl and ring-necked pheasants are susceptible to DRC-1339, they may be at reduced risk for ingesting a lethal dose of DRC-1339 due to their size (DeCino et al. 1966). Sparrows and finches seem to be able to tolerate high levels of DRC-1339. Toxicity levels are above 320.0 mg/kg for the house sparrow (*Passer domesticus*) and white-crowned sparrow (*Zonotrichia leucophrys*), and above 100.0 and 225.0 mg/kg for the Cassin's finch (*Carpodacus cassinii*) and the house finch (*Carpodacus mexicanus*), respectively. Schafer and Cunningham (1966) did observe that DRC-1339 had a soporific effect on house finches, and chronic or sub acute toxicity may also be occurring in non-target birds exposed to DRC-1339. Schafer et al. (1977) observed that DRC-1339 was a chronic toxicant to ring-necked pheasant, northern bobwhite, rock pigeon, and European starling (*Sturnus vulgaris*) that were exposed to a daily sub acute dose; chronic exposure to sub acute levels of DRC-1339 also affected reproduction on rock pigeon. An increase in egg breakage and a decrease in egg fertility and live chick production were observed by Schafer et al. (1977).

Predatory and scavenging birds could be exposed to DRC-1339 if they were to consume poisoned birds. Hawk species (Accipitridae) have been found to be tolerant of DRC-1339 when force fed the poison and when fed DRC-1339 poisoned birds over prolonged periods (DeCino et al. 1966, Schafer 1979, USDA 1994). According to Mull and Giri (1972), red-tailed hawks (*Buteo jamaicensis*) lack an enzyme in their kidneys that is found in other birds and is thought to be involved in the toxification of DRC-1339. The golden eagle (*Aquila chrysaetos*) and northern harrier (*Circus cyaneus*) have an LD_{50} greater than 100.0 mg/kg, and the American kestrel (*Falco sparverius*) and Cooper's hawk (*Accipiter cooperii*) are tolerant to greater than 320.0 mg/kg; however, owls (Strigiformes) have been identified as susceptible (Cunningham et al. 1979). The LD_{50} for the common barn owl (*Tyto alba*) was reported by Knittle (1989) at 4.2 mg/kg.

Most mammalian predators and scavengers are reported to be resistant to DRC-1339 toxicity; however, domestic cats (*Felis catus*) are more sensitive to acute DRC-1339 intoxication than other mammalian scavengers or predators, and could possibly suffer from chronic toxicity if their diet consisted primarily of poisoned birds for more than 30 consecutive days (Cunningham et al. 1979).

2.6. DRC-1339 Field Studies:

The risks associated with non-target animal exposure to DRC-1339 baits have been evaluated in rice fields in Louisiana (Glahn et al. 1990, Cummings et al 1992, Glahn and Wilson 1992 a,b), in poultry and cattle feedlots in several western states (Besser 1964, Ford 1967, Hickman 1967, Royall et al. 1967), and in ripening sunflower fields in North Dakota (Linz and Bergman 1996). These studies revealed that the impact of baiting on non-target species was minimal.

DRC-1339 has been useful in starling control at feedlots through the use of treated poultry pellets. The use of DRC-1339 treated barley and poultry pellets for starling control in cattle and poultry feedlots appear to have minimal impacts on non-target birds in several western states. Besser (1964) observed that house sparrows and rock pigeons fed regularly in a cattle feedlot where DRC-1339 treated barley had been applied. As results of this research, over 500 European starlings were found dead on transect searches, and the only unintended species collected was a rock pigeon. This species is on the DRC-1339 label; however, it was not a species targeted during the study.

Besides using baits treated with DRC-1339 to control starlings and blackbirds, an attempt was made to control these birds with aerial sprays of DRC-1339 at night roosts in Mississippi (Heisterberg et al. 1990). DRC-1339 was also considered for use in North Dakota to reduce flocks of blackbirds feeding in repining sunflower fields in late summer, but it was not effective (Linz and Bergman 1996). No evidence of a negative effect on non-target birds was found when DRC-1339-treated rice baits were applied to ripening sunflower fields in northeastern and southeastern North Dakota. Twenty-five species of non-target birds were observed in the baited sunflower fields, including 13 species of granivorous birds, mostly sparrows, but no non-target birds were observed feeding on the rice baits. There was no difference in non-target bird use of study fields through the baiting period and no dead non-target birds were found during periodic searches of the area (Linz and Bergman 1996).

Brown rice is the preferred bait for female red-winged blackbirds and yellow-headed blackbirds and was also favored by male red-winged blackbirds making it preferential for DRC-1339 baiting (Linz et al. 1995). A lethal dose of DRC-1339 for blackbirds can be applied to a single grain of rice (Cummings et al. 1992). Blackbirds have been successfully attracted to rice-baited staging areas in Louisiana. Brown rice baits were used in Louisiana rice fields in early spring to attract blackbirds and reduce the size of winter roosting populations. Several non-target species were observed in or around bait sites including mourning dove, killdeer (*Charadrius vociferus*), northern cardinal, eastern meadowlark, and several species of sparrows, but overall use of baited areas by theses species was low. Glahn and Wilson (1992a) found 3 northern cardinals that had died of DRC-1339; one dead Lincoln's sparrow (*Melospiza lincolnii*) was also found with an uncertain cause of death. Since DRC-1339 is slow acting, other non-targets may have been lost without being noticed. Many raptor species including northern harriers, red-tailed hawks, and American kestrels were observed scavenging on dead blackbirds, as well as American crows and gulls (Laridae), but none of these species were found dead near treated sites.

Cummings et al. (1992) estimated they killed 3.2 million blackbirds after baiting staging areas within 3.6 km of a blackbird roost in Louisiana with DRC-1339 treated rice. The roost declined from an estimated 4.0 million birds to 1.5 million birds 6 days post baiting, and to 45,000 birds 12 days post baiting (Cummings et al. 1992). Blackbirds have not been successfully attracted to ripening sunflower fields in North Dakota baited with DRC-1339 treated rice (Linz and Bergman 1996).

STUDY AREA

3.1. Study Area:

In 2007, the study area included parts of Barnes, Griggs, Nelson, Ramsey, Stutsman, and Walsh counties in central North Dakota. In 2008, the study area included portions of Barnes, Griggs, and Stutsman counties (Fig. 1). These counties lie within the Prairie Pothole Region (PPR) of North Dakota bordered on the west by the Missouri River and to the east by the Glacial Lake Agassiz Basin (Stewart and Kantrud 1972). Glaciers shaped the topography of the region during the Pleistocene Epoch and formed uneven deposits of glacial till and large buried ice blocks that today make up the numerous prairie potholes and sloughs (Ralston et al. 2004, Colton et al. 1963).

The vegetation of the region was once tall- or mixed-grass prairies; however, today the region is mostly characterized by agricultural lands for crops or pasture. The region was estimated to have between 2.8% and 4.3 % cattail cover and upwards of 6,500 km^2 (1,600,000 ac) of land in sunflower production in 2002 (Ralston et al. 2004).

We based our study site selection on historical knowledge of sunflower planting patterns, crop phenology, and blackbird damage to sunflower in North Dakota. Individual site selection was based on proximity to sunflower or corn fields, large roost sites, overhead dead perch trees, and adjacent gravel roadways.

3.2. Individual Study Sites:

Individual study sites were named according to the order in which they were placed on the landscape, the year of the field season, and the study area within

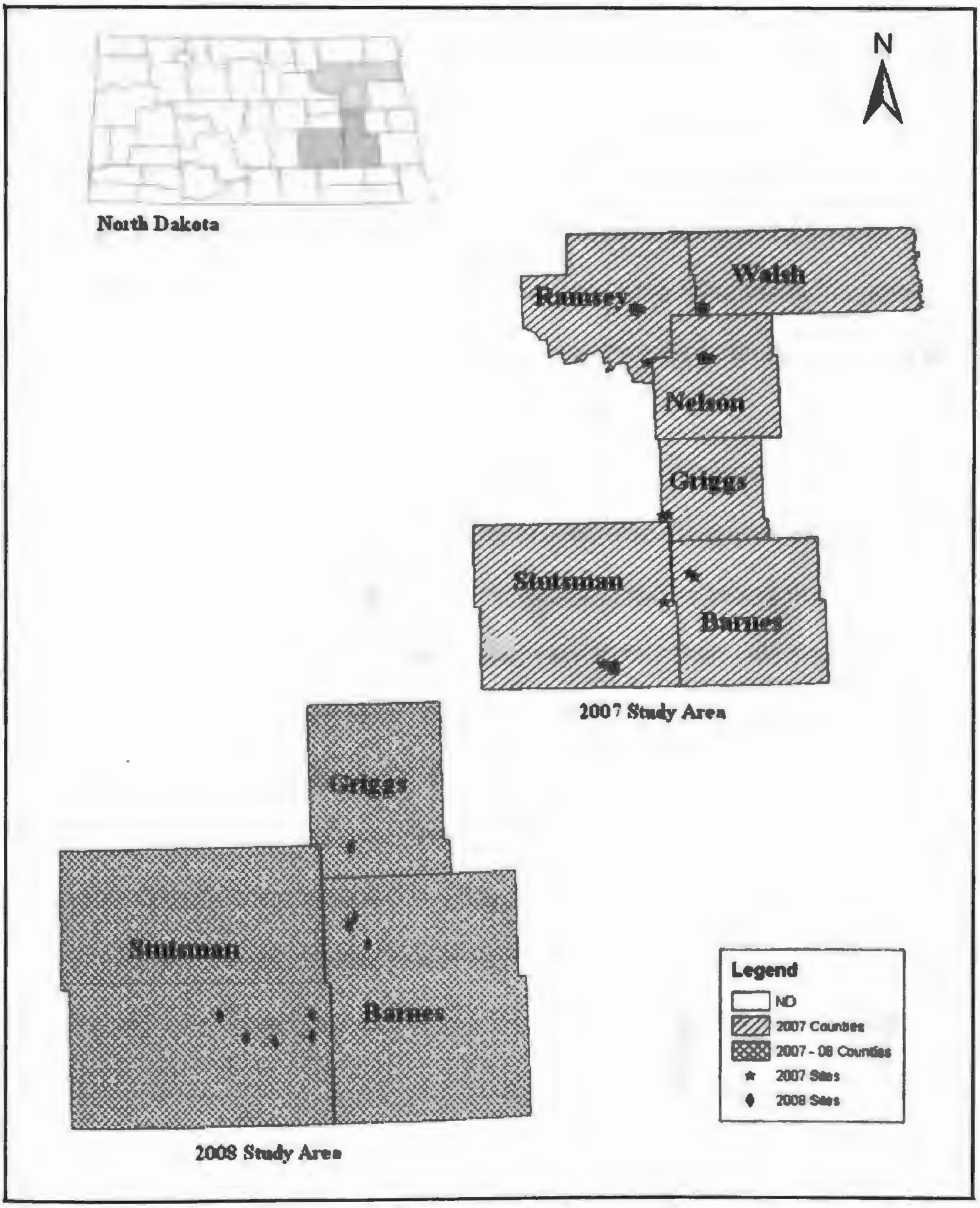

Figure 1. Study areas and site locations for field season 2007 and 2008.

(ESRI 2008)

which it fell; therefore, the first site in the Jamestown study area in fall 2007 that was the first to be placed on the landscape would be named J07-01. Because the first year of field study involved continuously changing site locations and a large number of short duration sites, those sites were not individually described other than to list the legal description of the location along with the descriptions for field season 2008 sites (Table 1). The 2008 field season sites were fewer in number and were focused on individual roost locations and therefore can be described in better detail.

In the Wimbledon and Jamestown study areas, study sites were located in near proximity to both corn or sunflower fields and large roost sites (Appendix A). Study sites were established near the roost wetlands but no closer than 50 m to surface water. There were no available roadways to test road side baiting techniques in the Wimbledon area, but the majority of sites in the Jamestown area were utilized for roadside research. Study sites were located in both Barnes and Griggs counties for the Wimbledon study area. Study sites were located only in Stutsman County for the Jamestown study area. A small number of study sites were temporarily closed or closed early as a result of either a reduction in roost size to under 5,000 blackbirds, or rainfall events that made sites inaccessible and or flooded.

Table 1. Locations of bait sites for the 2007 and 2008 field seasons in central North Dakota, showing dates of operation, tray configuration and electric fencing.

* Tray configuration refers to the formation of cage designs as described in Figures 1 and 2 (Pg. 36-37).

Site Number	Section	Twp. (N)	Range (W)	County	Dates	Configur-ation	Electric (Y/N)	Comments
J07-01	SE ¼ of 35	141	62	STUTSMAN	8/29 - 9/28	1-Vert	Y (9/18)	Vertical pair design employed on 9/18
J07-02	SW ¼ of 35	141	62	STUTSMAN	8/31 - 9/12	1-Vert	N	
J07-03	NE ¼ of 23	142	61	BARNES	8/28 - 9/11	1-Vert	N	
J07-04	NE ¼ of 23	142	61	BARNES	8/28 - 9/11	1-Vert	N	
J07-05	SE ¼ of 20	145	61	GRIGGS	8/28 - 9/4	1-Vert	N	
J07-06	SE ¼ of 20	145	61	GRIGGS	8/28 - 9/4	1-Vert	N	
J07-07	NE ¼ of 5	137	64	STUTSMAN	8/18 - 9/10	1-Vert	N	Location moved west 200 m
J07-08	NW ¼ of 5	137	64	STUTSMAN	8/18 - 10/11	1-Vert	Y (9/18)	Vertical pair design employed on 9/18
J07-08B	NW ¼ of 5	137	64	STUTSMAN	9/18 -10/11	1-Hor.	Y (9/18)	Height of 4'
J07-08C	NW ¼ of 5	137	64	STUTSMAN	9/19 - 10/11	1-Hor.	Y (9/18)	Height of 2'
J07-08D	NW ¼ of 5	137	64	STUTSMAN	9/20 - 10/11	1-Hor.	Y (9/18)	Height of 4' with side tray at 2'
J07-09	NE ¼ of 33	137	64	STUTSMAN	8/18 - 9/12	1-Vert	N	
J07-10	NE ¼ of 33	137	64	STUTSMAN	8/18 - 9/12	1-Vert	N	
J07-11	SE ¼ of 4	137	64	STUTSMAN	8/18 - 10/7	1-Vert	Y (9/18)	Vertical pair design employed on 9/18
J07-12	SW ¼ of 4	137	64	STUTSMAN	8/18 - 9/12	1-Vert	N	
J07-13	SW ¼ of 25	137	64	STUTSMAN	8/18 - 9/12	1-Vert	N	
J07-14	SE ¼ of 25	137	64	STUTSMAN	8/18 - 10/10	1-Vert	Y (9/18)	Vertical pair design employed on 9/18
J07-15	NW ¼ of 30	145	61	GRIGGS	8/28 - 10/10	1-Vert	Y (9/18)	Vertical pair design employed on 9/18
J07-16	NW ¼ of 30	145	61	GRIGGS	8/28 - 9/12	1-Vert	N	
J07-34	NW ¼ of 30	142	60	BARNES	9/18 - 10/8	Vert. Pair	Y (9/18)	
J07-34E	NW ¼ of 30	142	60	BARNES	9/18 - 10/8	Vert. Pair	Y (9/18)	
J07-35	NE ¼ of 25	142	60	BARNES	9/18 - 10/10	1-Hor.	Y (9/18)	Height of 18"

Table 1. continued

Site Number	Section	Twp. (N)	Range (W)	County	Dates	Configur – ation	Electric (Y/N)	Comments
DL07-01	SE ¼ of 29	155	59	WALSH	8/24 - 9/3	1-Vert	N	
DL07-02	SE ¼ of 29	155	59	WALSH	8/24 - 9/23	1-Vert	N	Vertical pair design employed on 9/10
DL07-03	SW ¼ of 21	155	59	WALSH	8/24 - 8/26	1-Vert	N	
DL07-04	NW ¼ of 28	155	59	WALSH	8/24 - 8/26	1-Vert	N	
DL07-05	NW ¼ of 11	152	62	RAMSEY	8/24 - 8/27	1-Vert	N	
DL07-06	NW ¼ of 11	152	62	RAMSEY	8/24 - 8/27	1-Vert	N	
DL07-07	SE ¼ of 6	152	59	NELSON	8/23 - 9/2	1-Vert	N	
DL07-08	SW ¼ of 6	152	59	NELSON	8/24 -9/28	1-Vert	N	Vertical pair design employed on 9/12
DL07-09	NW ¼ of 6	152	59	NELSON	8/23 - 9/1	1-Vert	N	
DL07-10	SW ¼ of 32	153	59	NELSON	8/23 - 9/2	1-Vert	N	
DL07-11	NW ¼ of 4	152	59	NELSON	8/24 - 8/31	1-Vert	N	
DL07-12	NW ¼ of 4	152	59	NELSON	8/23 - 9-2	1-Vert	N	
DL07-13	NE 1/4 of 22	155	62	RAMSEY	8/23 - 8/27	1-Vert	N	
DL07-14	NW ¼ of 22	155	62	RAMSEY	8/23 - 8/29	1-Vert	N	
DL07-15	SW ¼ of 15	155	62	RAMSEY	8/23 - 8/29	1-Vert	N	
DL07-16	SW ¼ of 22	155	62	RAMSEY	8/23 - 9/27	1-Vert	N	Vertical pair design employed on 8/30
DL07-18	NE ¼ of 29	155	59	WALSH	8/31 - 9/19	Vert. Pair	N	
DL07-18	NE ¼ of 29	155	59	WALSH	8/31 - 9/19	Vert. Pair	N	
DL07-19	NE ¼ of 29	155	59	WALSH	8/31 - 9/28	Vert. Pair	N	
DL07-20	SE ¼ of 11	152	62	RAMSEY	9/1 - 9/1	Vert. Quad	N	4 vertical cages in grouping
DL07-21	NE ¼ of 6	152	59	NELSON	9/7 - 9/28	Vert. Pair	N	

Table 1. continued

Site Number	Section	Twp. (N)	Range (W)	County	Dates	Configur – ation	Electric (Y/N)	Comments
DL07-22	SW ¼ of 6	152	59	NELSON	9/12 -9/26	Vert. Pair	N	
J08-01	SE 1/4 of 20	139	63	STUTSMAN	9/3 - 10/15	Vert. Pair	Y	
J08-02	SE 1/4 of 20	139	63	STUTSMAN	9/3 - 10/15	Hor. L	Y	
J08-03	SW ¼ of 16	139	64	STUTSMAN	9/3 - 10/12	Vert. Pair	Y	
J08-04	SW ¼ of 16	139	64	STUTSMAN	9/3 - 10/11	Hor. L	Y	
J08-05	SW ¼ of 27	140	65	STUTSMAN	9/10 - 10/6	Hor. L	Y	
J08-06	SW ¼ of 27	140	65	STUTSMAN	9/10 -10/6	Vert. Pair	Y	
J08-07	N ½ of 33	140	62	STUTSMAN	9/10 - 10/16	Hor. L	Y	
J08-08	N ½ of 33	140	62	STUTSMAN	9/10 - 10/16	Vert. Pair	Y	
J08-09	SE ¼ of 16	139	65	STUTSMAN	9/15 - 10/10	Vert. Pair	Y	
J08-10	SE ¼ of 16	139	65	STUTSMAN	9/15 - 10/10	Hor. L	Y	
W08-01	W ½ of 6	142	60	BARNES	9/3 - 10/17	Hor. L	Y	
W08-02	W ½ of 6	142	60	BARNES	9/3 - 10/10	Vert. Pair	Y	
W08-03	SW ¼ of 28	142	60	BARNES	9/8 - 10/8	Vert. Pair	Y	
W08-04	SW ¼ of 28	142	60	BARNES	9/8 - 10/18	Hor. L	Y	
W08-05	NW ¼ of 33	142	60	BARNES	9/8 - 10/11	Vert. Pair	Y	
W08-06	NW ¼ of 33	142	60	BARNES	9/8 - 9/20	Hor. L	Y	
W08-07	NW ¼ of 13	142	61	BARNES	9/11 - 9/20	Vert. Pair	Y	
W08-09	NW ¼ of 1	144	61	GRIGGS	9/18 - 10/11	Vert. Pair	Y	
W08-10	NW ¼ of 1	144	61	GRIGGS	9/18 - 10/11	Hor. L	Y	
W08-11	NE ¼ of 1	144	61	GRIGGS	9/18 - 10/09	Vert. Pair	Y	
W08-12	NE ¼ of 1	144	61	GRIGGS	9/18 - 10/09	Hor. L	Y	

METHODS

4.1. Site Selection and Preparation:

Field research began in early August when sunflower crops were just beginning to mature and large fall roost sites were beginning to form; the research continued through mid October when the majority of red-winged blackbirds had migrated from the region, roost sites had become unoccupied, and harvest of sunflower fields had begun. Site selection during the 2007 field season was based solely on the presence of blackbirds and sunflower fields. When a field experiencing damage was discovered, the nearest wetland, or in many instances the field itself, was used as a site. Decoy traps fitted with bait trays were placed on private lands near gravel roads and observed for bird activity. Gravel roadways adjacent to the fields or wetlands providing roost or forage for blackbirds were also part of the study sites. Each site was originally prepared with a single upright cage. If non-target species were observed at a site, then that site was abandoned and a new one established. As a result of predation of live decoys, many sites were modified into paired cages, and the cages were wrapped in a variety of meshes to reduce predation of decoys. Several experimental sites were protected using 6 or 12 volt electric fencing around the base of the cage. Because of the ever changing bait sites and cage conditions, statistical validity of the data from this year (2007) was weak; however, descriptive statistics and knowledge for the second research season were gained.

During the 2008 field season, site selection was based upon knowledge gained during the previous year. Tray sites were established only adjacent to roosts harboring greater than 5,000 blackbirds. Numbers of roosting blackbirds were established via morning flight line counts. Study participants arrived at roost sites prior to sunrise as blackbirds began to form flight lines headed for morning forage. Flock sizes were estimated and tallied to determine an estimate of overall roost size. When possible, bait sites/units were placed in proximity to dead trees, which are popular perch sites. In an attempt to discourage non-target tray use, vegetation around bait station units was trimmed to a height less than 15 cm (6 in), and to a radius of 7.5 m (25 ft) from the unit. Whenever possible, units were placed in tilled fields where vegetation was scant. Each site was prepared with one of two cage/tray units. All sites during this 2008 field season were protected using 12 volt electric fencing to reduce predation of decoys.

4.2. Cage Designs:

During the 2007 field season, we used modified Australian crow traps (decoy traps), made of 2.5x5-cm (1x2-in) woven wire with 1.2x1.2x2-m (4x4x6-ft) sides, with a 0.5-m (1.5-ft) drop box with a single 5-cm (2-in) slit for birds to enter the traps. We attached a 0.6x1.2-m (2x4-ft) plywood board to the top of the decoy trap, with a 5x5-cm (2x2-in) wood rim placed around the edges of the plywood. A second rim was placed about 12 cm (4.5 in) from the edges of the board to reduce loss of rice due to wind dispersal. A small experimental group of traps were designed to have heights of 1.2 m (4 ft) and 0.5 m (1.5 ft) (Fig. 2). These traps contained captive blackbirds that were initially captured with mist nets. Fresh food and water were provided *ad libitum*.

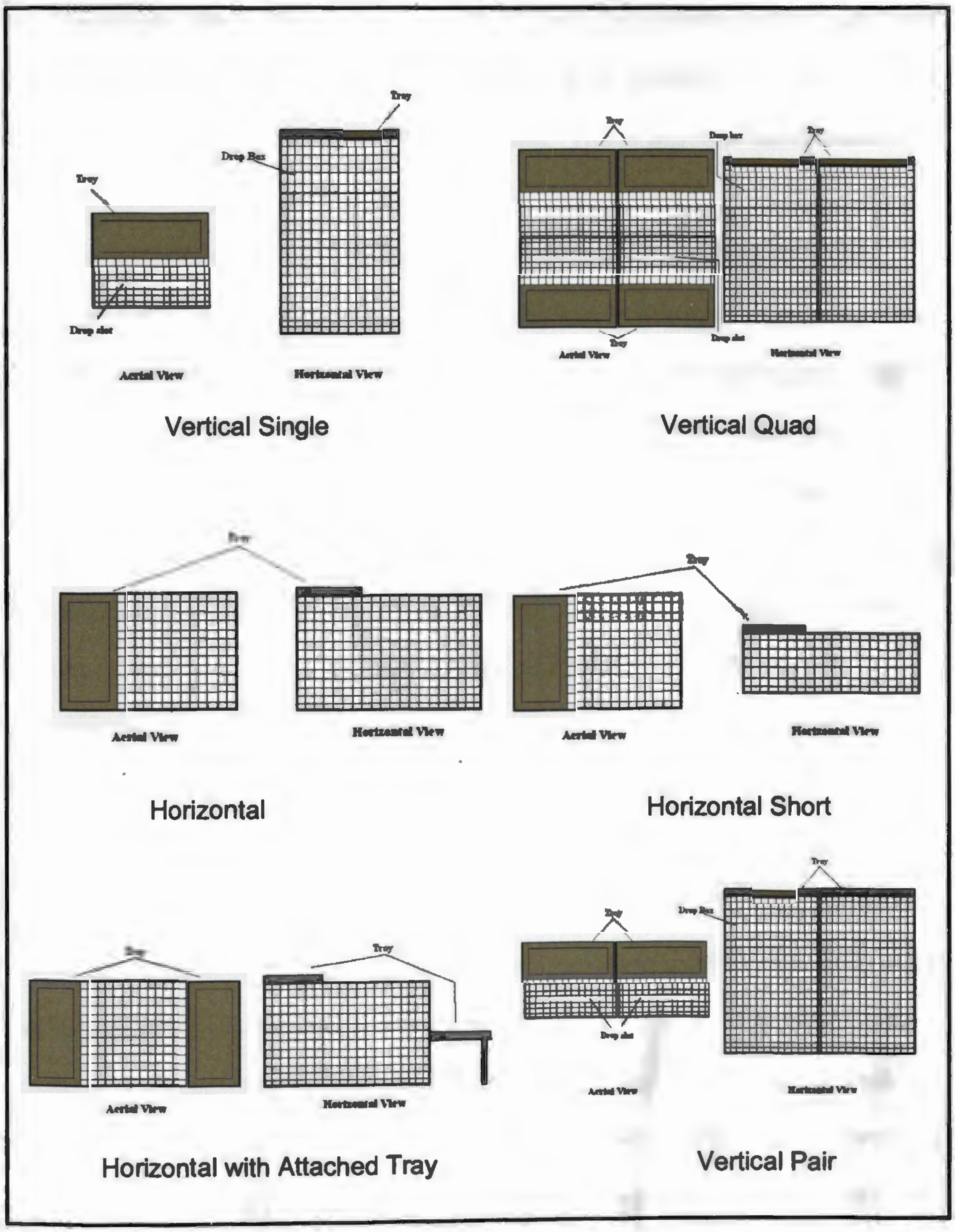

Figure 2. Configurations of baited tray sites during the 2007 field season.

To test the effects of using woven wire for excluding mourning doves and ring-necked pheasants, half of the plywood bait trays were guarded with 5x10-cm (2x4-in) woven wire guards and half were unguarded. These two treatments were assigned randomly.

Arrangement of traps in the 2008 season was slightly modified from the previous year. Decoy traps were organized into one of two functional units. The first was a pair of 1.2x1.2x2-m (4x4x6 ft) vertically-positioned traps/cages placed side by side, with one functioning as a trap and the other as a holding cage (Fig. 3). The other functional unit was designed once again with a trap/cage configuration with both portions of the same dimensions previously given, but one was oriented in a horizontal fashion such that the maximum vertical height was 1.2 m (4 ft). The traps/cages were placed in the shape of an "L", with one trap standing vertically and the other cage attached to its base extending horizontally (Fig. 3). The single slit drop was changed to three funnels measuring 10 cm (4 in) in diameter, with each funnel spaced 10 cm (4 in) apart in the drop down portion. These funnels were 15 cm (6 in) in depth and had cable ties hanging downward from the end of the funnel. These funnels were designed to allow easy entry but to increase the difficulty of escape by decoy birds. A plywood bait tray was attached to the top of the decoy trap/cage. In the 2007 field season, experimental welded wire exclosures for large non-target species were tested. During that research, no such birds were observed; therefore, wire exclosures were not used in 2008. If large non-target birds had been observed during this field season, the exclosures

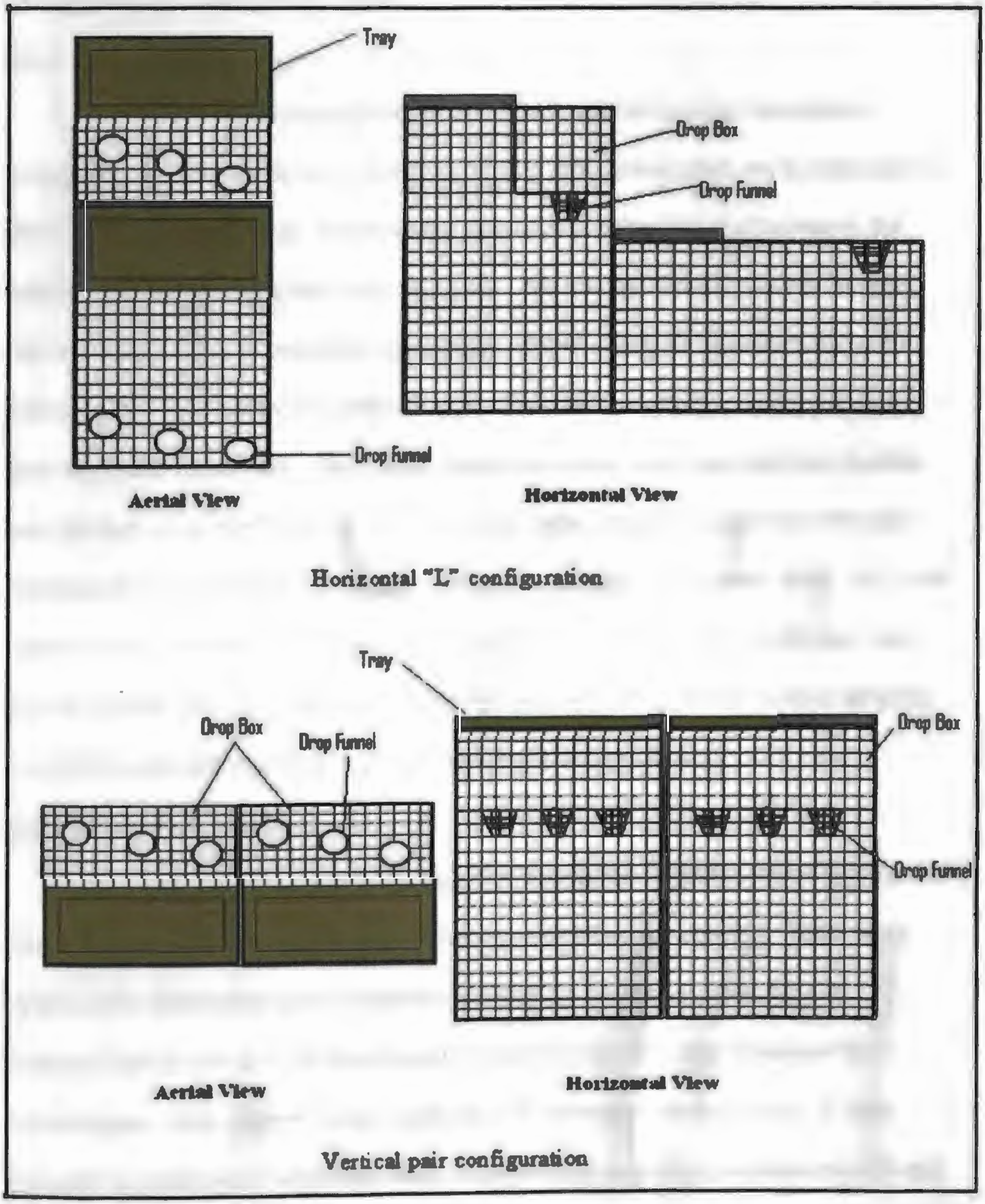

Figure 3. Configurations of baited tray sites during the 2008 field season.

would have been implemented. No large non-target birds were observed, and thus the exclosures proved unnecessary.

4.3. Decoy Capture:

Decoy birds, including red-winged blackbirds, yellow-headed blackbirds, common grackles, and brown-headed cowbirds (*Molothrus ater*), were captured for use at sites as live decoys to encourage use of rice-baited trays attached to the cages. Birds were captured using mist nets. Narrow paths were created through dense cattail stands at blackbird roost sites. Within these paths, mist nets were placed over water within the cattail stands. Blackbirds flying through the cattails were captured in the nets. Nets were placed no earlier than one half hour before sunrise and were monitored by two individuals who removed birds from the nets and placed them in transport cages. Nets were run during all hours of the day, but capture rates were highest during the first few hours of daylight and the last hour before sunset. Mist nets were not operated past sunset. A small number of birds were also captured via the funnels on the cages at bait sites.

4.4. Baited Road Sides:

During both the 2007 and 2008 seasons, roadsides adjacent to bait trays were treated with one of two treatments, either rice baited or as a control. Sites were observed to determine use of roadways as well as impact on adjacent sites. Frequencies of use for both baited and control roadsides were calculated in percentages. Also, paired t-tests were used to compare the mean use of sites adjacent to baited and controlled sites, to determine any effect on sites contributed by roadsides.

4.5. Avian Monitoring:

Study sites were monitored to determine avian use by target and non-target species, weather permitting. Observations were not conducted in heavy rains or when winds were greater than 24 km/h (15 mph). Study participants randomly visited the study sites (decoy traps/bait trays) for 1-h intervals throughout daylight hours to record numbers, species, and ages (when possible) of blackbirds and non-targets on the bait trays and baited gravel roadsides. Observations began a half hour after sunrise and continued throughout the day until sunset. The observer parked a vehicle about 50 m (54 yd) from the tray sites and immediately estimated the number of blackbirds in various habitats (e.g., sunflower, corn, gravel road, trees) within 0.4 km (0.25 mi). After a 10-min quiet period, 1-min counts were made alternating between the gravel road and bait trays, with 2 min between observations. At the end of the 1-h observation period, the observer again estimated the number of blackbirds within 0.4 km (0.25 mi). If there was not a road to observe, the tray was observed for each 1-min observation. During the 2008 field season, observations were conducted in the same manner as in 2007, except that sites with roads were only given one minute between observations such that one minute was spent on the tray, then 1-min on the road and than 1-min before resuming. This was done only at locations with roadsides. Observations resulted in 20 periods of observation per hour. The behavior of birds visiting tray sites was recorded as perching or feeding.

Binoculars and spotting scopes were used for observations. If the species of bird could not be determined, then identification was made to the closest known taxonomic group such as genus or family. These data, along with date, time, and weather conditions, were recorded on data sheets printed on rain-resistant paper.

4.6. Rice Monitoring:

During the 2007 field season, rice was applied to half of the roadsides at a rate of 5 cups (900 g) per strip (1mx50m). Rice was scattered using a hand held broadcast grass seeder and was replenished on road shoulders every 5 days. Rice was applied on the tops of the cages at a rate of 0.5 cups (90 g) per tray. The trays were checked every 3 days to determine the amount of rice being consumed. No rice remained at some trays after 3 days; therefore, rice levels were increased to 180 g per tray. Rice amounts during this field season (2007) were measured in cups and converted to weights using a known mass of dry brown rice. During the 2008 field season, similar procedures were used; however, rice on the bait trays was weighed every day using scales measuring to the nearest 0.1 g. Rice on the roadways was done exactly as the previous field season.

4.7. Habitat Analysis:

Habitat types within 0.4 km (0.25 mi) of bait sites were recorded to determine site characteristics. GIS software was also employed using National Agricultural Statistics Service (NASS) information about land cover and crop types. Ground truthing of NASS data was done by hand written observations at each site. NASS raster data on crop types were modified into classes including small grains, beans, corn, sunflower, grasslands, wooded, open water, herbaceous wetland (cattail), and developed. Each class was extracted to form polygons of each feature. The small grain polygon included all types of wheat, barley, durum and oats. The beans polygon included dry edible beans and soybeans. All grasslands including pasture and hay were joined. All emergent vegetations including cattail were placed in the herbaceous wetland polygon. Wooded areas included heavy shelterbelts, farm groves and other small woodlots. Sunflower and corn were individual polygon features for those two crops specifically. Finally, the developed polygon feature consisted of major roadways and ditches, as well as farm lots and cities. GIS software using the measure polygon tool was used after clipping polygon features to a 0.4-km (0.25-mi) buffer around each individual tray site. Thus, total hectares of cover were determined within those buffers to determine percentages of adjacent habitat including wetlands and sunflower/corn fields (Table 2). Analysis of surrounding habitat was done to determine if sites that preformed better than others had similar site characteristics.

4.8. Statistical Analysis:

Descriptive statistics were used to summarize the data on avian use of the bait trays and road sides for both the 2007 and 2008 data. Avian use of sites was broken into categories for target species, granivorous non-target species that primarily eat seeds and grains, and other non-target species that could be either insectivorous or birds of prey (Table 3). I used descriptive statistics to compare percentages of use, mean weekly use, and general patterns or trends among avian use at bait trays. Inferential statistics were not appropriate because the formations

Table 2. Percentages (%) of total land cover for each type of land cover within 0.4 km (0.25 mi) buffer of each tray site.

Site	Sun-flower	Corn	Cattail	Open-Water	Grass	Grain	Bean	Developed Road/Ditch	Wooded
W08-01	0.0	25.5	25.1	19.6	14.0	4.6	10.1	0.0	1.2
W08-02	0.0	36.6	16.3	16.4	9.7	0.0	20.9	0.0	0.2
W08-03	39.2	0.0	21.5	0.0	18.2	0.0	21.0	0.0	0.0
W08-04	27.2	0.0	28.9	0.0	29.7	0.0	14.2	0.0	0.0
W08-05	11.2	0.0	36.1	0.0	46.0	0.0	6.8	0.0	0.0
W08-06	13.5	0.0	29.4	0.0	57.1	0.0	0.0	0.0	0.0
W08-07	36.7	37.3	5.9	0.7	0.0	0.0	4.4	11.4	3.7
W08-08	0.0	23.0	7.2	21.5	4.7	0.0	30.2	8.7	4.6
W08-09	37.9	20.0	16.3	0.0	17.6	0.0	8.2	0.0	0.0
W08-10	45.9	1.9	17.1	0.0	14.6	0.0	20.5	0.0	0.0
W08-11	37.9	0.0	23.4	0.0	12.8	6.2	19.8	0.0	0.0
W08-12	27.6	0.0	27.5	0.0	15.9	18.8	10.3	0.0	0.0
J08-01	36.0	0.0	8.0	7.2	9.9	0.0	27.7	9.2	2.1
J08-02	8.6	23.9	9.7	4.9	12.6	0.0	27.9	12.4	0.0
J08-03	0.0	0.0	12.4	14.4	37.0	0.0	26.3	9.4	0.5
J08-04	0.0	0.0	16.0	18.4	17.7	0.0	41.8	4.8	1.4
J08-05	0.0	27.3	17.6	5.3	0.0	0.0	41.2	8.7	0.0
J08-06	0.0	1.6	7.8	0.7	0.0	0.0	89.9	0.0	0.0
J08-07	0.0	0.0	14.2	18.0	43.8	0.0	16.2	7.9	0.0
J08-08	0.0	3.9	9.4	29.7	17.0	0.0	32.1	7.9	0.0
J08-09	10.5	0.0	8.7	3.9	10.7	56.3	1.4	8.5	0.0
J08-10	15.7	4.4	3.8	3.7	13.4	50.7	0.0	8.3	0.0

Table 3. Bird groupings based on feeding ecology for analysis of avian non-target use of baited tray sites in central North Dakota from August to October 2007 and 2008.

Bird Group	2007	2008
Target	Red-winged blackbird	Red-winged blackbird
	Yellow-headed blackbird	Yellow-headed blackbird
	Common Grackle	Common Grackle
	European Starling	European Starling
	Brown-headed Cowbird	Brown-headed Cowbird
	Brewer's blackbird	Brewer's blackbird
Granivorous Non-targets	Clay-colored sparrow	American tree sparrow
	Grasshopper sparrow	Clay-colored sparrow
	Harris' sparrow	Chipping Sparrow
	Savannah sparrow	Harris' sparrow
	Song sparrow	Savannah sparrow
	Vesper sparrow	Unidentified sparrow
	Unidentified sparrow	Western meadowlark
		American robin
		House sparrow
		Northern flicker
		Unknown
Other Non-targets	Cooper's hawk	Sharp-shinned hawk
		Merlin
		Cooper's hawk
		Northern harrier
		Barn swallow
		Yellow-rumped warbler
		Unidentified wren
		Says phoebe

of trays, locations, and decoy numbers were changed frequently resulting in a small sample size for each particular site during the 2007 field season.

Data collected during the 2008 field season were organized according to roost (n=10) and individual sites at the roost (n=22). The number of birds recorded during a single observation was broken down by species and summed for each species. The number of birds recorded per observation was used to analyze avian activity among sites. Square root transformation was used to normalize data and to account for the large number of zeros in the data set. A paired t-test was used to determine if tray use was significantly different between tray configurations within a roost site. No significant difference was noted; therefore, all observations at all tray sites were grouped together.

An Analysis of Variance with nested design (nested ANOVA) was used to compare differences in use between study areas, date periods, and periods of time over the course of fall depredation. Each of these variables was nested within the other starting with study area, date period, and finally period of time. A separate nested ANOVA was designed to compare area, wetland, and date period using time periods 2 and 3 as replicates. These particular time periods were chosen due to the regular frequency with which sites were visited during these periods. Date periods were set at 7-day intervals from the first observations made on 3 September 2008 through the last observations made on 18 October 2008. Time periods were developed for each day of observations. Time periods were sunrise to 2 h post sunrise, from 2 h to 4 h post sunrise, 4 h prior to sunset to 2 h prior to sunset, and 2 h prior to sunset until sunset. A mid day period was also designated for the time frame between 4 h post sunrise and 4 h prior to sunset. These time and date periods were developed to provide insight into the most efficient time to bait blackbirds, as well as timing for avoidance of non-target species. Analysis of covariance (ANCOVA) was utilized to determine if the number of birds observed in proximity to tray locations at the beginning and the end of observations correlated with greater observed use. Also, ANCOVA was used to determine if the number of decoys within cages affected observed use. Program SAS was used to complete statistical analysis of data. Process GLM (general linear models) was used due to the unbalanced form of the data. Within the process, data were analyzed with the dependent variable set as avian use for both targets and non-targets, and with independent variables of study area, date period, and time period in a nested format. Analysis of covariance was used first with the number of surrounding birds as the covariate, and secondly as the number of decoys as the covariate. A Tukey's test, which is commonly used with ANOVA because it reduces experiment-wise error and defines critical values to determine significance of difference between variables, was used to determine and rank significantly different date periods and time periods.

RESULTS

5.1. Field Season 2007:

Avian use observations were conducted for 524 h between 15 August and 12 October, with 156 h in Nelson, Ramsey, and Walsh counties and 368 h in Stutsman, Griggs, and Barnes counties. During the course of research, 51 sites were established; however, a handful of these 51 sites were modifications of already existing sites. Of the original 51 sites, 22 had only targets present, 4 had only non-targets present and 7 had both targets and non-targets present. Thus, 29 sites had target species present, and 11 sites had non-targets present. There were 18 sites that were not visited by either target or non-target species.

5.2. All Baited Sites 2007:

There were 968 recorded individual visits to trays by 12 different species, with a few birds only identified to family (Table 4). Of these visits, 920 were individual blackbird visits to trays: 851 red-winged blackbirds, 12 yellow-headed blackbirds, 10 European starlings, 30 brown-headed cowbirds, and 17 common grackles. Blackbirds accounted for 95% of all tray visits (n=920) (Table 5). There were 48 recorded non-target visits to trays. Sparrow species were the most prevalent visitors, with clay-colored sparrows (*Spizella pallida*) (n=11), grasshopper sparrows (*Ammodramus savannarum*), savannah sparrows (*Passerculus sandwichensis*) (n=11), song sparrows (*Melospiza melodia*) (n=7), vesper sparrows (*Pooecetes gramineus*) (n=1), and unidentified sparrows (n=14) accounting for 94% (n=45) of the non-targets. A single Cooper's hawk was observed, but is not of significance because it is a bird of prey.

Table 4. Avian species observed August - October 2007 and 2008 at rice-baited trays attached to decoy cages and at rice-baited roadsides located in central North Dakota.

Family	Common Name	Scientific Name	2007[a]	2008[a]
Accipitridae	Cooper's hawk	(*Accipiter cooperii*)	T	T
	Northern harrier	(*Circus cyaneus*)		T
	Sharp-shinned hawk	(*Accipiter striatus*)		T
	Unidentified hawk			T
Alaudidae	Horned lark	(*Eremophila alpestris*)	R	
Emberizidae	American tree sparrow	(*Spizella arborea*)		T
	Chipping sparrow	(*Spizzela passerina*)		T
	Clay-colored sparrow	(*Spizella pallida*)	T	T
	Grasshopper sparrow	(*Ammodramus savannarum*)	T	
	Harris' sparrow	(*Zonotrichia querula*)		T
	Savannah sparrow	(*Passerculus sandwichensis*)	T, R	T
	Song sparrow	(*Melospiza melodia*)	T, R	
	Unidentified sparrow		T, R	T, R
	Vesper sparrow	(*Pooecetes gramineus*)	T	
Falconidae	Merlin	(*Falco columbarius*)		T
Fringillidae	American goldfinch	(*Carduelis tristis*)	R	
Hirundinidae	Barn swallow	(*Hirundo rustica*)		T, R
Icteridae	Brewer's blackbird	(*Euphagus cyanocephalus*)		T, R
	Brown-headed cowbird	(*Molothrus ater*)	T	T
	Common grackle	(*Quiscalus quiscula*)	T	T, R
	Red-winged blackbird	(*Agelaius phoeniceus*)	T, R	T, R
	Western meadowlark	(*Sturnella neglecta*)		T
	Yellow-headed blackbird	(*Xanthocephalus xanthocephalus*)	T	T, R
Muscicapidae	American robin	(*Turdus migratorius*)		T
Parulidae	Yellow-rumped warbler	(*Dendroica coronata*)		T
Passeridae	House sparrow	(*Passer domesticus*)		T
Phasianidae	Ring-necked pheasant	(*Phasianus colchicus*)	R	
Picidae	Northern flicker	(*Colaptes auratus*)		T
Sturnidae	European starling	(*Sturnus vulgaris*)	T	T,R
Troglodytidae	Unidentified wren		T	
Tyrannidae	Say's phoebe	(*Sayornis saya*)	T	
Unknown	Unknown		R	T

[a] T = bait tray observation, R= roadside observation

Table 5. Number and percentage of total observations for avian species observed August - October 2007 and 2008 at rice-baited trays on decoy cages located in central North Dakota.

Common Name	Total	Percent of Total	Number 2007	Percent 2007	Number 2008	Percent 2008
Northern harrier	1	0.03%	0	0.00%	1	0.03%
Cooper's hawk	21	0.54%	1	0.10%	20	0.68%
Sharp-shinned hawk	2	0.05%	0	0.00%	2	0.07%
Unidentified hawk	9	0.23%	0	0.00%	9	0.31%
American tree sparrow	2	0.05%	0	0.00%	2	0.07%
Grasshopper sparrow	1	0.03%	1	0.10%	0	0.00%
Vesper sparrow	1	0.03%	1	0.10%	0	0.00%
Chipping sparrow	1	0.03%	0	0.00%	1	0.03%
Clay-colored sparrow	12	0.31%	11	1.14%	1	0.03%
Harris' sparrow	5	0.13%	0	0.00%	5	0.17%
Unidentified sparrow	21	0.54%	14	1.45%	7	0.24%
Savannah sparrow	12	0.31%	11	1.14%	1	0.03%
Song sparrow	7	0.18%	7	0.72%	0	0.00%
Merlin	1	0.03%	0	0.00%	1	0.03%
Brewer's blackbird	2	0.05%	0	0.00%	1	0.07%
Brown-headed cowbird	31	0.80%	30	3.10%	2	0.03%
Common grackle	353	9.08%	17	1.76%	336	11.51%
Western meadowlark	1	0.03%	0	0.00%	1	0.03%
Yellow-headed blackbird	123	3.16%	12	1.24%	111	3.80%
Red-winged blackbird	3006	77.31%	851	87.91%	2155	73.80%
Barn swallow	2	0.05%	0	0.00%	2	0.07%
European starling	260	6.69%	10	1.03%	250	8.56%
American robin	2	0.05%	0	0.00%	2	0.07%
Yellow-rumped warbler	3	0.08%	0	0.00%	3	0.10%
House sparrow	1	0.03%	0	0.00%	1	0.03%
Northern flicker	3	0.08%	0	0.00%	3	0.10%
Unidentified wren	1	0.03%	1	0.10%	0	0.00%
Say's phoebe	1	0.03%	1	0.10%	0	0.00%
Unknown	3	0.08%	0	0.00%	3	0.10%
Total	3888	100.00%	968	100.00%	2920	100.00%

Due to a frequent loss of decoy birds to predation, the ever changing configuration and implementation of bait sites, and small sample size at baited locations due to regular movement of sites, inferential statistics were not practical with much of the data gained during the 2007 field season. Avian use was analyzed by looking at means of use at sites, as well as behavior of the species, whether feeding or perching at baited trays.

Blackbird use of tray sites generally increased over the course of the study and had a peak use around 1 October (Fig. 4). Non-target use of tray sites was nearly non-existent with average use of less than 1 bird/h of observation; non-target use displayed little predictable activity (Fig. 5). When blackbirds visited trays, 84.5% of them fed on the rice, whereas 54% of non-blackbirds consumed rice (Fig. 6). The site with the most abundant blackbird populations (without non-targets) had an average of 9.8 blackbird visits/h of observation. Another site with high activity averaged 5.6 blackbird visits/h of observation.

5.3. Field Season 2008:

Avian use was monitored for 487 h between 3 September and 18 October, with 188 h of observation in the Jamestown area in Stutsman County and 299 h in the Wimbledon area including Barnes and Griggs counties. During this time, 22 sites were established. Of the original 22 sites, 20 had target (blackbird) species present. Of those 20 sites, 4 had only target species present. The remaining 16 sites had both target and non-target avian use. The 16 sites having both target and non-target use had granivorous non-target birds at 12 of the sites, leaving 4 sites with low-risk

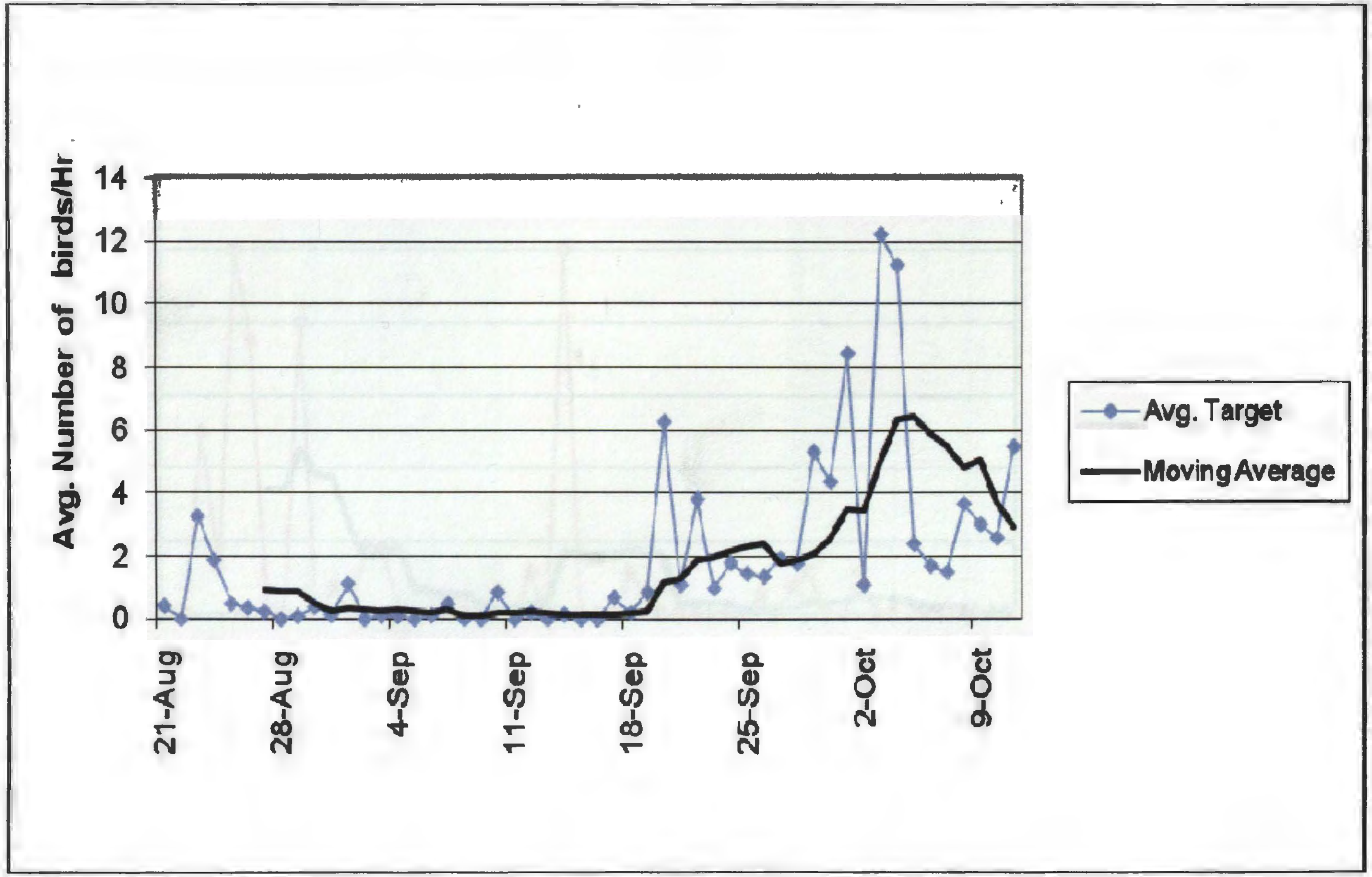

Figure 4. Average number of target birds per hour of observation and 7-day moving averages in 2007.

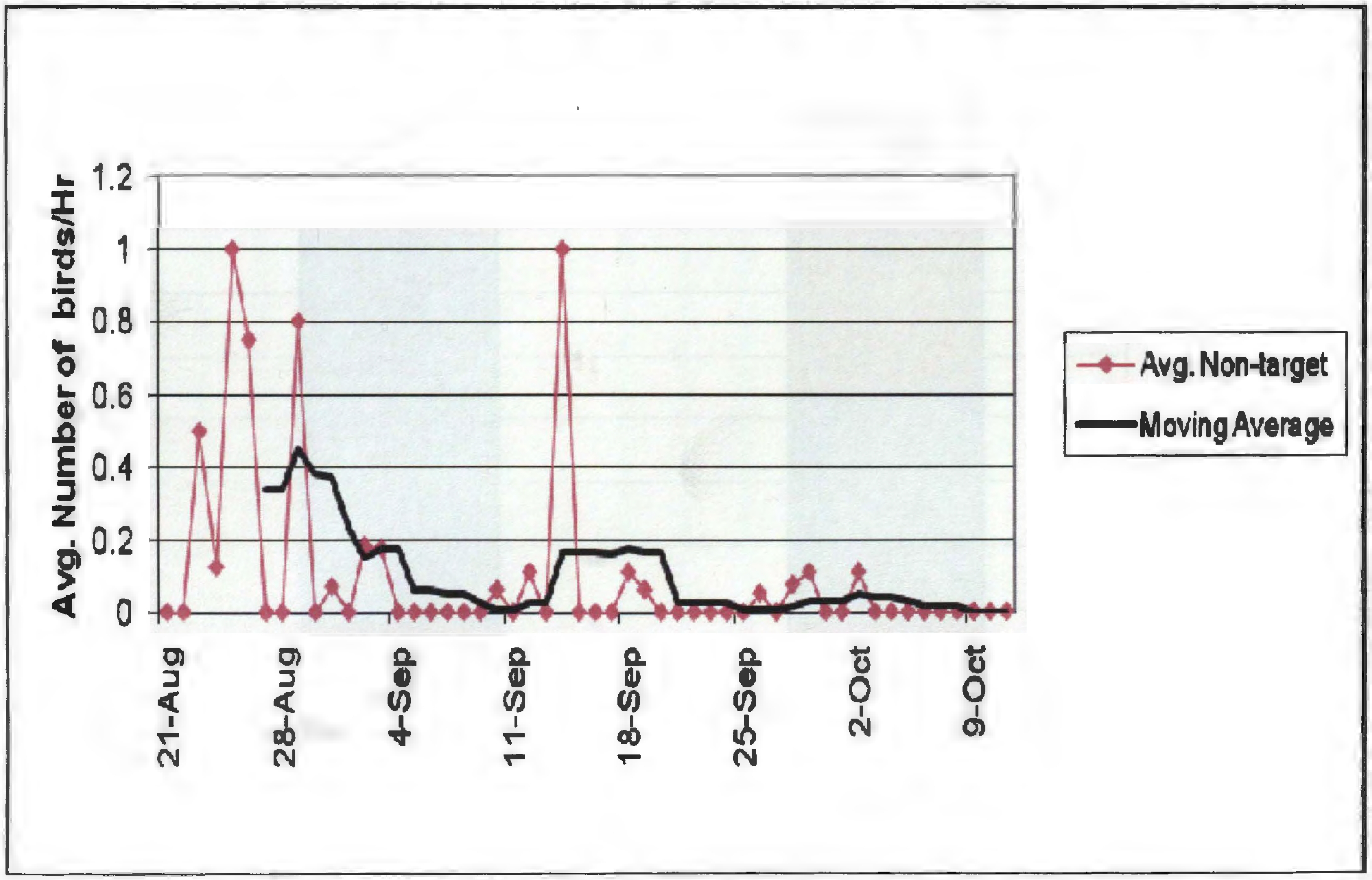

Figure 5. Average number of non-target birds per hour of observation and 7-day moving averages in 2007

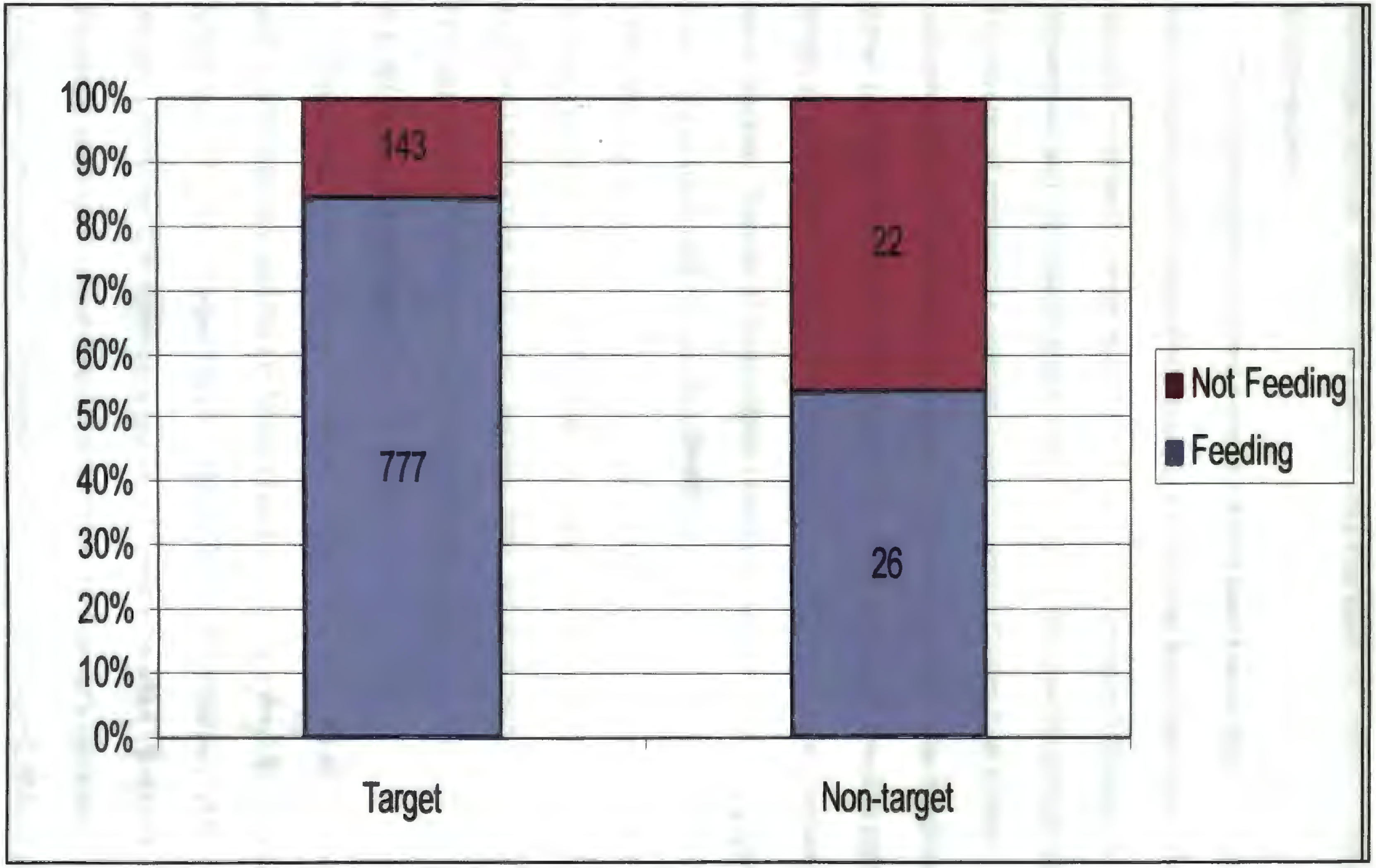

Figure 6. Activities of target and non-target species at tray sites during 2007. Numbers within bars represent number of birds.

non-target species. There were only two sites that were not visited by either targets or non-targets.

Through the use of a paired t-test, the mean use of each cage configuration was compared within each study area, as well as over the entire study. The reported p-values for target species in each study area were 0.39 and 0.50 for the Jamestown and Wimbledon areas, respectively; neither was statistically significant. For non-target granivorous species, p-values were 0.32 and 0.40 for the Jamestown and Wimbledon areas respectively; again neither was significant. When configurations were examined for the entire field season across both study areas, p-values of 0.25 and 0.48 for target and non-target species, respectively, were reported. Results of these paired t-tests indicated that avian use of each cage configuration was not significantly different, thus there was no preference in cage design for attracting target species to feed, or discouraging use by non-targeted species. All observations for all configurations could therefore be combined to examine study area, wetland, date, and time relations throughout the field season and the time of sunflower depredation.

5.4. All Baited Sites 2008:

There were 2,920 recorded individual visits to trays by 20 different species, with a few birds only identified to family (Table 4). There were 2,855 individual target species visits to baited trays. These visits to trays included, 2,155 red-winged blackbirds, 336 common grackles, 111 yellow-headed blackbirds, 250 European starlings, 1 brown-headed cowbird, and 2 Brewer's blackbirds (*Euphagus cyanocephalus*). Blackbirds accounted for 98% (n=2,855) of all tray visits (Table 4). Peak activity for target species occurred between 20 September and 18 October, with a peak of 24.5 birds/h (SE = 10.96) of observation (Fig. 7). There was an extremely high peak on 4 September during one observation at a site in Stutsman County that was entirely common grackles, and it was a single occurrence outside of normal activity at that time; therefore, that peak is not considered the actual peak of activity.

There were 65 recorded non-blackbird visits to trays. Raptor species were the most prevalent of visitors with 33 observations, with Cooper's hawks being the most prevalent at 20 observations. Sharp-shinned hawks (*Accipiter striatus*), northern harriers and merlins (*Falco columbarius)* were also observed along with a few unidentified hawks. These raptor species accounted for 51% of all non-target observations. A variety of other non-granivorous birds were observed, including barn swallows (*Hirundo rustica*), northern flickers (*Colaptes auratus*), and yellow-rumped warblers (*Dendroica coronata*). Of the granivorous species observed, sparrows were most prevalent, including Harris' sparrows (*Zonotrichia querula*), clay-colored sparrows, American tree sparrows (*Spizella arborea*), savannah sparrows, chipping sparrows (*Spizella passerina*) and unidentified sparrows; in total, sparrows accounted for 28% of the non-blackbirds (Table 5). Peak activity for non-targets occurred between 17 September and 6 October, but more specifically the peak for granivorous species occurred between 22 September and 8 October, with a maximum value of 0.36 birds/h (SE= 0.09) of observation (Fig. 8). When blackbirds visited trays, 85.5% of them fed on rice, while 20% of all

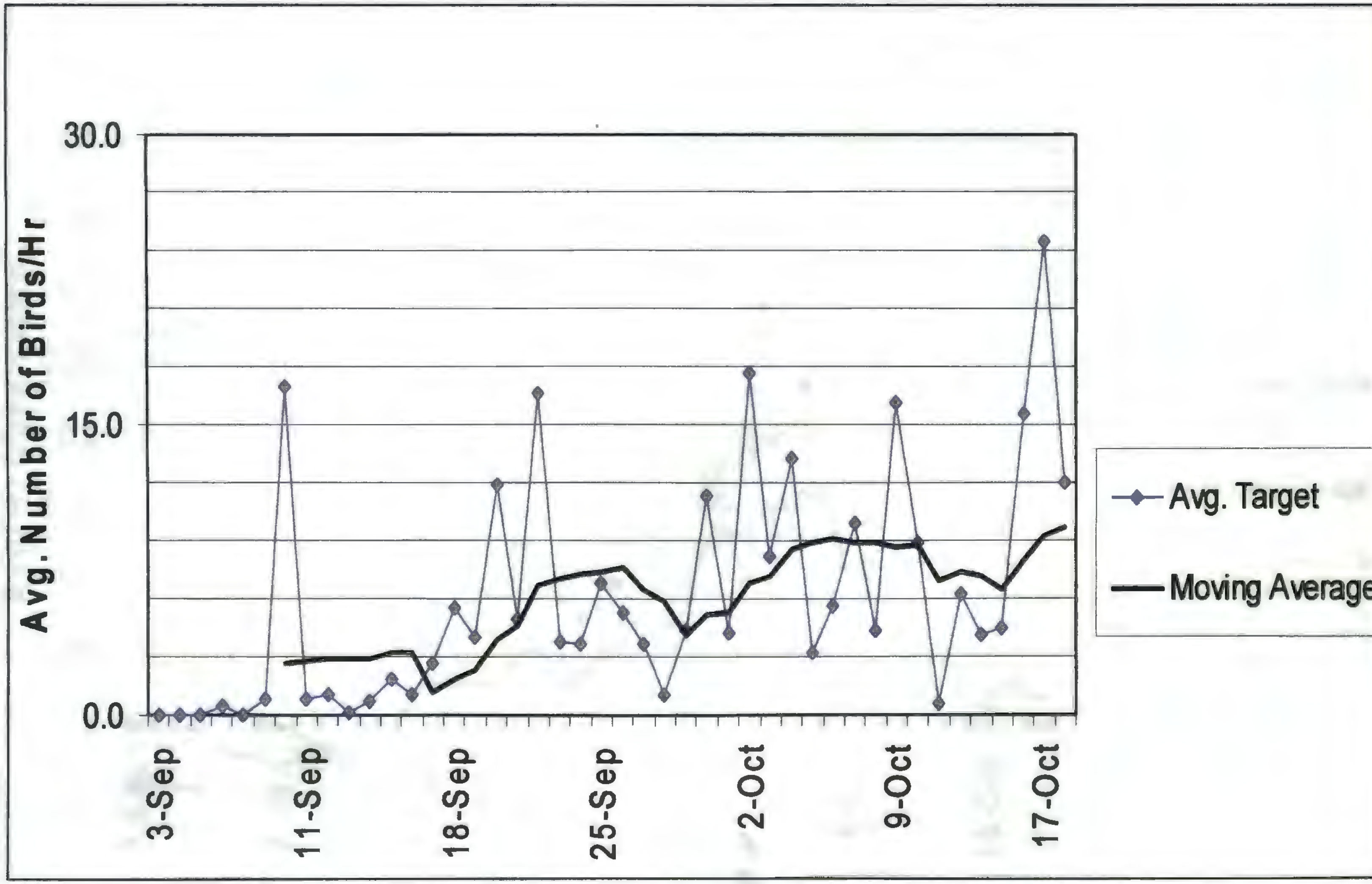

Figure 7. Average number of target birds per hour of observation and 7-day moving averages in 2008. A single observation far outside of normal activity was removed for 4 Sept.

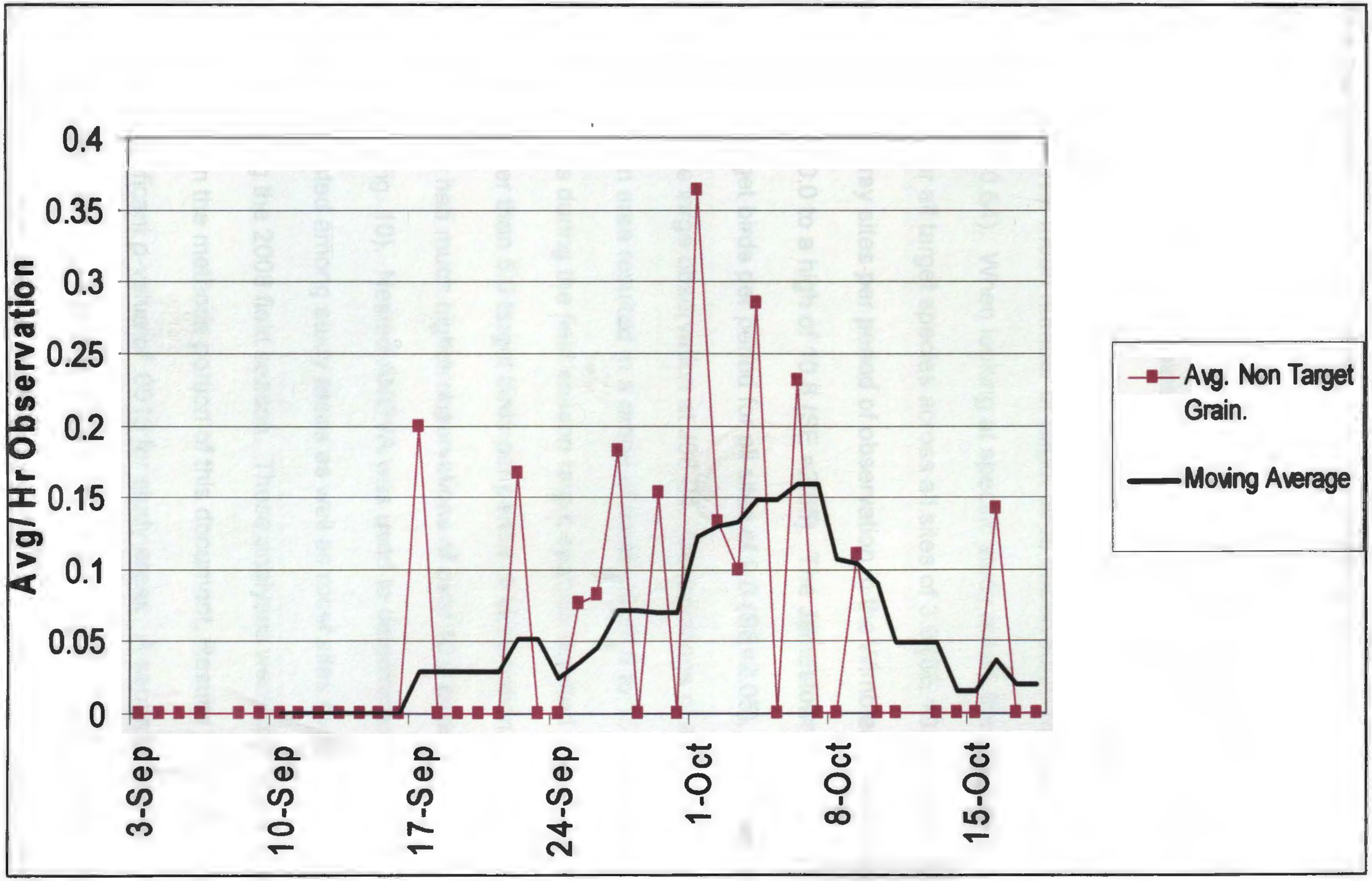

Figure 8. Average number of granivorous non-target birds per hour of observation and 7-day moving averages in 2008.

non-blackbirds ate rice; however, when considering only granivorous non-targets, 48% of them ate rice (Fig. 9).

The numbers of birds observed during consecutive 1-min observations at individual tray sites were combined for data analysis; therefore, means are reported as the mean number of bird's observed/20-min period during the 2008 field season. The mean number of target birds observed/20-min period at all sites was 5.3 (SE =0.64). When looking at specific study areas, the Wimbledon area had a mean for all target species across all sites of 3.9 (SE =0.54). Means of target use of tray sites per period of observation in the Wimbledon area ranged from a low of 0.0 to a high of 10.8 (SE =2.65). The Jamestown area had a mean number of target birds per period for all sites of 9.0 (SE=2.05), or 7.6 (SE=1.41) discounting the large observation at J08-04. Observations of all target species in the Jamestown area resulted in a range of means from 0 to 15.7 (SE=5.64). Across all sites during the field season target species resulted in a total of 8 sites that had greater than 5.0 target birds per period of observation; however, half of these sites (4) had much higher observations of over 10.0 birds per hour of observation (Fig. 10). Nested ANOVA was used to determine if a significant difference existed among study areas as well as roost sites (wetlands) within areas of study during the 2008 field season. These analyses were conducted separately as described in the methods portion of this document. Results for target species yielded a significant p-value of .0013 for study areas. A separate nested ANOVA provided a significant p-value of <0.0001 for roost sites (wetlands). Tukey's test for ranking also was used to show that J-wetland 4, J wetland 1, and W-wetland 1

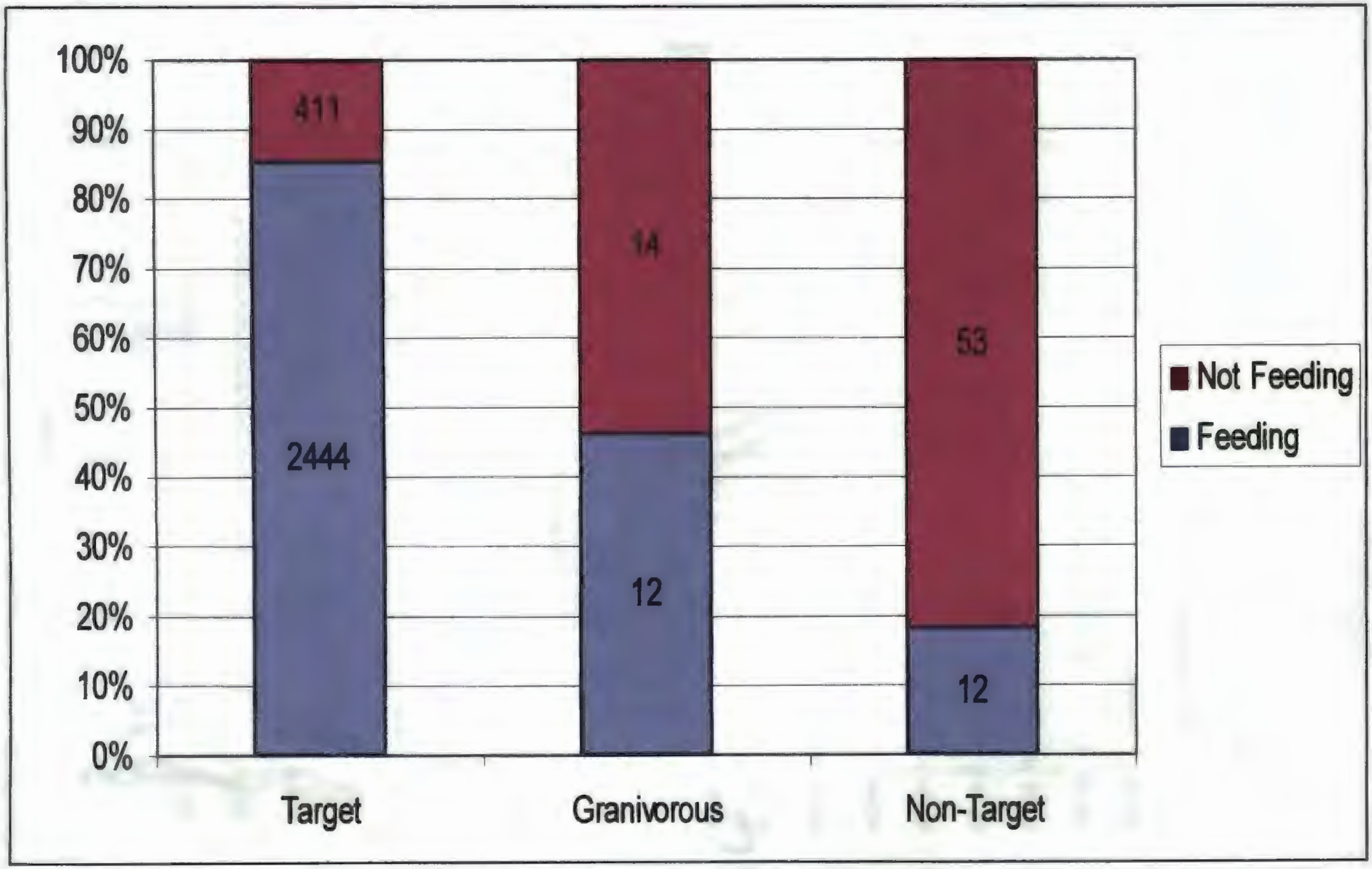

Figure 9. Activities of target and non-target species at tray sites during 2008. Numbers within bars represent number of birds.

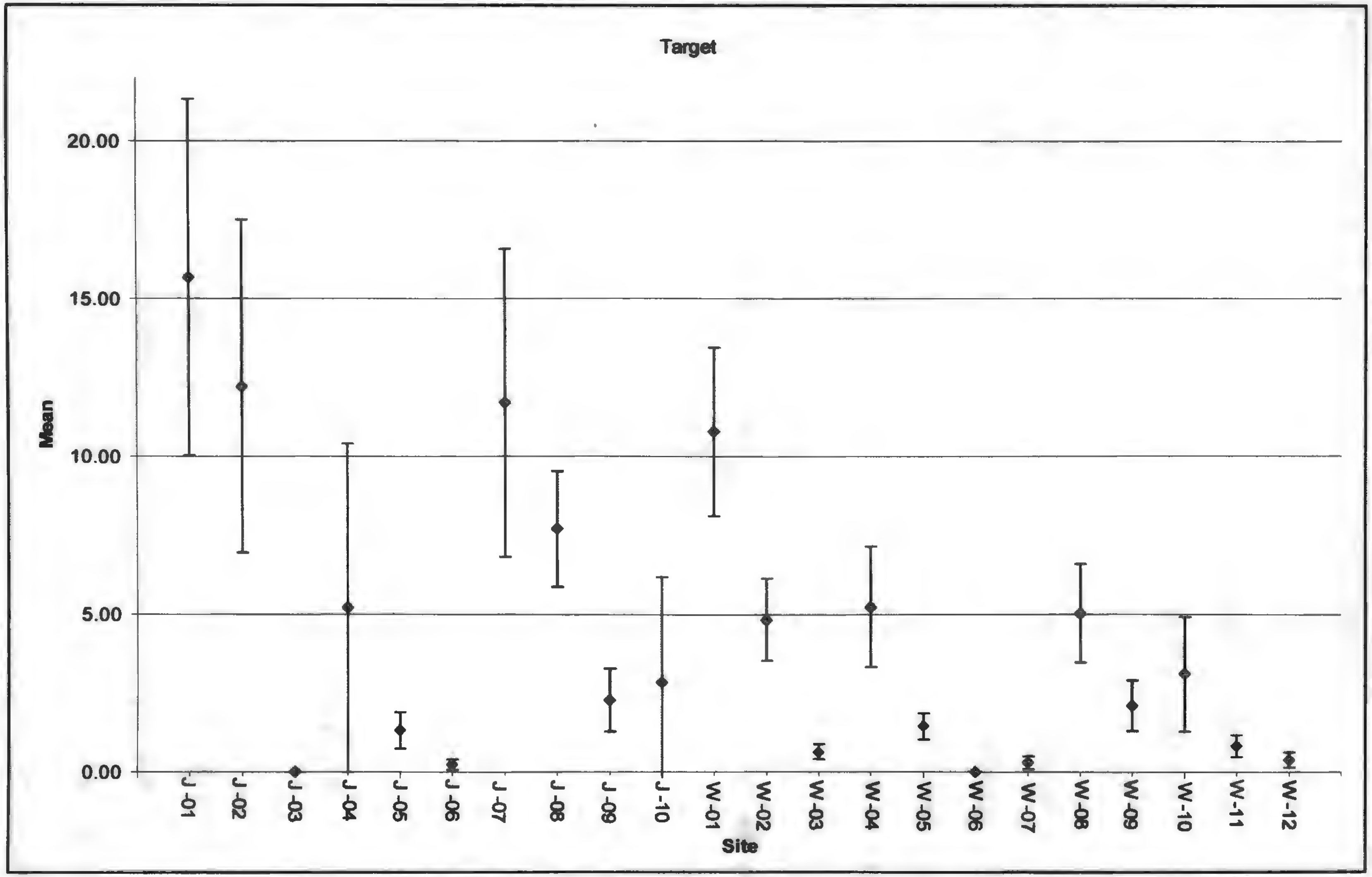

Figure 10. Means and standard errors of target species use at each baited tray site during the 2008 field season, with one outlying observation removed from site J08-04.

were some of the best sites for target use, with J-wetland 3 and W-wetland 3 being the worst sites.

The mean number of granivorous non-target birds recorded for all sites is based on a 20-min per hour observation of tray sites. The mean number of granivorous non-target species for all sites was 0.06 (SE =0.01). Examination of all granivorous observations indicated that means for granivorous non-target species across all study sites per period of observation in the Wimbledon area was 0.05 (SE=0.02). In the Wimbledon area, sites ranged from a mean of 0.0 at sites W08-03, W08-05, W08-06, and W08-07 to a maximum of .11 (SE=0.11) at site W08-12. The Jamestown area had a granivorous non-target mean of 0.07 (SE=0.03). Means ranged from 0.0 at sites J08-02, J08-03, J08-04, J08-05, J08-09, and J08-10, to a maximum mean of 0.39 at site J08-06 in the Jamestown area. All sites within the Jamestown and Wimbledon study areas had means below 0.50 granivorous non-target birds and other non-targets per period of observation (Figs. 11 & 12). Nested ANOVA and Tukey's test for ranking were used on non-target data. Granivorous non-targets were shown to have a non-significant p-value of 0.489 for wetlands and 0.325 for study areas. Granivorous non-target use of tray sites at wetlands was, therefore, not significantly different than random chance would produce for use of study areas or separate sites.

Frequencies of occurrence (percentage of observations where at least 1 target bird was observed) were monitored for each wetland. These frequencies revealed that some sites were consistently frequented by target species, while others were rarely visited. Frequencies of occurrence for target species were greater than or

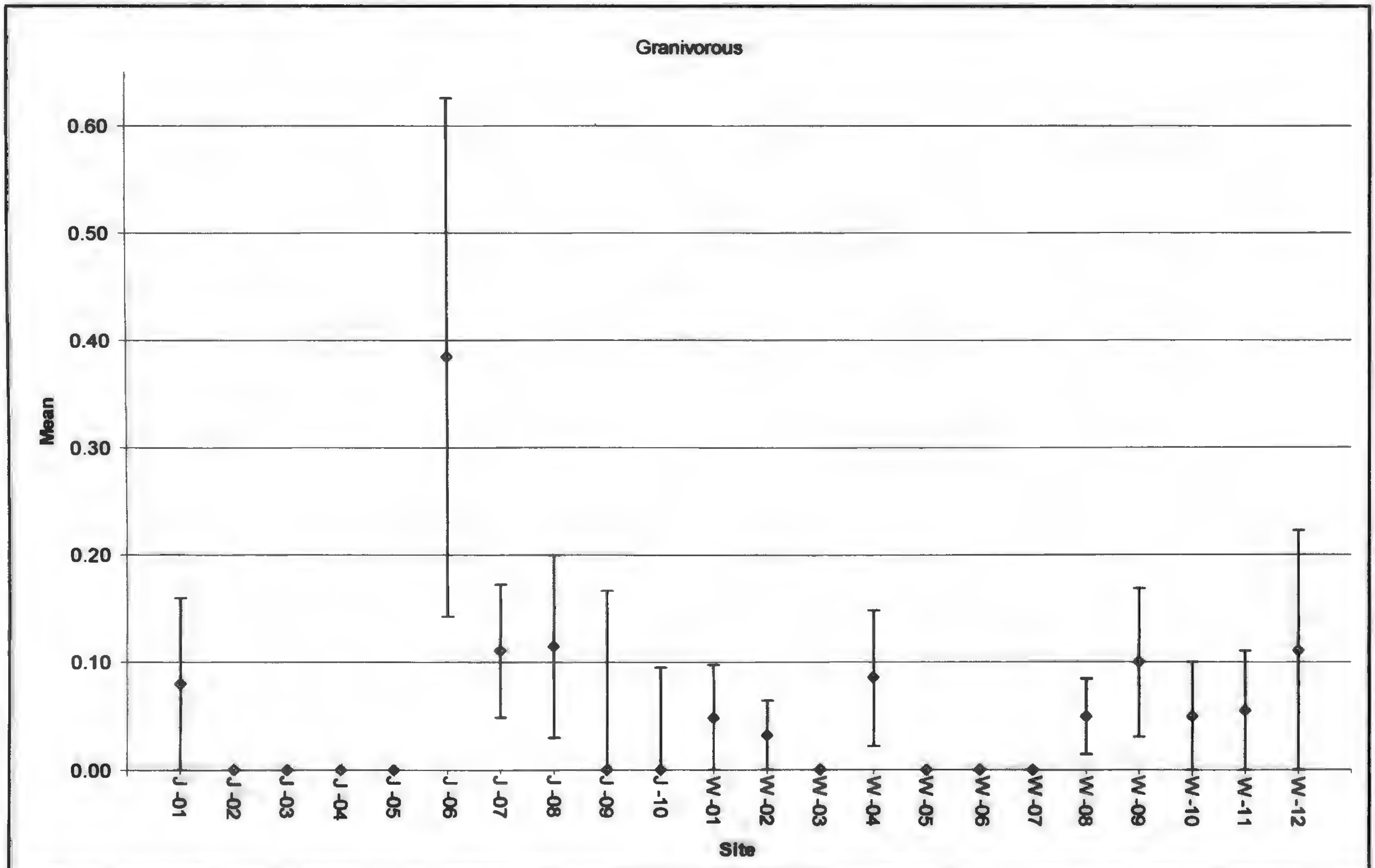

Figure 11. Means and standard errors of non-target avian use at each site during the 2008 field season for granivorous species.

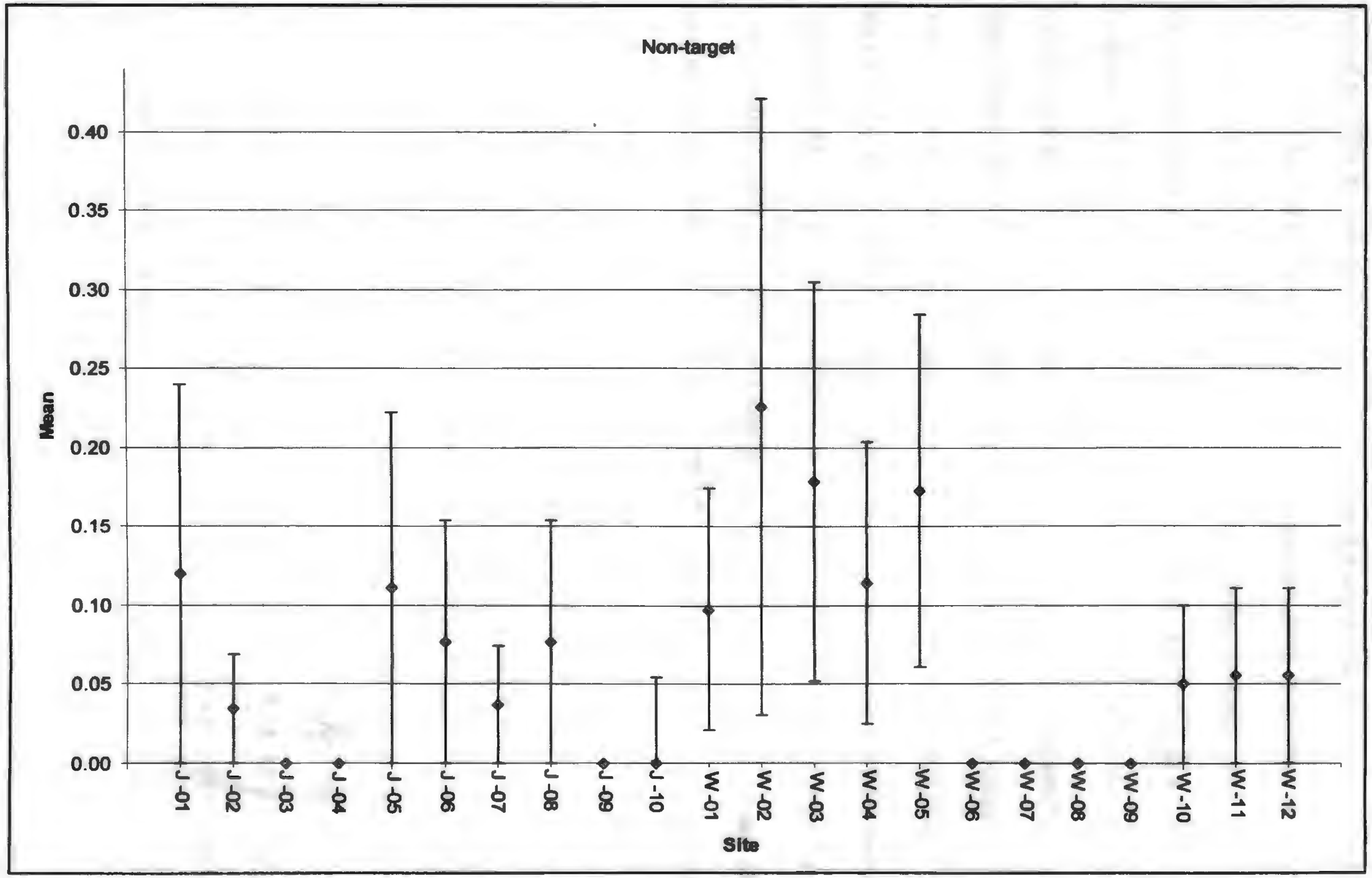

Figure 12. Means and standard errors of non-target avian use at each site during the 2008 field season for non-targets other than granivorous species.

equal to 50% at only two wetlands and ranged from a low of 15% to a high of 86% (Fig. 13). Also, frequencies for non-target species were observed, revealing that no particular site showed consistent use by non-target species, particularly granivorous species; frequencies ranged from as low as 0% to as high as 10% for granivorous species, and a minimum of 0% to a maximum of 7% for other non-target species (Fig. 13). Frequencies of bird activity at wetlands were compared with mean use of baited tray sites to determine the full extent of activity at those sites. Both frequency and mean use were high at sites J08-01 andJ08-02 (J-wetland 1), J08-07 and J08-08 (J-wetland 2), W08-01 and W08-02 (W-wetland 1), and W08-08 (W-wetland 4) indicating that target species regularly used the site with relatively large numbers of birds (Figs. 10 &13). Sites J08-09 and J08-10 (J-wetland 5), and W08-09,10,11 and W08-12 (W-wetland 5) were more moderate in means, while still maintaining a relatively high frequency of use indicating that target species use was moderate in comparison to other wetlands (Figs. 9, 11 & 12). Sites J08-03 and J08-04 (J-wetland 2), and J08-05 and J08-06 (J-wetland 3), and W08-03,04,05 and W08-06 (W-wetland 2) had low frequencies of use and small mean use by target species indicating that in comparison to the other sites overall use was minimal (Figs. 10 & 13). Measures of frequency and mean use were small for granivorous and other non-target species at all sites indicating that use of baited tray sites by all non-target species was infrequent and occurred in only small numbers (Figs. 11, 12 &13).

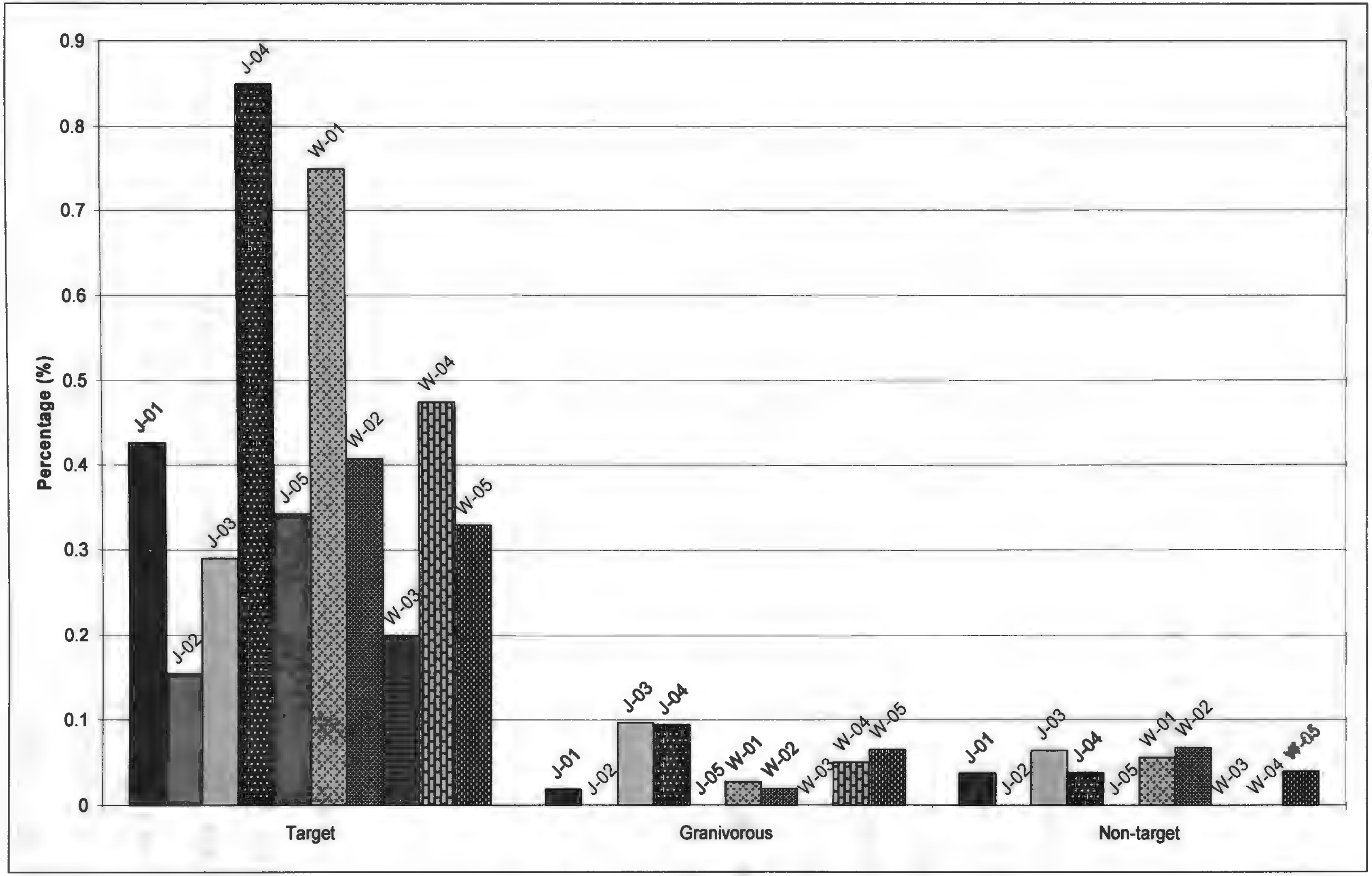

Figure 13. Frequencies of observations for avian groupings at each wetland during the 2008 field season, displayed as a percentage of observations with at least one bird observed.

5.5. Effect of Date Period on Site Use:

During the course of research, the date and time for all observations was recorded. Data were broken down into date periods and time periods as previously described. Data were analyzed for date periods nested within each study area to determine any effect that may have been had by changing date periods throughout the season. Target species were analyzed using nested ANOVA, which resulted in a p-value of <0.0001, indicating a significant relationship between changing date and changing observations for target species. Results of the Tukey's Test ranked date periods in the order of greatest use to lowest use, with date period 7 (15 Oct.- 21 Oct.) showing the greatest use and date period 1 (3 Sept. - 9 Sept) showing the lowest use, with generally an increase between the two periods (Fig. 13). The same data were gathered for granivorous and other non-target species. The effect of date periods was significant with a p-value of 0.0003. However, the Tukey's test for ranking did not display significant results for date period, and plotting of percentages of use indicated that non-target use for both groupings showed no detectable pattern (Fig. 14).

5.6. Effect of Time Period on Site Use:

Time period data were analyzed for both target and non-target species. Analysis was completed using nested ANOVA, as well as the Tukey's test to determine significance. Time of day was nested within area and date period, and analyzed to determine any effect that may have been had by changing time throughout the day. Target species were analyzed using factorial ANOVA, which resulted in a p-value of >0.001, indicating a significant relationship between

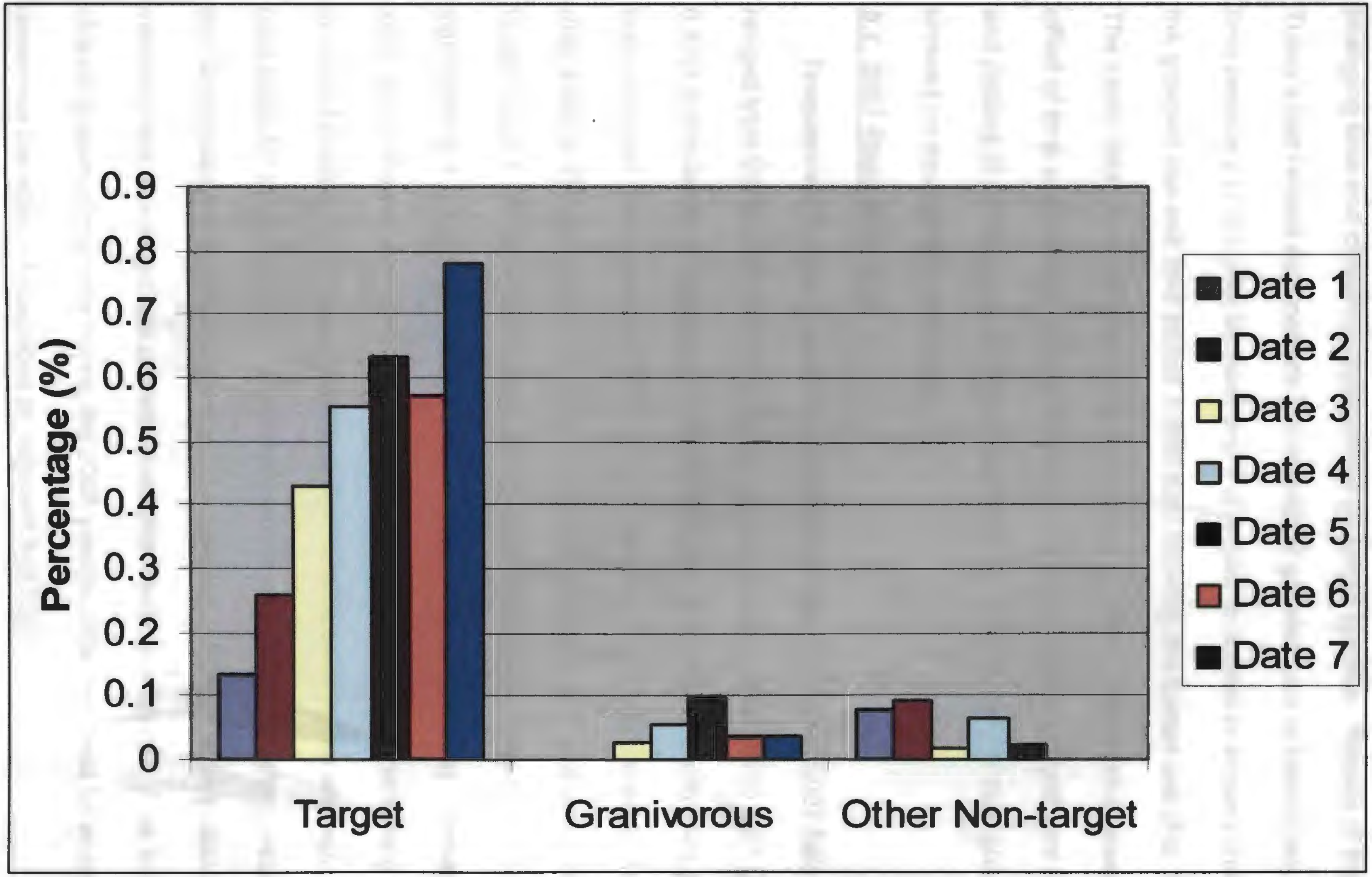

Figure 14. Comparison of date periods for target, granivorous non-target and other non-target species. Displaying frequency of observations with at least one bird observed during each date period.

changing time and changing observations for target species. Results of the Tukey's test ranked date periods in the order of greatest use to lowest use, with time periods 2 (2-4 h post sunrise) and 5 (2 h prior to sunset to sunset) showing the greatest use and time period 3 (Mid day) showing the lowest use (Fig. 15). The same data were gathered for granivorous and other non-target species. The effect of time periods was not significant ($p = 1.000$). The non-significant result and plotting of percentages of use indicate that non-target use for both groupings showed no detectable pattern (Fig. 15).

5.7. 2007 Road Side Use:

Frequencies of use for baited and controlled sites during the 2007 field season ranged from 0% to 25% ($\bar{x}$ =2.7%) for target species and from 0% to 50% ($\bar{x}$= 6.6%) in non-target species over both study areas (Fig. 16). Results from paired t-tests indicated that during the 2007 season, control road sides compared to baited road sides in the Jamestown had non-significant differences in use ($p= 0.397$) for target species. Similar results were found in the Devils Lake area with a non-significant ($p = 0.752$) result between control and baited road sides. The entire 2007 study showed non-significant ($p= 0.728$) differences when comparing baited to control roadsides indicating that there was no difference in use amongst baited road sides for target species. Non-target use of road sides was also calculated for the Jamestown ($p= 0.653$) and Devils Lake area ($p= 0.995$). These p-values indicated that non-target use of baited roadsides was inconsistent. Due to the ever changing style of tray sites during the 2007 season, data could not be analyzed to determine the effect of roadsides on adjacent bait trays.

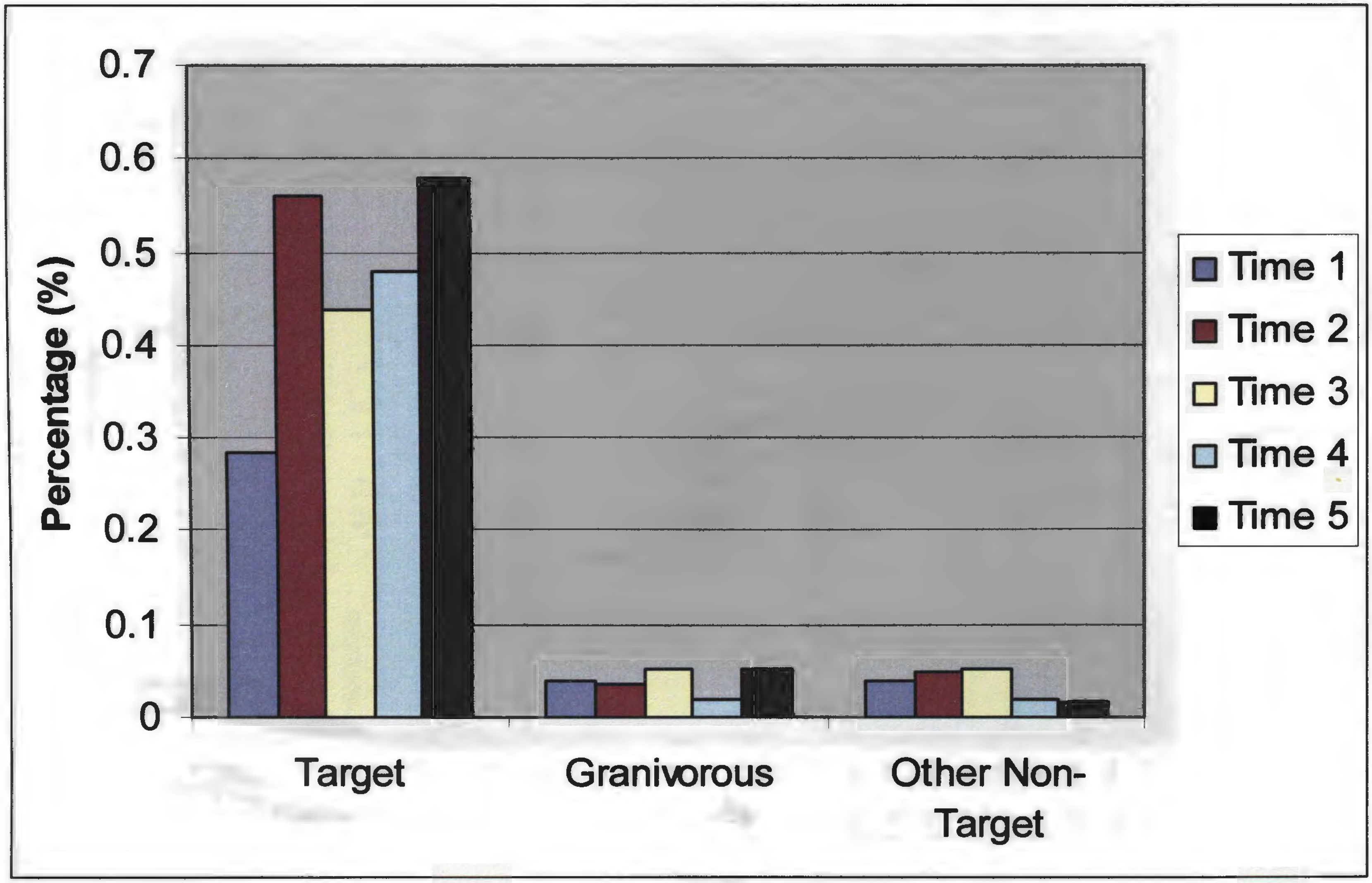

Figure 15. Comparison of time of day periods for target, granivorous non-target and other non-target species. Displaying frequency of observations with at least one bird observed during each period of daylight.

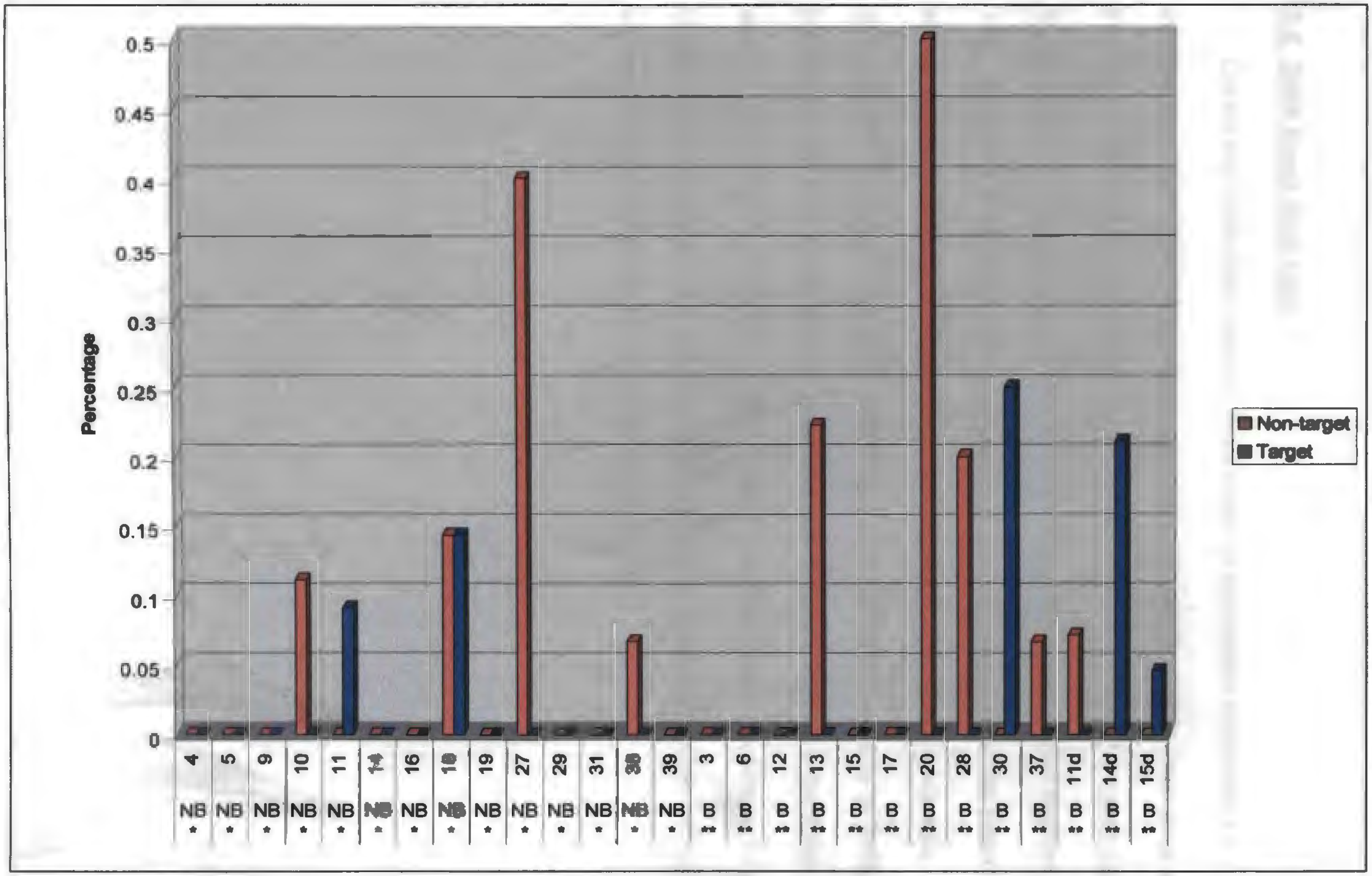

Figure 16. Frequency of use for baited and control roadsides displayed in percent of observations with at least one bird observed adjacent to tray sites during the 2007 field season

5.8. 2008 Road Side Use:

During the 2008 field season, there were no applicable roadsides for comparison in the Wimbledon area, so data are from the Jamestown area alone. Frequency of use by target species ranged from 0% to 11.5% ($\bar{x}$ =4.6%) and non-target species ranged from 0% to 7.7% ($\bar{x}$ = 1.3%) during the 2008 season (Fig. 17). The sites during the 2008 season were tested using the paired t-test to reveal a p-value of 0.312 for roadsides for target species. Data were also analyzed for non-target species, revealing a non significant p-value of 0.454, indicating that non-target use of roadsides was random. Data for the 2008 season were analyzed using a paired t-test for avian use of baited trays adjacent to roadsides. The resultant p-value was 0.131, a non-significant value indicating that no benefit was gained by baited adjacent roadsides.

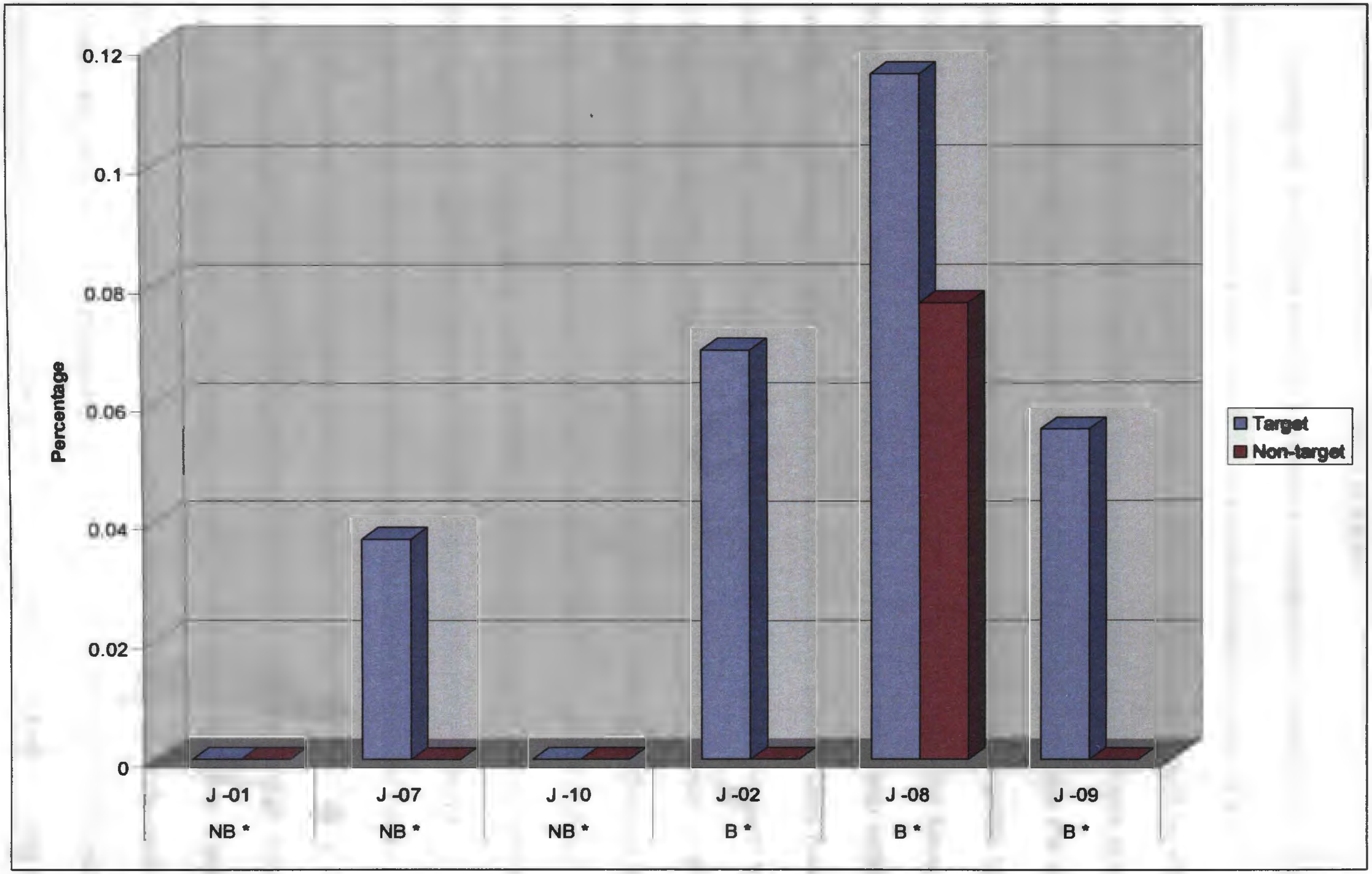

Figure 17. Frequency of use for baited and control roadsides displayed in percent of observations with at least one bird observed adjacent to tray sites during the 2008 field season.

DISCUSSION

During the 2007 field season, I gained knowledge applicable to the 2008 season. Electric fencing was critical for reducing predation of decoy birds. It was also concluded that removal of vegetation around the tray sites could be effective in reducing non-blackbird use of the trays, because small songbird and sparrow species like to feed in the grass and on the ground for seeds and use the taller vegetation to help avoid predation. Also, the proximity to roosts or perch trees was beneficial, allowing perching blackbirds an opportunity to observe the trays, be enticed by decoys, and visit the site. The following year locations near cattail roosts were given priority over those near sunflower fields alone. Sites near sunflower fields alone did not have as much blackbird activity as the sites near cattail roosts, probably because the birds preferred ripening sunflower over the brown rice bait. Additionally, blackbirds returned to the roost in mid-morning and loafed in and around the roost, giving them time to find and experiment with the bait stations. Large roost sites are likely more feasible than scattered small sites for implementing bait trays with DRC-1339. Larger numbers of decoys (approximately 10/trap) also may attract more blackbirds to the bait trays.

The use of DRC-1339 baited rice trays in central North Dakota during fall migration would be limited to the time frame in which blackbirds are present at large roosting sites in the area, as well as during the time period when damage to sunflower is occurring. Other birds present during these time period would also potentially be at risk of unintentional DRC-1339 poisoning if they were to eat poisoned baits. The number of target species that may be affected during this baiting program can be determined using the avian use observations, as well as the amount of rice consumed. Observations of non-target species use of tray sites, as well as the likelihood that these species would consume rice baits are the only available methods for determining non-target risks at tray sites. Also, information on LD_{50} values for non-target species can provide some insight into the non-target risks of DRC-1339 baited rice trays.

6.1. Blackbird Use:

Blackbird (target) use of tray sites was established on many occasions. Often blackbirds were observed at tray sites where observations of non-target species did not occur, making them favorable locations for DRC-1339 application. Blackbird use of tray sites was substantially smaller than the at large populations available in surrounding agricultural fields or roosting sites and was, therefore, a very limited response. Similar results were obtained by Cummings et al. (1990) where they observed amounts of bait consumption indicating only a small percentage of the surrounding blackbird population using baited decoy fields were consuming treated baits. They also concluded it is difficult to lure target species away from a preferred food, in this case ripening sunflower, to bait on the ground or elevated trays. Blackbirds were observed at mean peaks of 12.1 (2007), and 24.5 (2008) birds/h of observation across all sites, and exceeded 10.0 birds/h of observation on 2 separate days in 2007, and 10 different days during 2008. There were no sites during the 2007 season with an overall average use greater than 10.0 birds per hour. There were 4 sites during the 2008 season that recorded overall use of greater than 10.0 targets/h of observation. Bait stations during the

2008 season showed substantially increased use in comparison to the first field season, likely as a result of implementation of knowledge gained from that first field season. Also, decoy birds had greater longevity in sites, due to an almost complete lack of predation afforded by electric fencing barriers at tray sites. These figures indicate that study revisions from one field season to the next were likely responsible for increased target use.

Statistical analysis indicated that there was no difference among bait site configurations; therefore, data for vertical pair designs and horizontal "L" configurations were combined for further analyses. Also, vertical pairings should be favored in future field applications because they provide easy access to the decoys and were as effective as the "L" configuration.

Blackbird data were analyzed and shown to be significant for date periods, time periods and individual wetlands, and avian use could be influenced by these factors. Analysis indicated that 15 October through 21 October (period 7) was the greatest level of use by target species during this research, but periods 5 and 6 (first two weeks in October) were also similar in blackbird use, providing significantly greater use than other date periods. Thus, baiting during the first 3 weeks in October would be optimal; however, a large portion of the damage to sunflower would have already occurred by this date. Date periods 1 and 2 (3 September to 16 September) had the lowest activity, thus baiting would be least effective during this period. Unfortunately, it is during this time that the most damage would be prevented if baiting were successful. Time periods of 2 h prior to sunset through sunset, and 2 h to 4 h post sunrise were the best for bait consumption. Individual wetlands varied in success, but analysis of covariance indicated that the number of birds in surrounding roosts was not a significant factor in determining the success of a wetland bait site. The interactions between number of birds in the roost and date period, time period, and site were not significant. The number of decoys was not shown to be significant in any interactions. These results indicate that targeting large roosts along with larger numbers of decoys may provide the best baiting strategies. However, bait site utilization of even the largest numbers during the final field season are simply too small to be an effective management tool under current protocol. This is consistent with the findings of Linz and Bergman (1996) where data demonstrated that sufficient numbers of blackbirds were not killed to reduce the number of birds feeding in sunflower fields. Poor efficacy could be in part related to fluctuations in roosting blackbird populations during migration, or changing locations of preferred feeding sites (Linz and Bergman 1996). Blackbirds are attracted to brown rice, and the rice makes a suitable carrier for DRC-1339 baits (Linz et al., 2003). This method has been used effectively in Louisiana to protect newly planted rice fields and results in large numbers of dead blackbirds (Glahn and Wilson 1992). These results are vastly different than those observed in this research. A handful of explanations may exist. Most specifically, preferred alternative foods are not readily available for the birds at that time, thus large quantities of grain on the landscape provide a food source that blackbirds are likely to utilize. Also, extremely large roosts of potentially millions of birds exist on the landscape and are not subject to the daily fluctuation of birds that fall migration roosts may be.

These conditions do not exist during a fall baiting program and the potential allure of decoy birds is not sufficient enough to entice a large enough response by target species to be effective.

Baited roadsides had no effect on the effectiveness of adjacent sites in either field season, and they were visited infrequently by blackbirds. There was no significant preference for baited road sides in comparison to control road sides. Also, many of the preferred wetlands for baiting during the 2008 field season had no adjacent roadsides available. For these reasons, the use of baited roadsides is neither practical nor effective.

6.2. Non-target Risks:

During the sunflower growing season and the time frame of intense blackbird damage to the crop, a host of bird species can be found migrating through the central Dakotas (Appendix B). It is during this time frame that a baiting project focused on blackbird roost size reduction and damage reduction would be conducted. Non-target species of birds may therefore be at risk, and a variety of non-target species were observed on bait trays, though infrequently. During the course of this research, 3,888 individuals consisting of 25 species were observed. There were a small number of birds only identified to family. Of all the observations of individual birds at tray sites, 69 individuals (1.8%) were granivorous species that may feed on brown rice. The most prevalent species were sparrows. Unidentified sparrows represented 21 observations (30.4%), clay-colored and savannah sparrows represented 12 observations each (17.4%). Other prevalent species included song sparrow (10.1%) and Harris' sparrow (7.2%).

Other field studies also showed an assortment of non-target species, with a majority of them being sparrow species including field sparrows, song sparrows, savannah sparrows, white-crowned sparrows (*Zonotrichia leucophrys*) and chipping sparrows (*Spizella passerina*) (Cummings et al. 1990, Linz et al. 2001, Cummings et al. 2002).

Primary hazards associated with many of the granivorous species observed are minimal because the $LD_{50's}$ for these species are high; therefore, the likelihood of mortality via acute poisoning is small. For example, the LD_{50} values associated with sparrow species which were the most prevalent of non-target species observed vary from highly sensitive to insensitive. The LD_{50} of the dark-eyed junco (*Junco hyemulis*) is 162.0 mg/kg (Eisemann et al. 2003); in contrast, the LD_{50} for the American tree sparrows (*Spizellu arborea*) was 3.5 mg/kg (Eisemann et al. 2003). White-crowned sparrows were reported to have an LD_{50} value of >320.0 mg/kg (Schafer et al., 1983). Acute dietary toxicity studies suggest that song sparrows and savannah sparrows are insensitive to DRC-1339 with LD_{50} values for these two species estimated at >714.0 mg/kg (Eisemann et al. 2003). Nonetheless, chronic poisoning may still be a concern. Extremely sensitive non-target species such as meadowlarks and mourning doves (LD_{50} values of <10mg/kg and 5.4mg/kg, respectively) were not observed on bait trays throughout the duration of the study, with the exception of one non-feeding meadowlark in the Jamestown area, indicating a nearly non-existent risk to these species.

A host of raptor species were observed on and around bait trays, including red-tailed hawks, Cooper's hawks, sharp-shinned hawks, northern harriers and merlins. In general secondary hazards to theses avian predators are likely low due to small likelihood of finding carcasses before mammalian predators and scavengers. Also, Kostecke (1998) observed few of these species at camera sites around bird carcasses. Some risk still may remain to raptors that capture sick but still living birds because they may have greater levels of DRC-1339 in their bodies. However, these avian predator species are known to be tolerant of DRC-1339, with oral LD_{50} values greater than 100.0 mg/kg (Schafer 1970, 1979; Cunningham et al. 1979, Schafer et al. 1983, Knittle 1989). Data on granivorous non-target species were analyzed to determine if date period, time of day, and individual wetlands had an effect on tray use. These results indicate that non-target use of tray sites was not predictable. This randomness makes a baiting program difficult because it is unlikely to guarantee zero non-targets as required by the current DRC-1339 label. Furthermore, the data show that no particular method that was utilized to avoid non-targets was consistently effective.

6.3. Rice Consumption and Take Model:

Throughout the course of the study rice consumption was monitored. Roadside rice quantities were not measured in terms of consumption. Tray levels were measured, and amounts consumed were recorded. If certain sites were having large amounts of rice consumption but observations due to random chance missed the birds as they fed, then sites displaying large amounts of consumption, but lower avian use during observations could still be effective baiting sites. Levels of rice consumption were also used to calculate a take model.

Results indicate possible issues with efficacy of baiting based on non-target concerns and a relatively small response by target species to baited sites. By analyzing rice consumption, the number of birds that could have been taken during the 2008 field season was estimated. This take model is based on all rice eaten at all sites, and is an idealistic model in that it assumes each DRC-1339 rice grain that could be consumed resulted in the take of one bird. Using percentages of use, broken down by species and sex, the total numbers of birds in each category that would be taken over the course of the study was determined (Appendix C).

Based upon total rice consumption in 2008, we estimate that if toxic bait had been used approximately 27,000 blackbirds would have been killed. Using data from the Peer et al. (2003) model, this reduction in blackbirds would equate to approximately a $900 reduction in damage. Comparison of these values to the cost of implementation of a baiting program provides an economic cost to benefit ratio. With such a small response of target birds and the cost of finding sites, capturing decoys, and monitoring sites, the cost of management is greater than the benefits gained. In short, based on this research, use of DRC-1339 rice-baited trays with accompanying live decoys and/or rice-baited roadsides are not cost-effective methods of reducing blackbird damage to sunflower.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

Field research and review of literature indicate that the use of DRC-1339 avicide with live decoys and bait trays does not pose a serious risk to non-target bird species. The majority of non-target birds observed at tray sites have LD_{50} values large enough that consumption of the avicide would not likely result in death. Furthermore, the use of trays by these species was so minimal that incidences of avicide consumption would be nearly non-existent. However, the label for use on DRC-1339 does not allow for any non-target use of bait sites regardless of how small the risk.

Mourning dove and ring-necked pheasant use of bait trays was shown to be non-existent within these two field seasons; not a single incidence of use by either of these species was observed. Blackbird use of tray sites was observed, and in several instances sites were established at which no non-target species were observed, and thus meeting the restrictions of the label for DRC-1339. In specific instances, blackbird use of trays was substantial; however, use of all bait station configurations and locations was insufficient to warrant this procedure as a control measure for blackbird depredation of sunflower on a regular basis. The impact on the number of birds affected by baiting was simply too small in comparison to the at large population in surrounding sunflower and cattail roosts to be an efficient use of resources.

In very specific instances where the availability of large roosts, nearby sunflower, suitable perch trees and tilled or harvested ground on which to place bait stations is available, management may be possible. However, this would likely require much larger bait stations and a substantially greater number of decoy birds to attract feeding birds to the site. Further research may investigate this possibility. In general, it is highly unlikely that a set of circumstances would be present such that any substantial economic savings via fall population reduction using live decoys and DRC-1339 could be achieved.

FUTURE RESEARCH

Scientists have conducted research for decades in an attempt to manage depredation by blackbirds to ripening crops. This attempt to use bait cages and live decoy blackbirds is impractical as a management strategy, as currently designed.

Future research could be focused on blackbird use of substantially larger bait trays where competition among feeding birds on trays is reduced and a greater flock size of feeding birds could be established. Also, investigations of the efficacy of grouping bait trays near roost sites to provide more room for feeding birds could be researched. Additionally, increased size of bait trays would coincide with an increase in decoy cage size. A study on the effects of increased number of decoys on blackbird response to bait sites may be warranted.

The lack of a clear pattern of habitat types surrounding baited sites leaves questions as to what may make some sites potentially better bait sites than others. Research to determine placement of tray sites around wetlands in relation to flight lines, perching structure or other wetland characteristics, as well as the distance to corn or sunflower fields for foraging, may be pursued to determine if placement of trays around particular wetlands could result in greater blackbird use.

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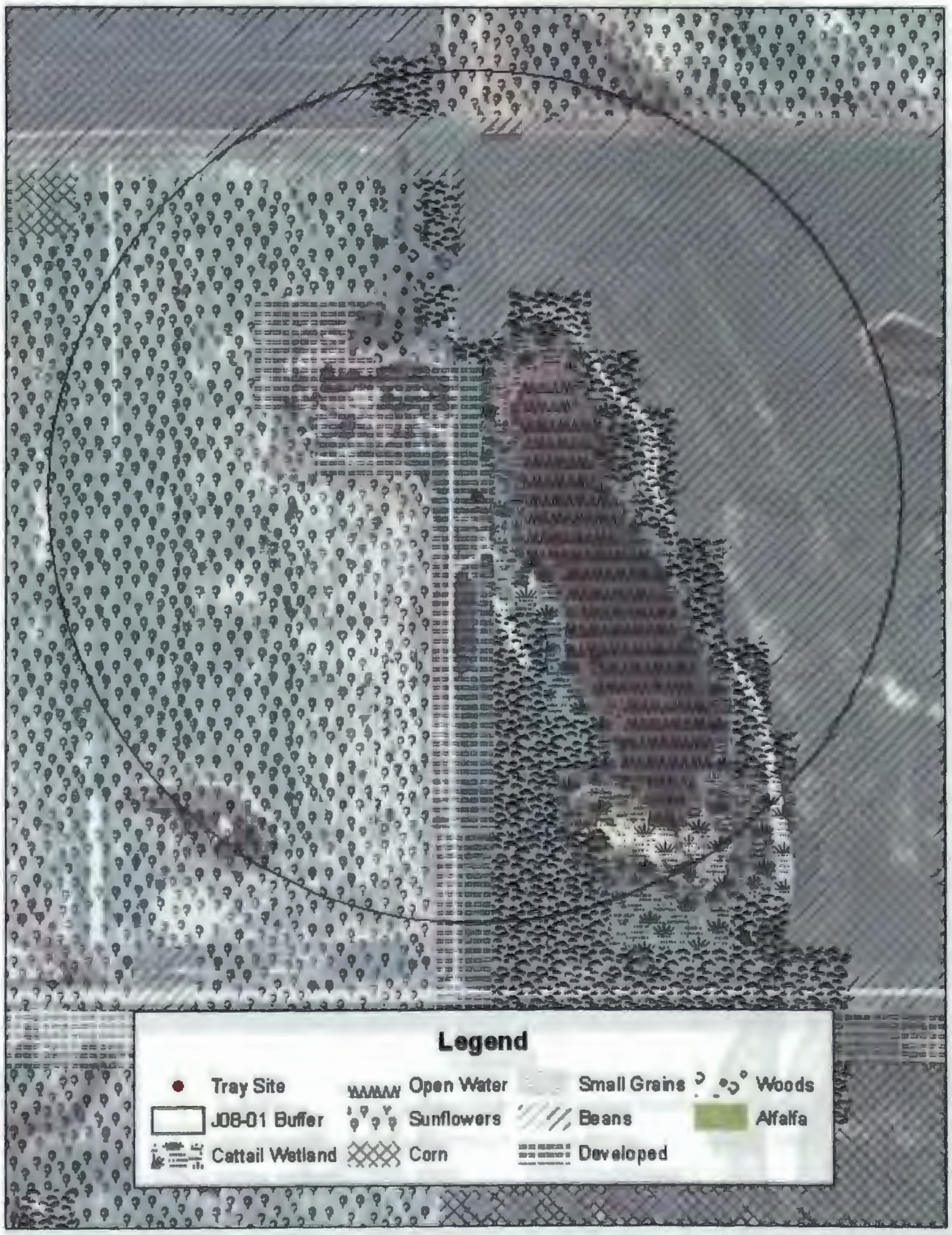
APPENDIX A. 2008 SITE LOCATIONS AND LAND COVER

Baited sites W08-01 and W08-02 were located at the same roost site located in Barnes County in the west half of Sec. 6 in Township 142 N, Range 60 W. Site W08-01 was on the south side of the wetland near perch trees, and W08-02 was located on the north end of the wetland near perch trees as well. A large cornfield was located to the north and east sides of the wetland. Study sites W08-03, W08-04, W08-05 and W08-06 were all located on the same roost in Barnes County. W08-03 and W08-04 were located in the SW ¼ of Sec. 28 in Township 142 N. and Range 60 W. Sites W08-05 and W08-06 were located in the NW ¼ of Sec. 33 in Township 142 N. and Range 60 W. The study sites were located on the west edge of large shallow marsh. There was a large sunflower field to the north end of the wetland as well as to the west. The study area was primarily CRP with thin scattered tree rows. Site W08-04 had a small perch tree placed near it and W08-06 also had adjacent perch trees. Study sites W08-07 and W08-08 were located on a central roost and a loafing roost in Barnes County. Study site W08-07 located on the loafing roost in the NW ¼ of Sec. 13 in Township 142 N. and Range 61 W. This site had a large sunflower field to the north and east of it. Site W08-08 was located on the central roost in the SW ¼ of Sec. 12 in Township 142 N. and Range 61 W. This study site was near a very large open water wetland, with corn to the east and west, with a large sunflower field to the south. There was a large farm grove to the south and east of the site. Study sites W08-09, W08-10, W08-11, and W08-12 were located on a large roost in Griggs county W08-09 and W08-10 were located in the NW ¼ and sites W08-11, and W08-12 were located in the NE ¼ of

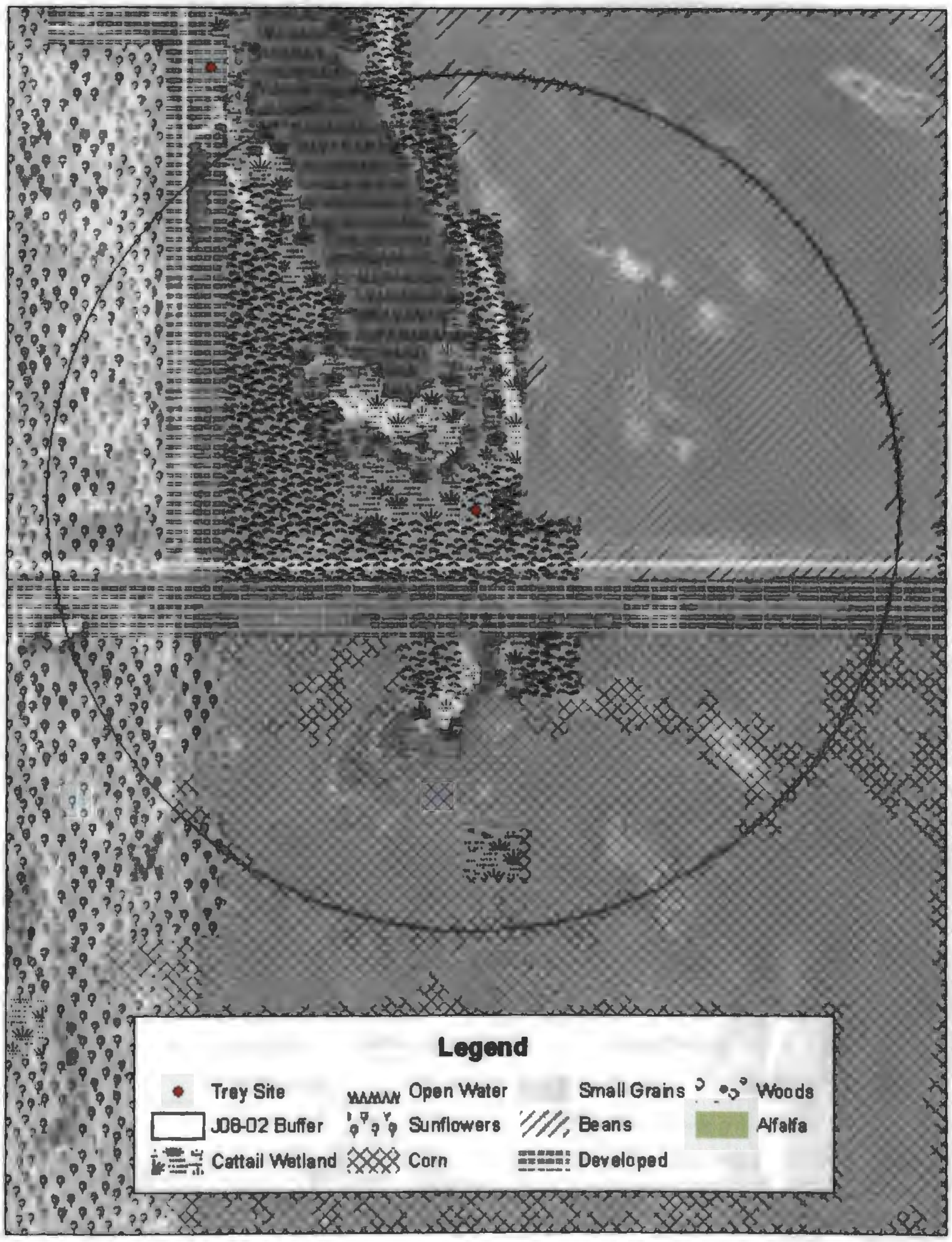
Sec. 1 in Township 144 N. and Range 61 W. These sites were all located on the southern edge of a large shallow marsh. There was a large sunflower field to the south of these sites.

Study sites J08-01 and J08-02 were located on the same roost in Stutsman County. They were located in the Se ¼ of Sec. 20 of Township 139 N. and Range 63 W. Site J08-01 was associated with a control roadside and J08-02 was in proximity to a baited section of roadside. These sites were located to the south and west of the roost site and were associated with large sunflower fields to the north and west and a large corn field to the south. There was a farm site and grove to the north and west in near proximity to the sites. Study sites J08-03 and J08-04 were located on the same roost in Stutsman County. The sites were located in the SW ¼ of Sec. 16 in Township 139 N. and Range 64 W. These sites were not associated with a roadside test, and were removed early on in the field season as a result of interference with farming operations after further discussion with the landowner. These study sites were located to the south and east of the wetland, and were associated with a large corn field to the north, otherwise surrounded by soybean fields. There was a substantial section of CRP and hay land associated with the wetland and study sites as well as an abundance of dead perch trees. Study sites J08-05 and J08-06 were located on the same roost in Stutsman County in the SW ¼ of Sec. 27 in Township 140 N. and Range 65 W. Study site J08-05 was associated with a baited roadside, while site J08-06 had no potential roadsides. Study Site J08-05 was located on the west side of the wetland while site J08-06 was located on the south east side of the wetland. These sites had a corn fields to the north and west, but were mostly surrounded by soybean fields. There was another large wetland complex to the west of the study sites. Study sites J08-07 and J08-08 were located on the same roost in Stutsman County. The sites were located in the N ½ of Sec. 33 in Township 140 N. and Range 62 W. Study site J08-07 had a control section of roadside adjacent to it, while J08-08 was adjacent to a baited section of roadside. These sites were located next to a large open water marsh, with site J08-7 located on the west side of the marsh and J08-08 located on the east edge. There was a large cornfield to the north and west as well as the west, however the majority of land surrounding the sites was CRP grasslands and marsh, or soybean fields. Study Sites J08-09 and J08-10 were located on the same roost in Stutsman County. They were located in the SE ¼ of Sec. 16 in Township 139 N. and Range 65 W. Study site J08-09 was in proximity of a baited portion of roadside, while site J08-10 was near a control portion of roadside. These sites were located on a fairly small wetland, with a large sunflower field to the south and a large cornfield to the west. Site J08-09 was located on the east side of the wetland and J08-10 was located on the west side of the wetland. Both sites were primarily surrounded by harvested grain field.

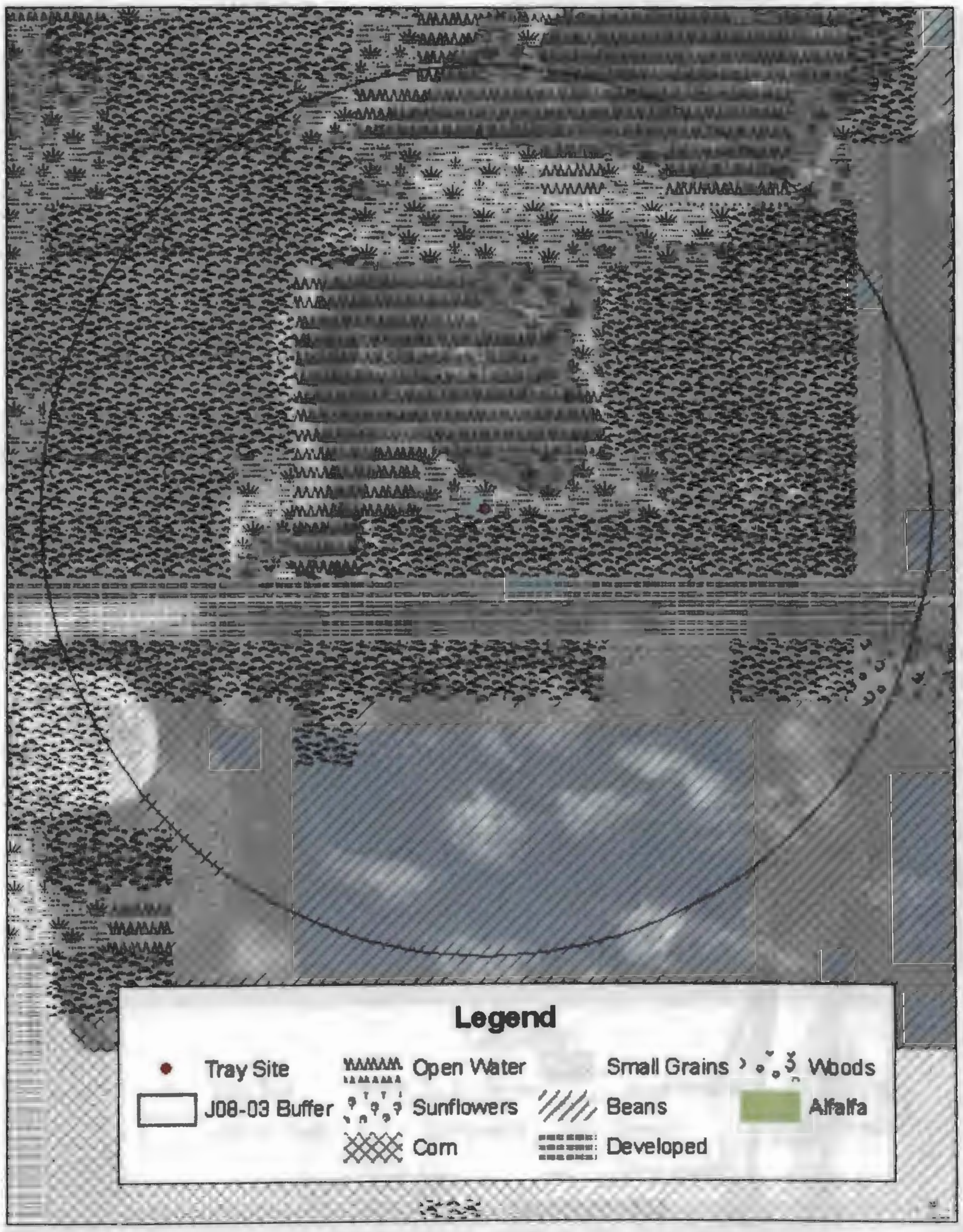
J08-01 Tray Site and Buffer



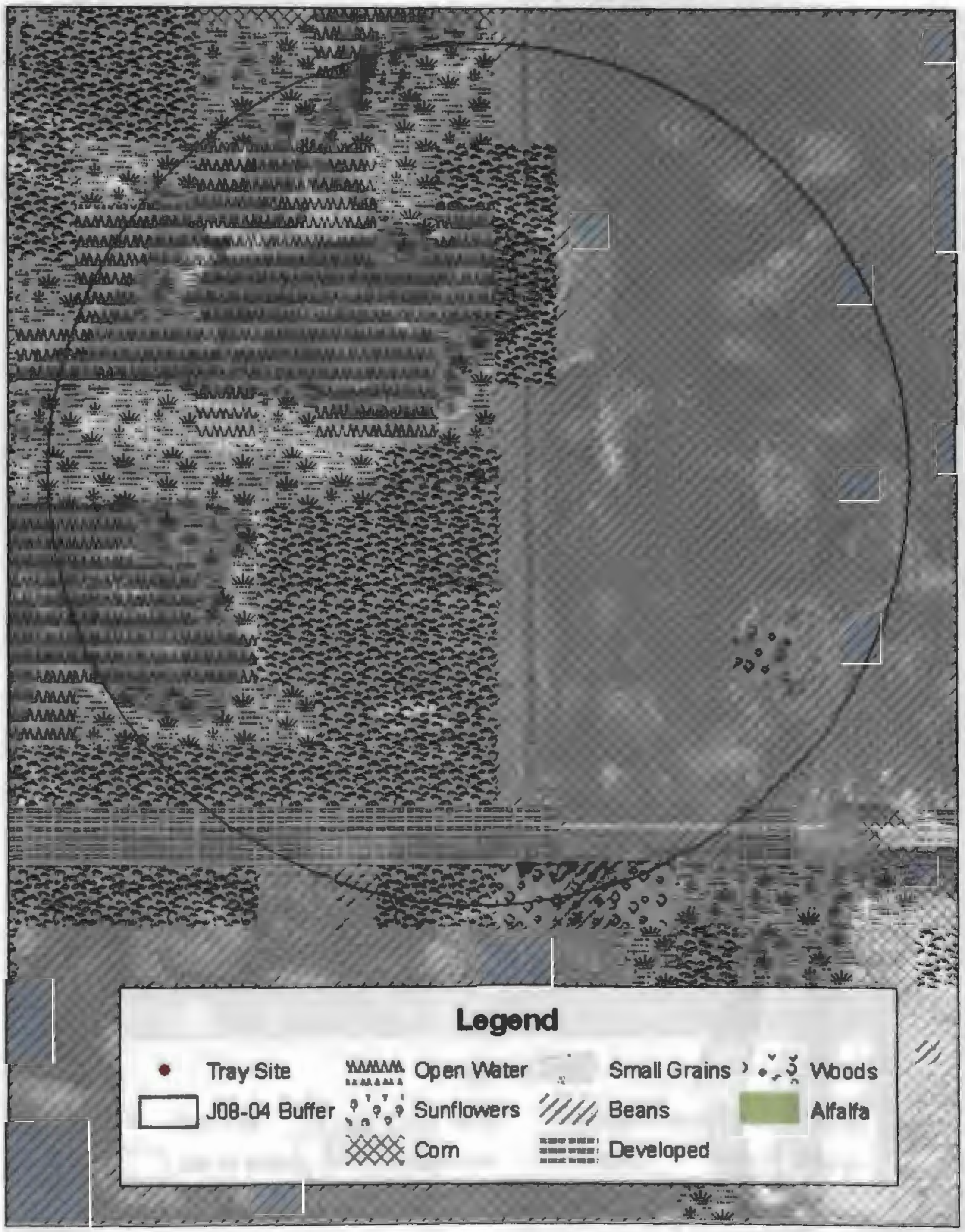
J08-02 Tray Site and Buffer



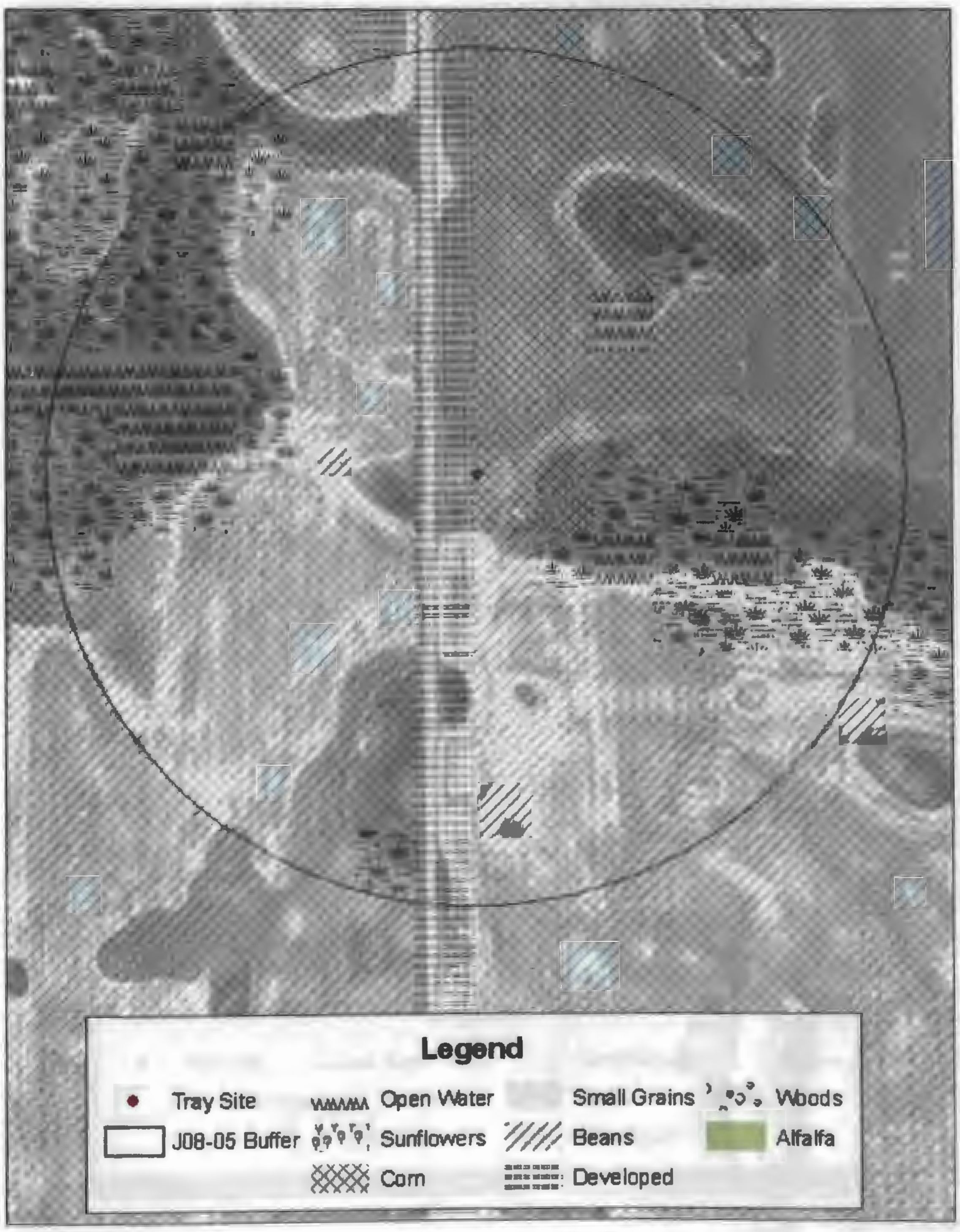
J08-03 Tray Site and Buffer



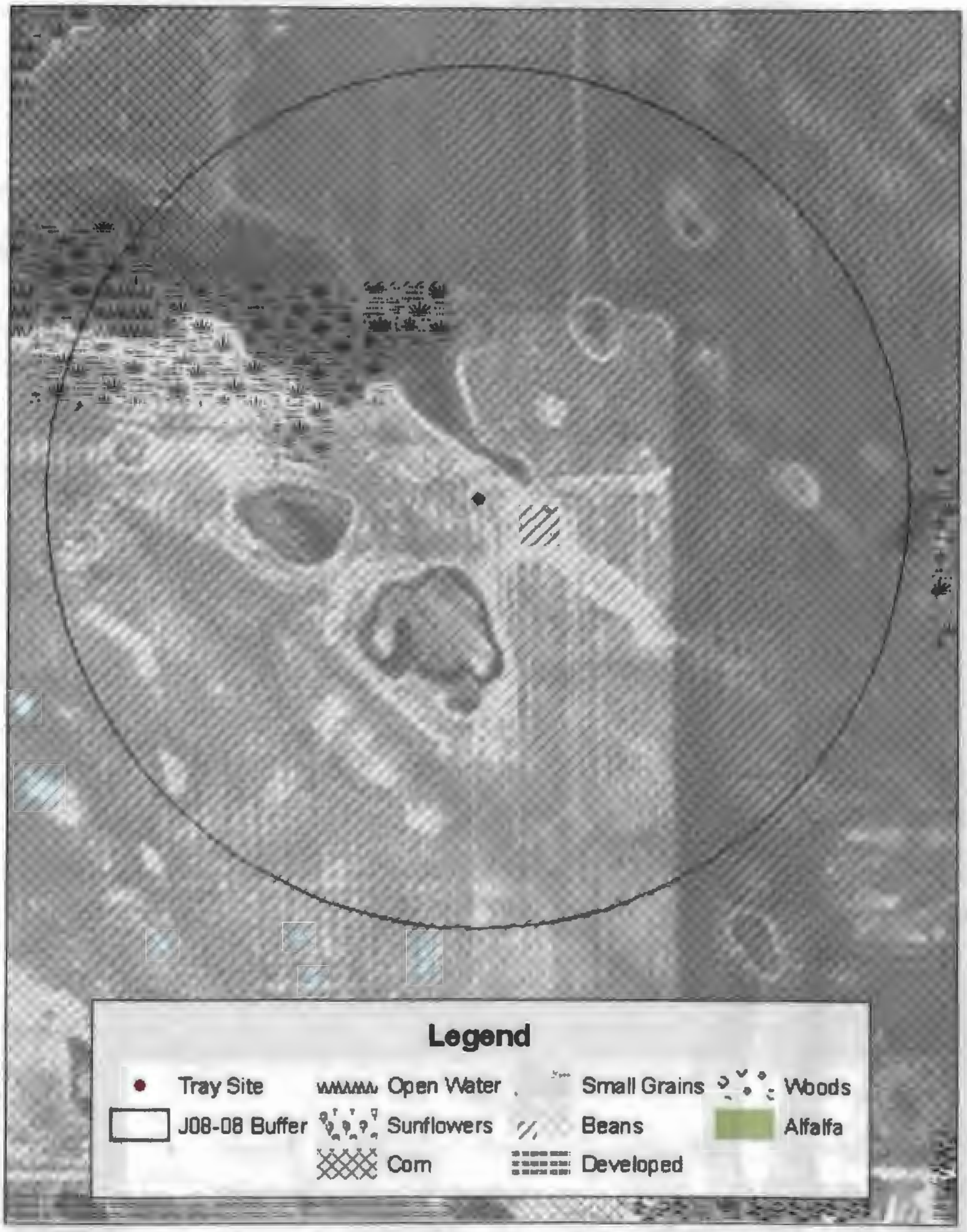
J08-04 Tray Site and Buffer



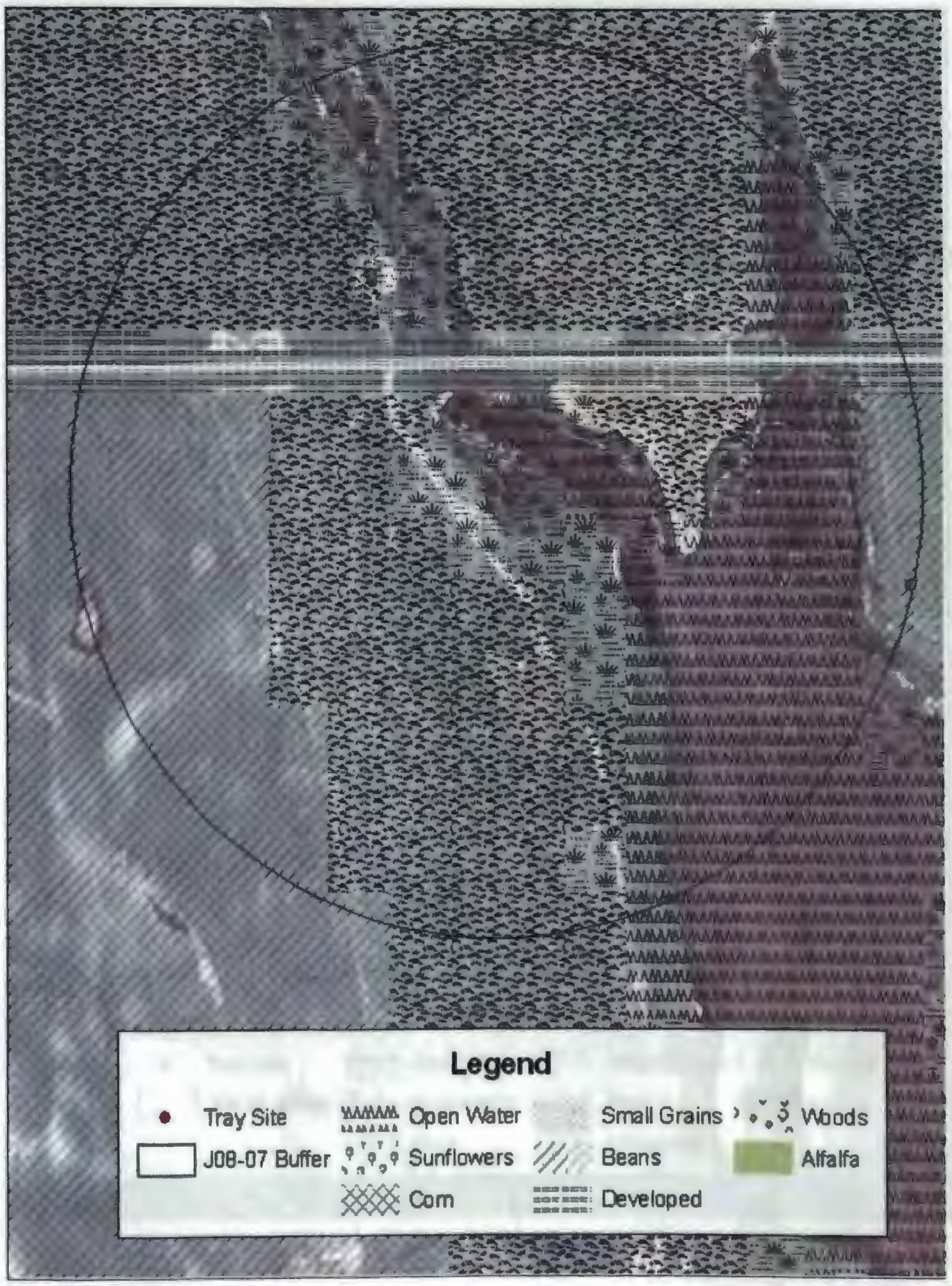
J08-05 Tray Site and Buffer



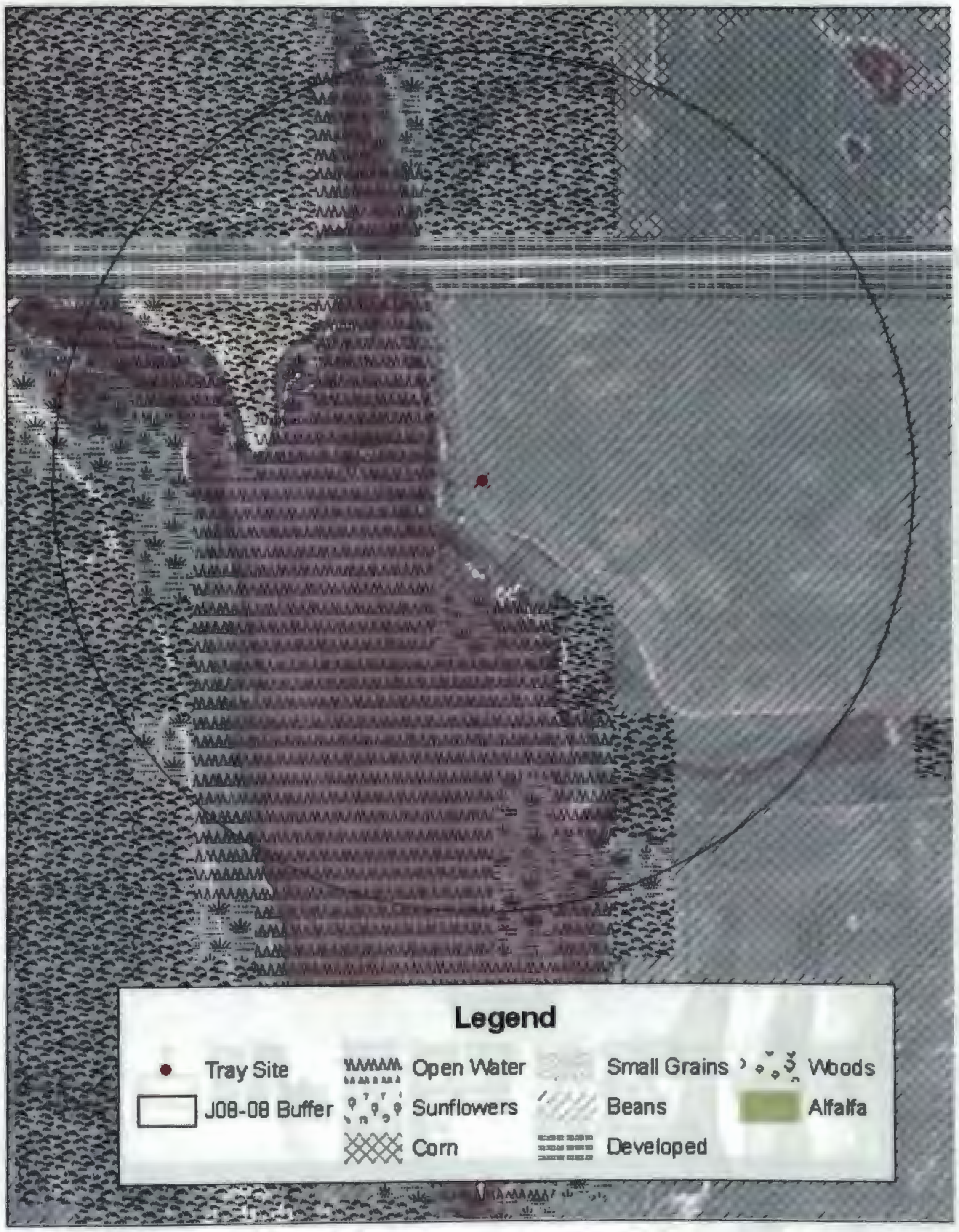
J08-06 Tray Site and Buffer



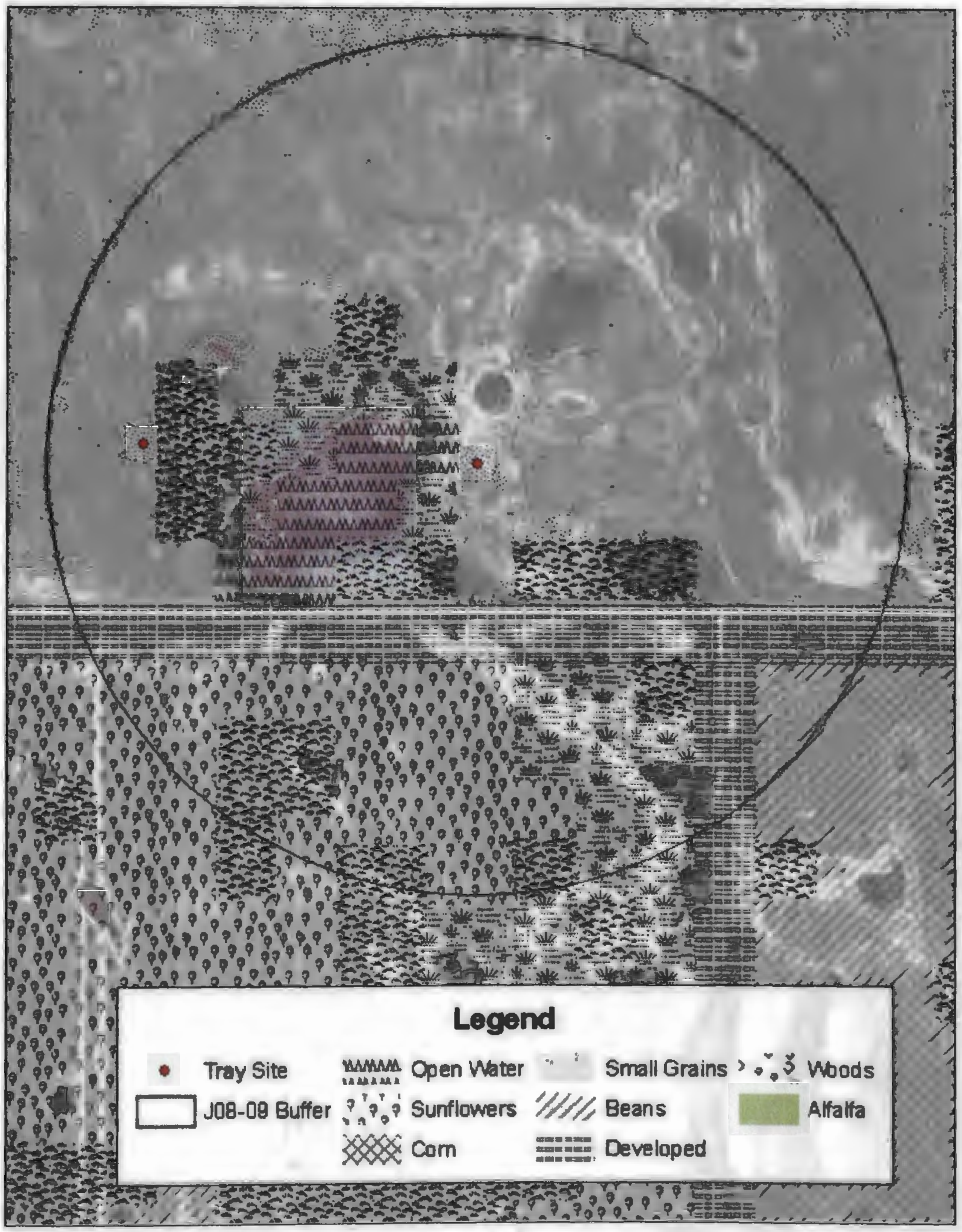
J08-07 Tray Site and Buffer



J08-08 Tray Site and Buffer



J08-09 Tray Site and Buffer



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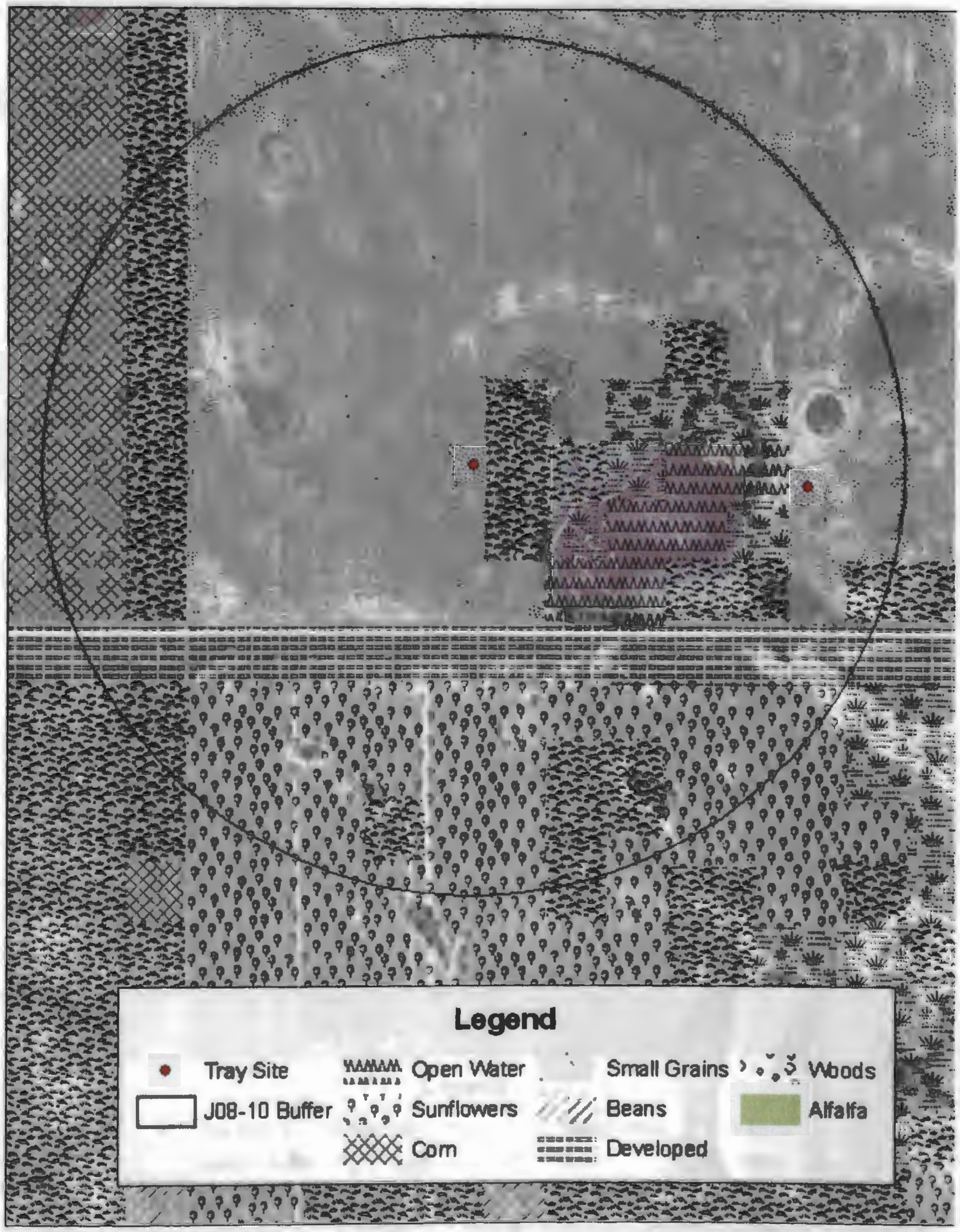
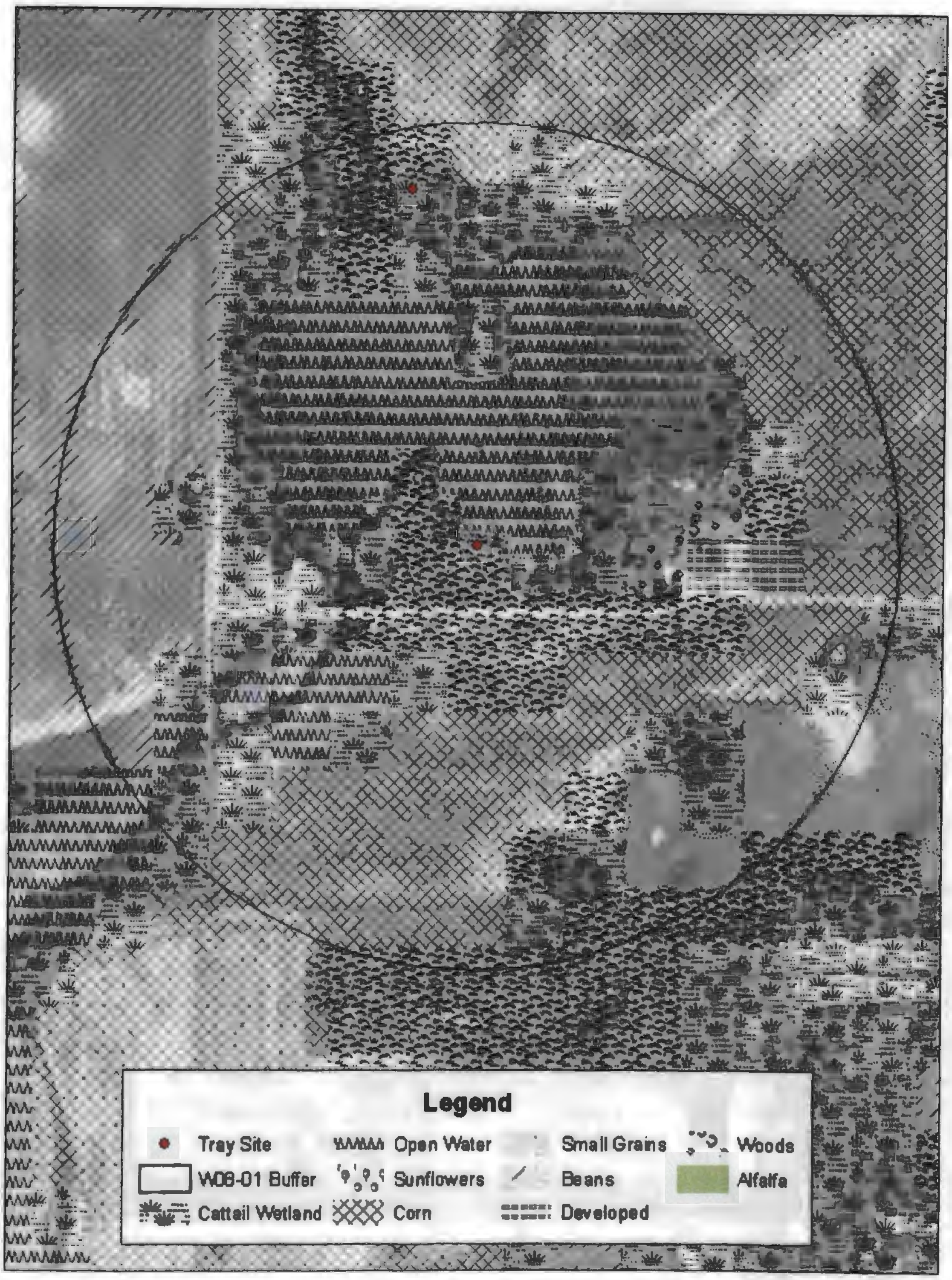
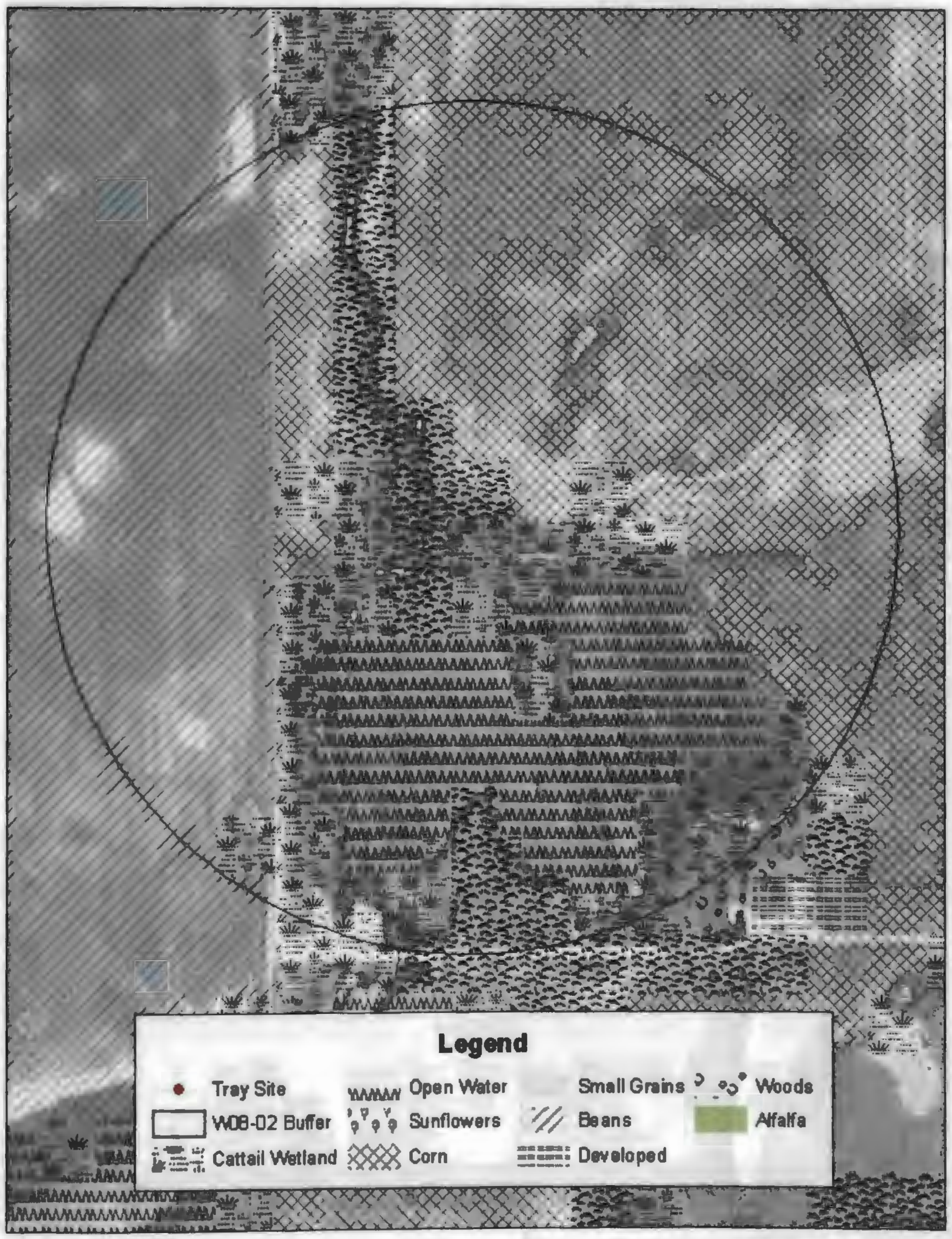


W08-01 Tray Site and Buffer



W08-02 Tray Site and Buffer



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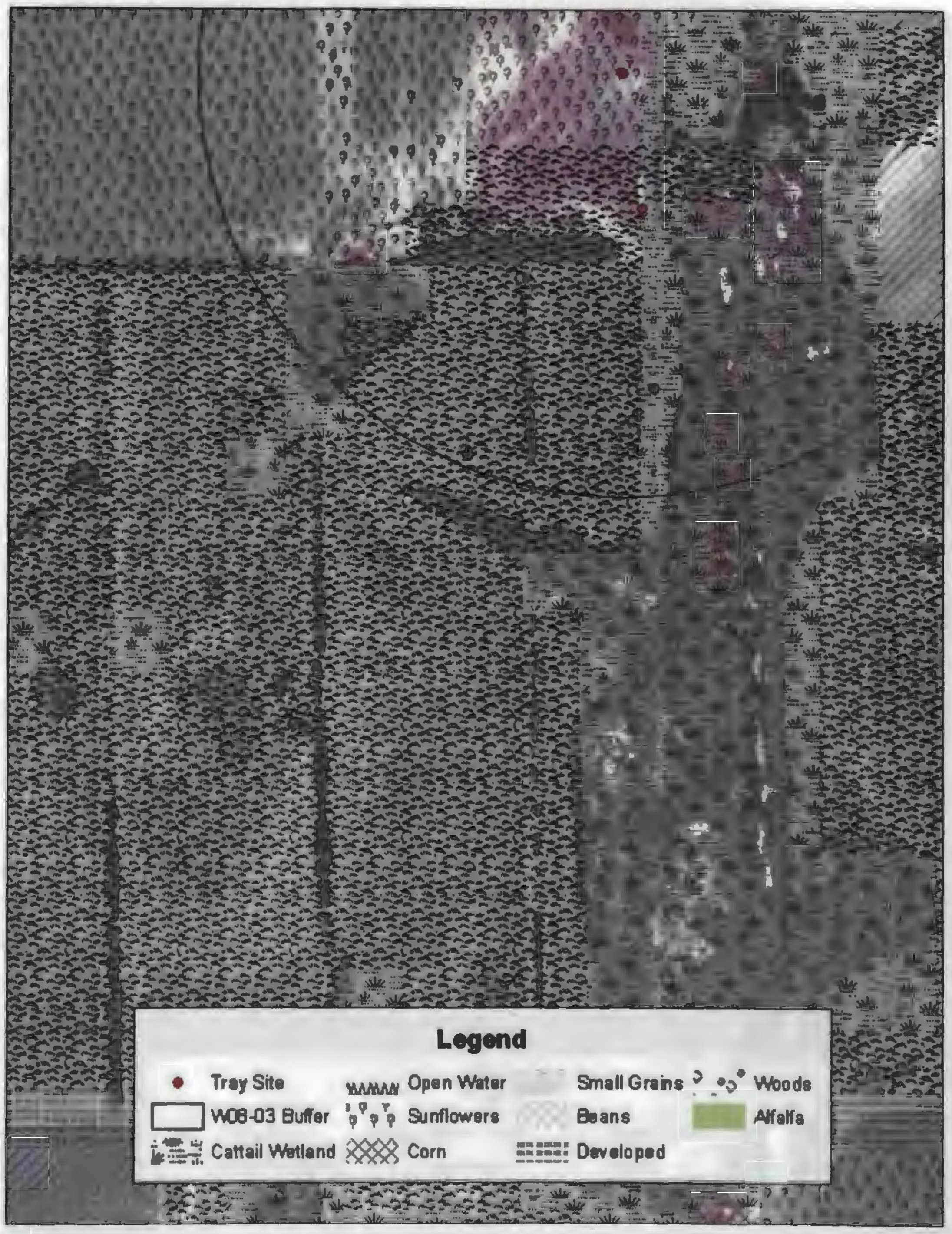

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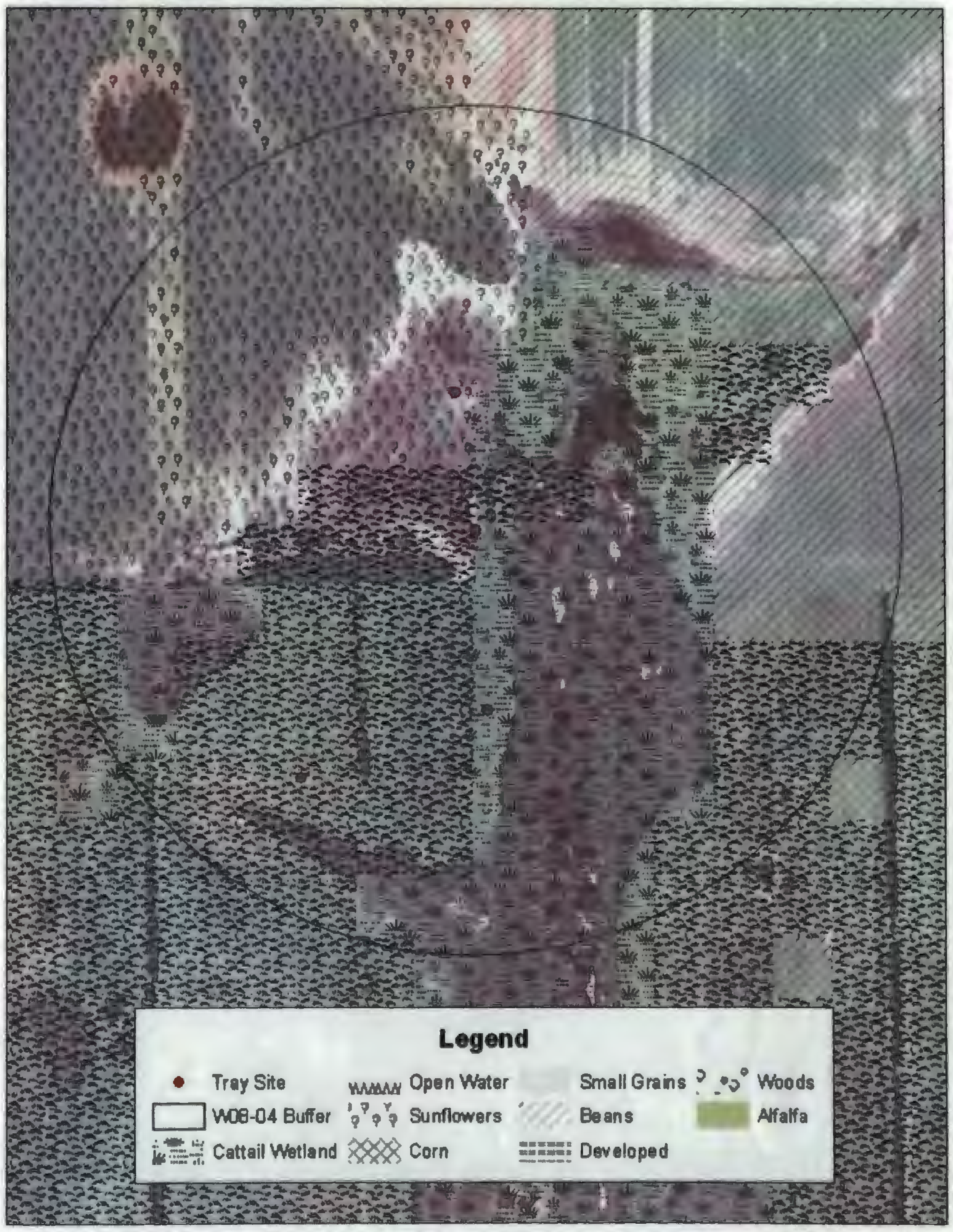
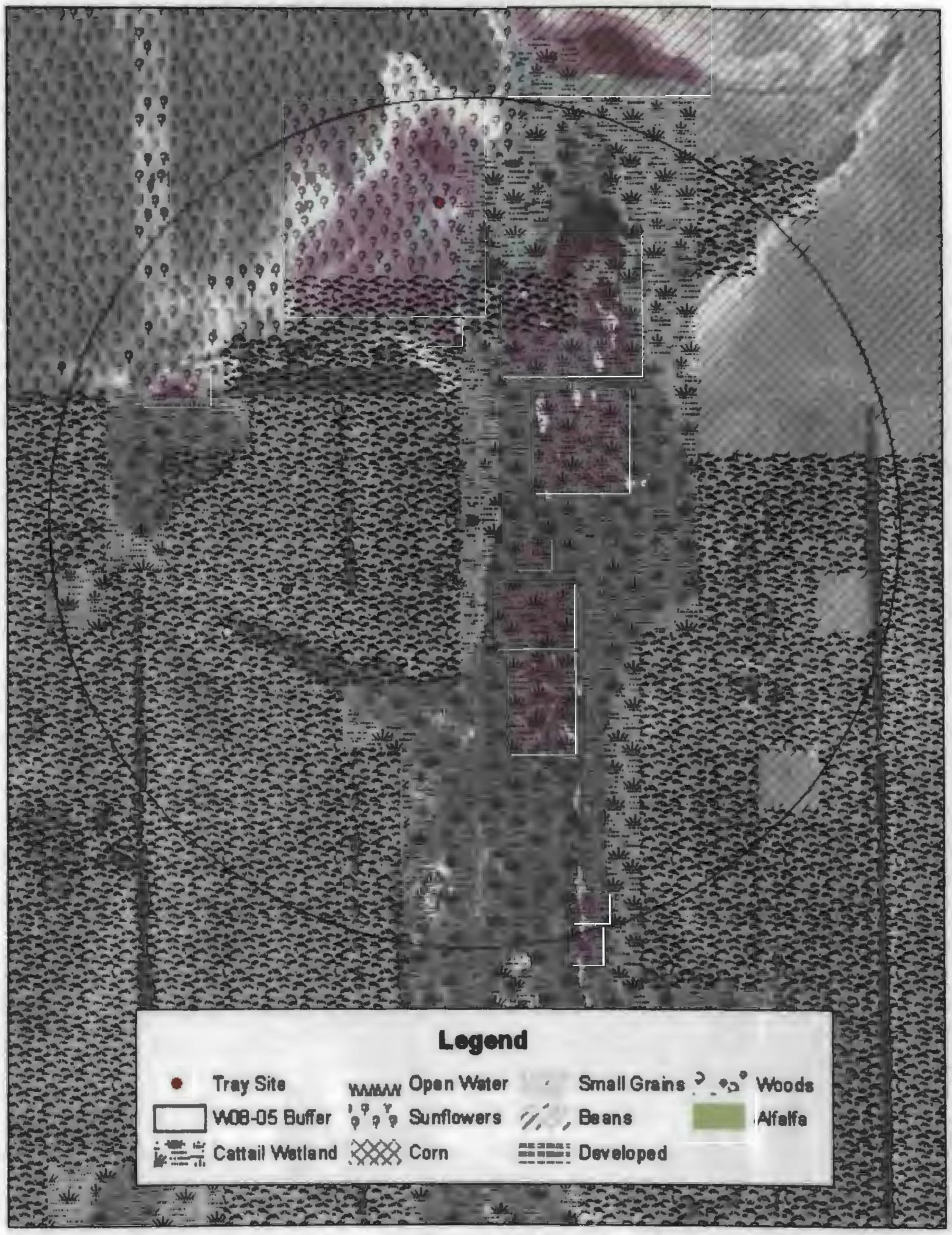
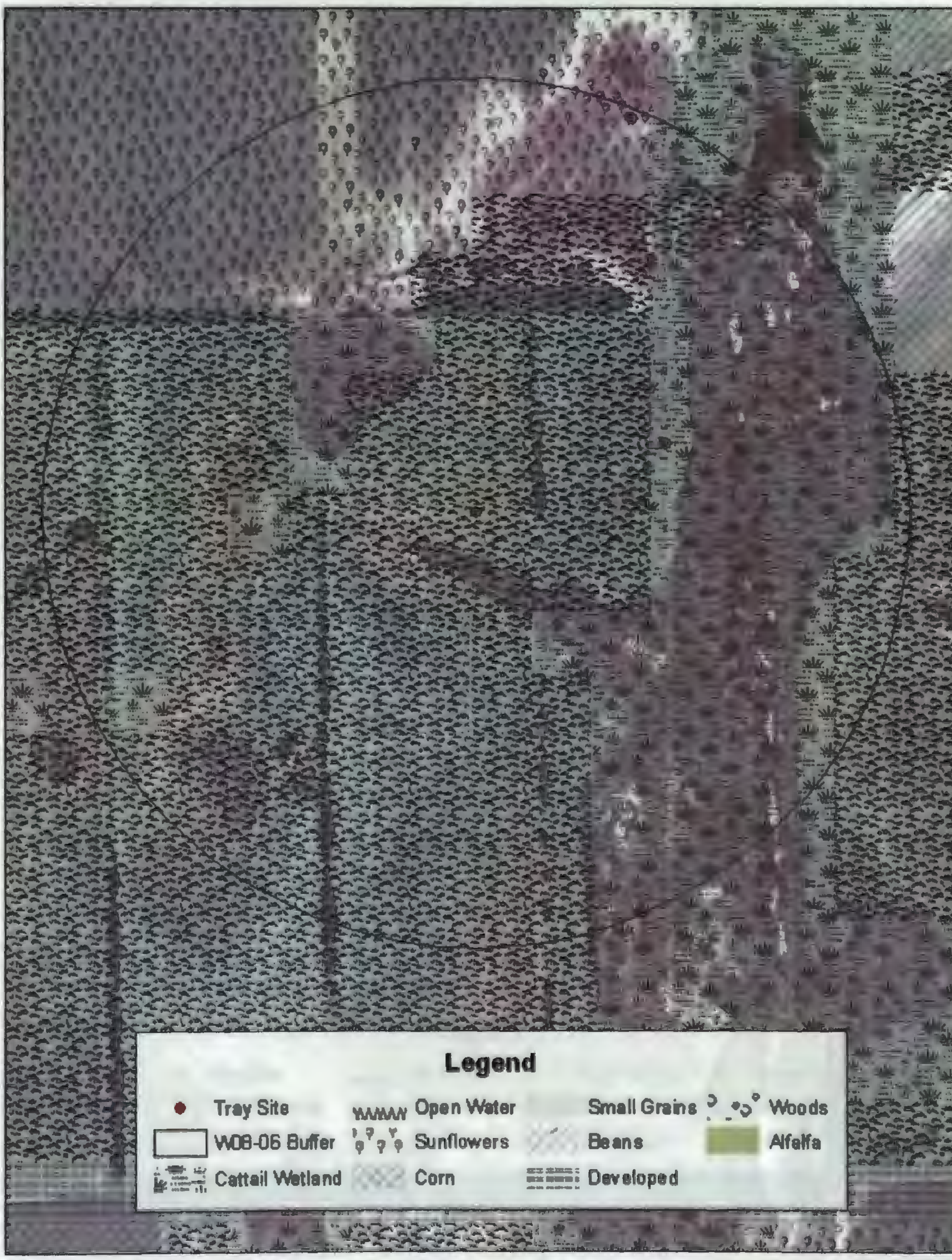


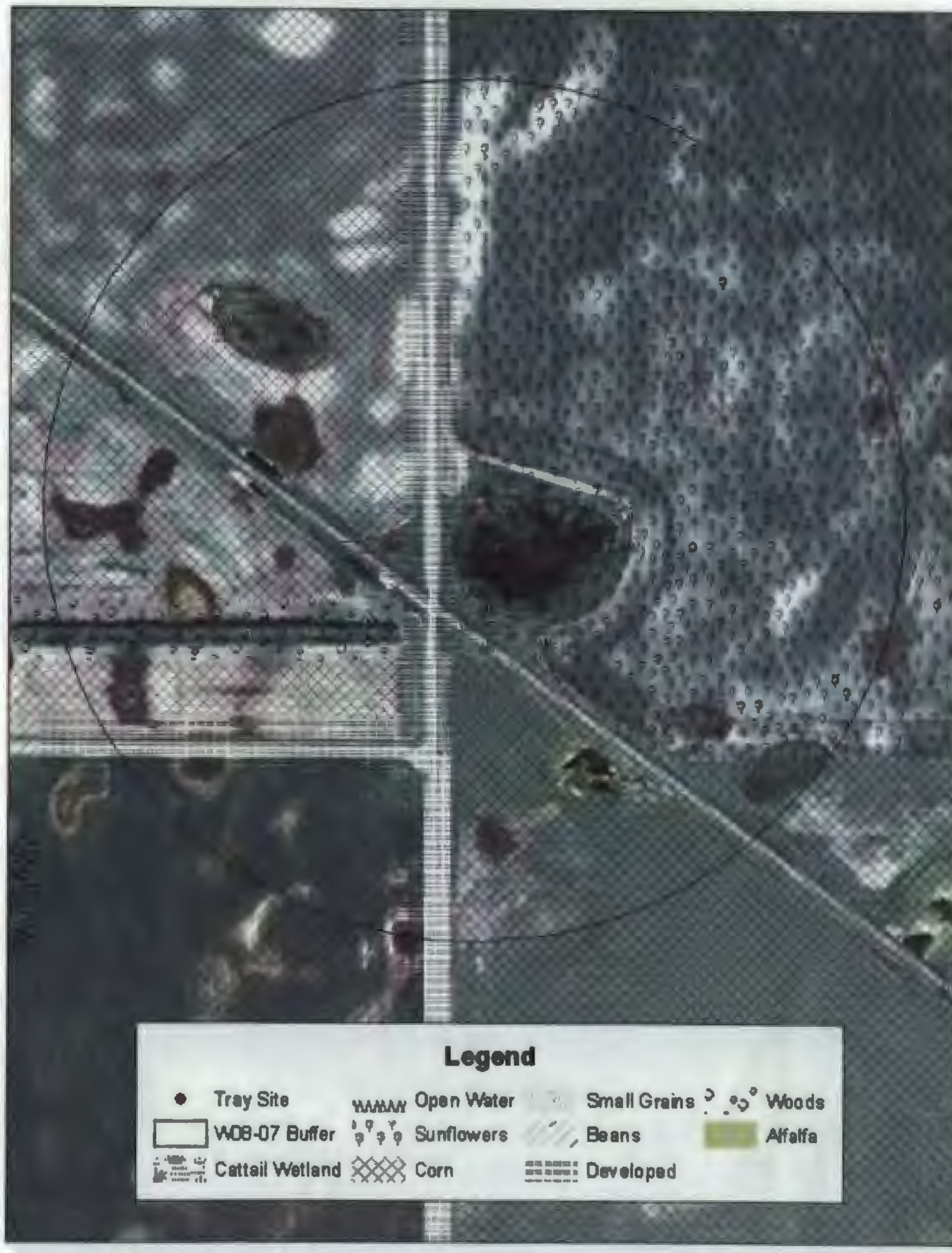
W08-05 Tray Site and Buffer



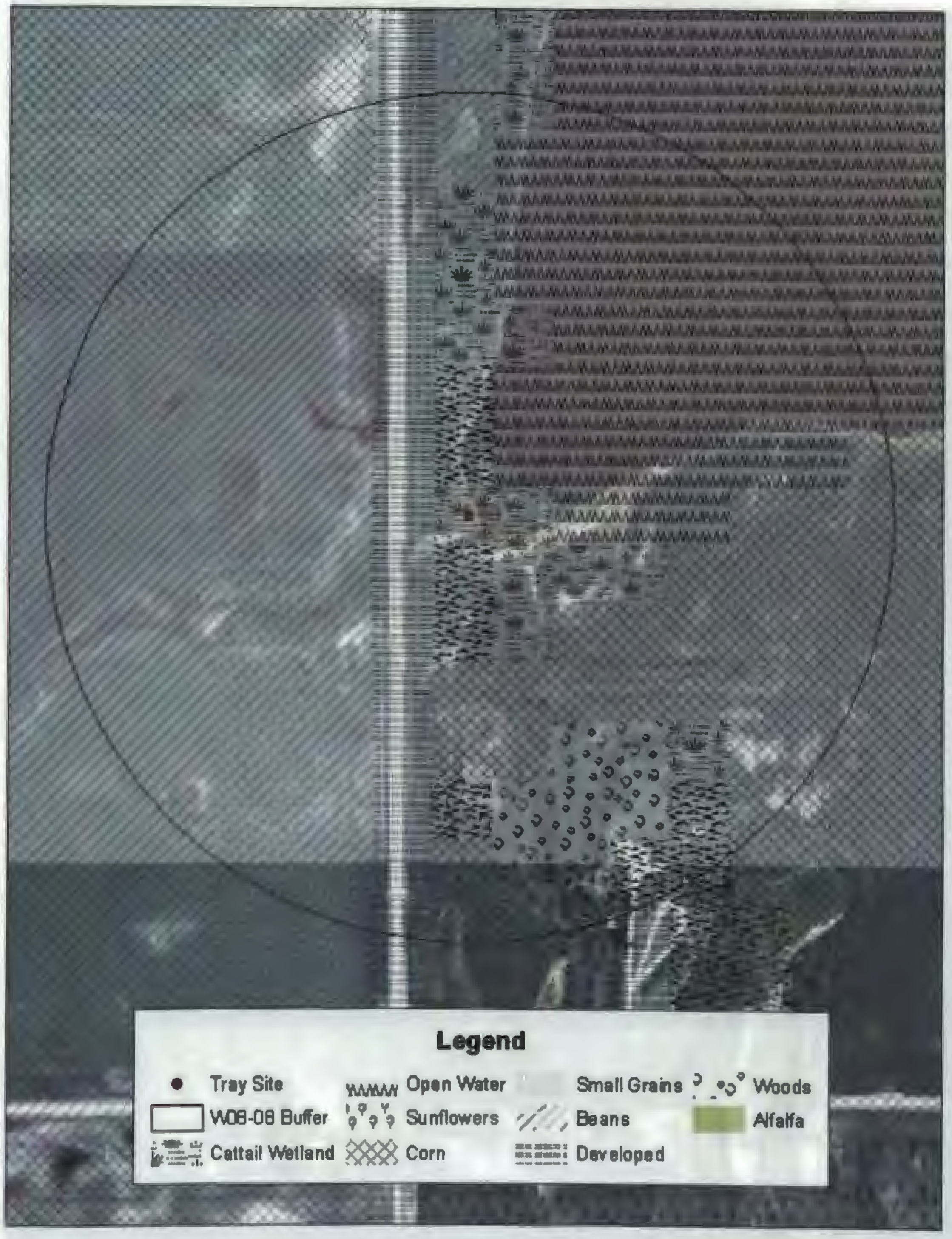
W08-06 Tray Site and Buffer



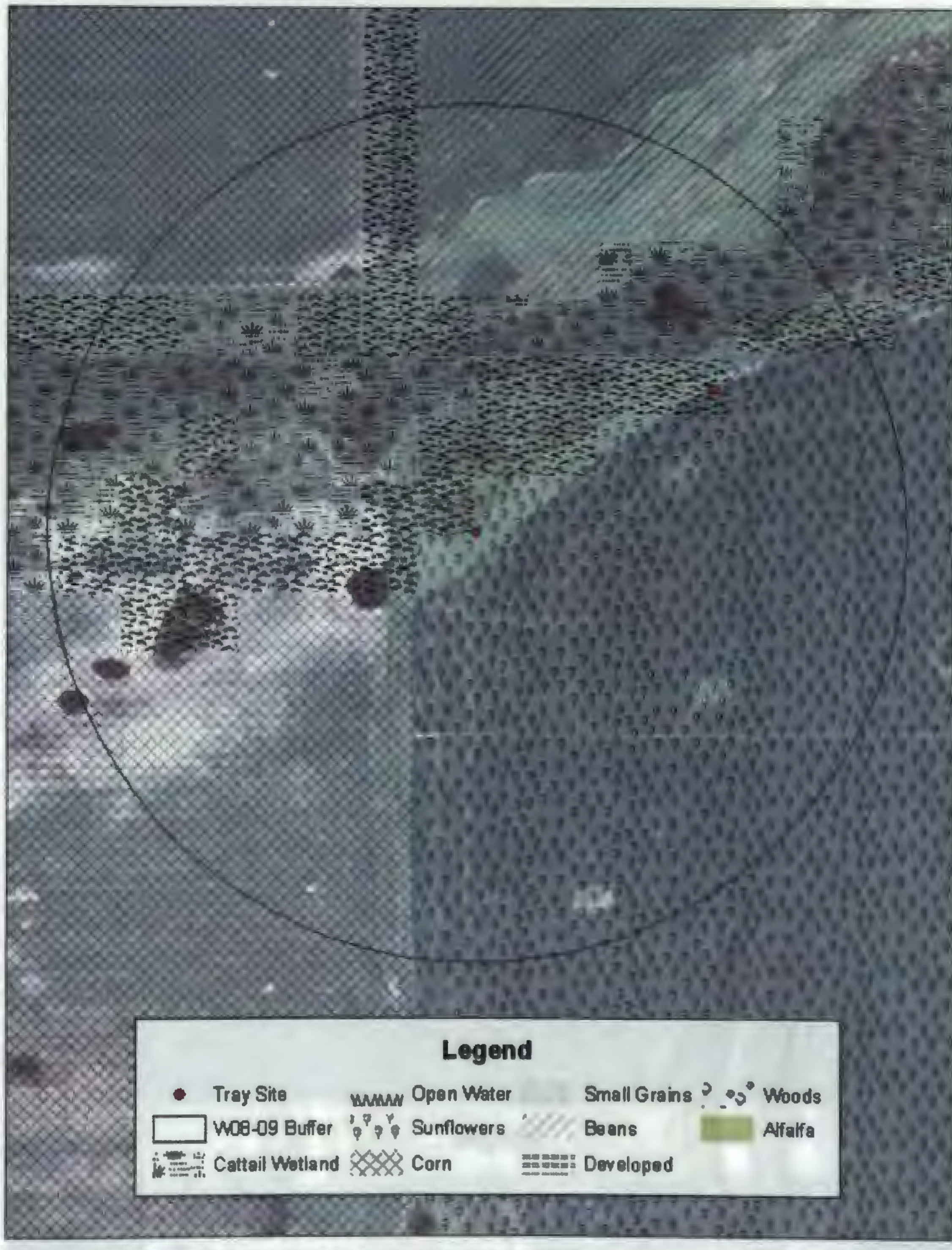
W08-07 Tray Site and Buffer



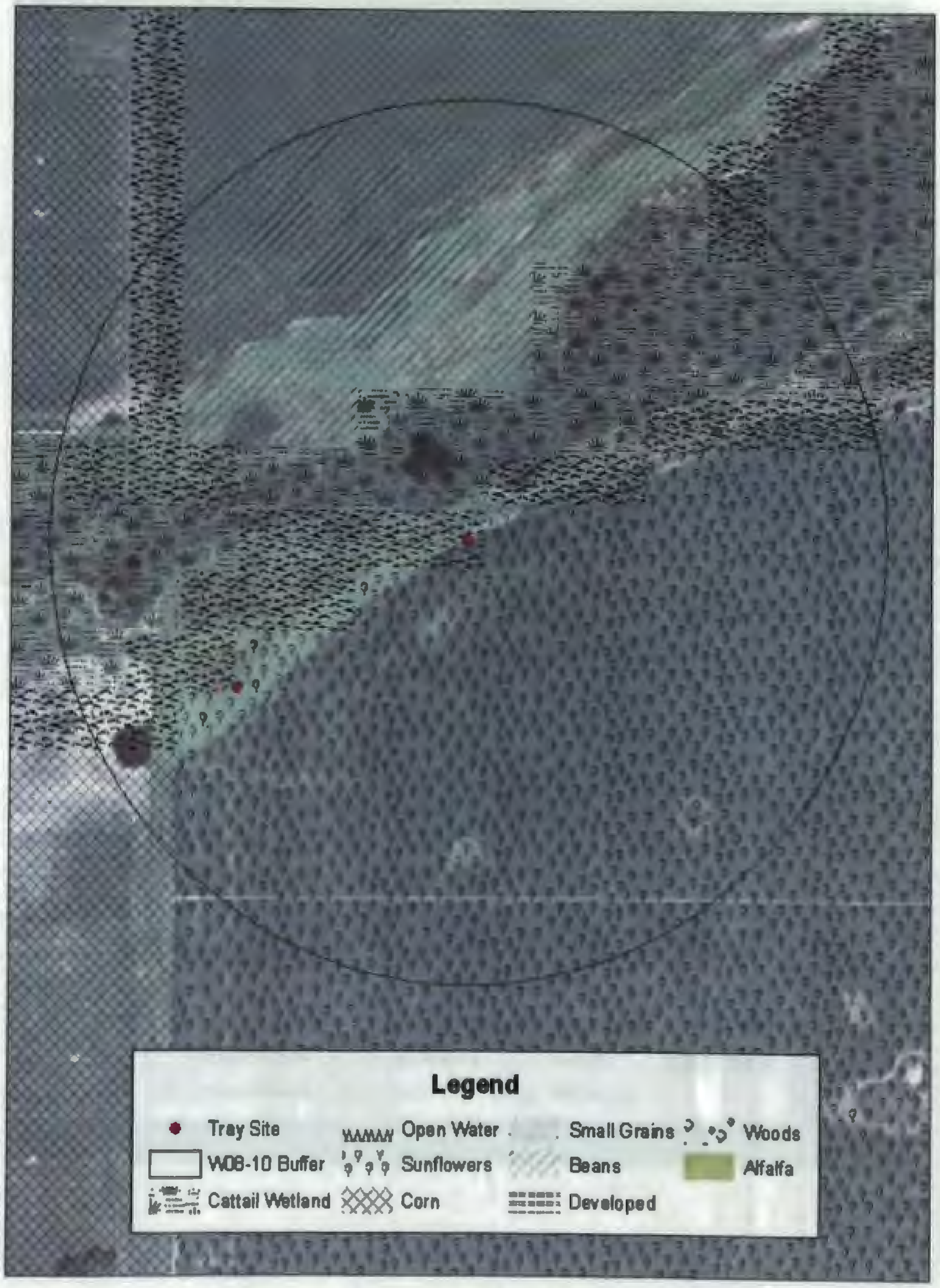
W08-08 Tray Site and Buffer



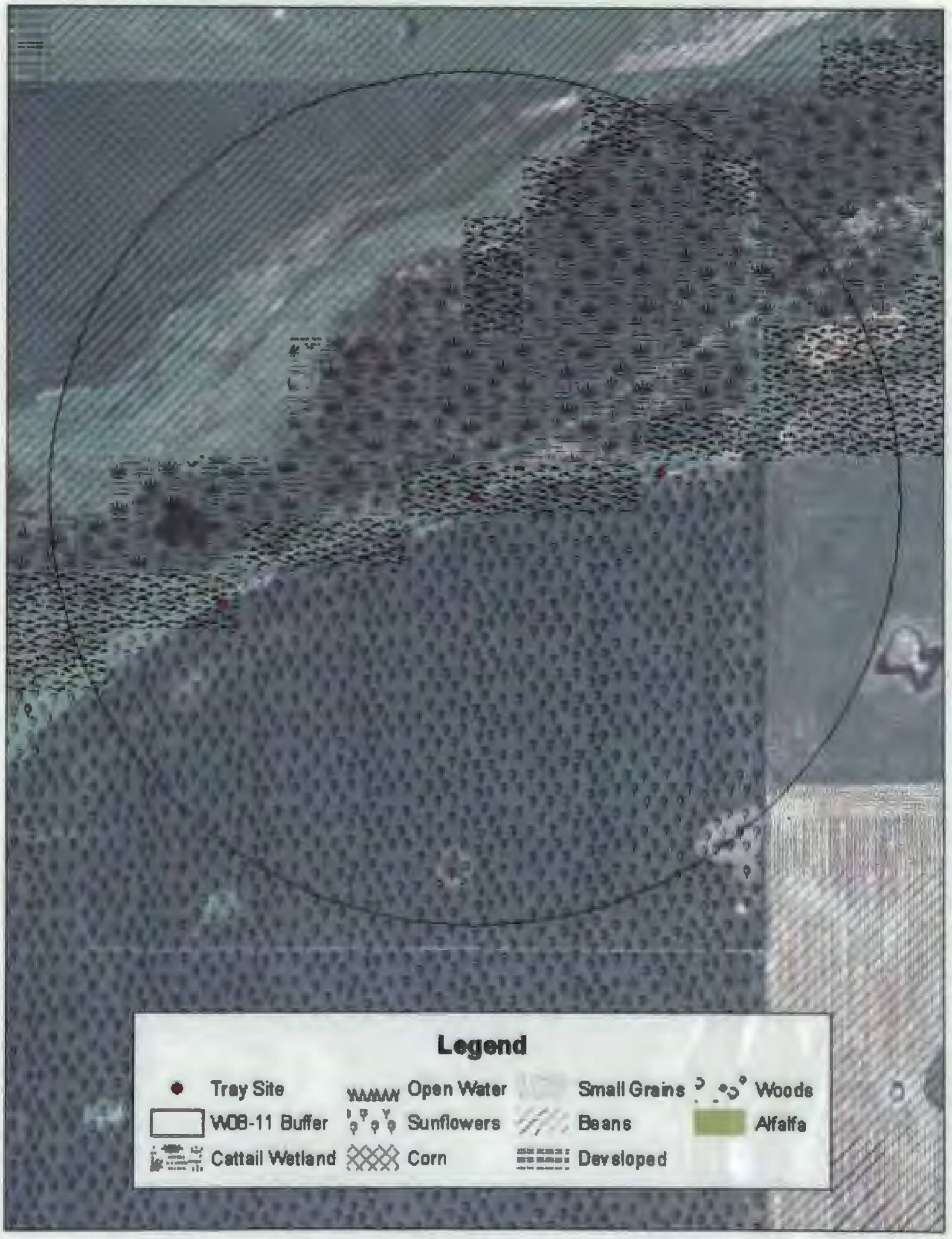
W08-09 Tray Site and Buffer



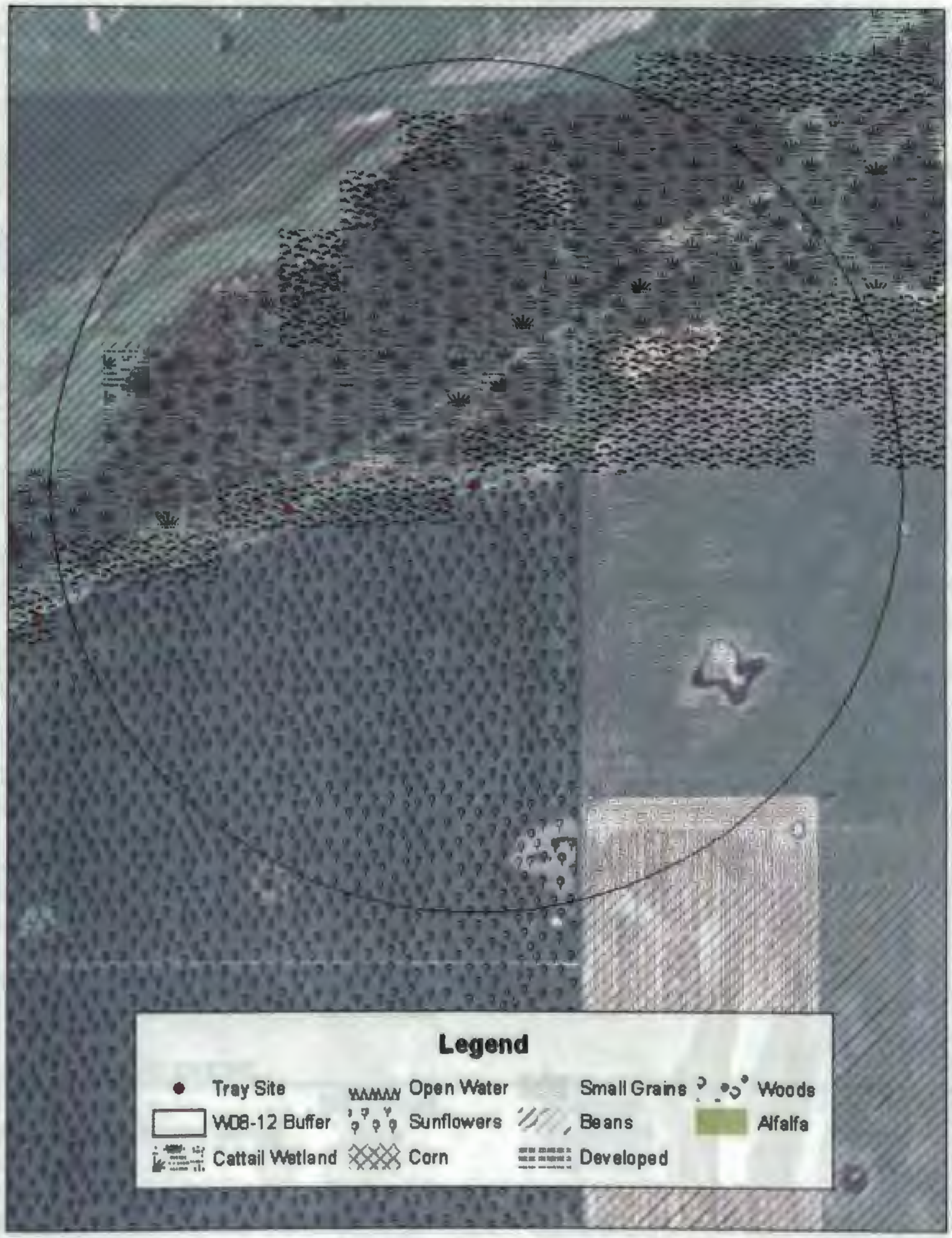
W08-10 Tray Site and Buffer



W08-11 Tray Site and Buffer



W08-12 Tray Site and Buffer



APPENDIX B. AVIAN SPECIES STATUS AND DIETS IN CENTRAL NORTH DAKOTA DURING SUNFLOWER GROWING SEASON

Family/Species	Summer Status* (June - August)	Fall Status* (September - November)	Primary Diet**
LOONS			
Common Loon	Rare	Rare	Fish
GREBES			
Pied-billed Grebe*	Common	Common	Insects
Homed Grebe*	Uncommon	Uncommon	Insects
Red-necked Grebe*	Rare	Rare	Fish
Eared Grebe*	Common	Common	Insects
Western Grebe*	Common	Common	Fish
Clark's Grebe	Rare	Rare	Fish
PELICANS			
American White Pelican	Common	Common	Fish
CORMORANTS			
Double-crested Cormorant	Common	Common	Fish
BITTERNS, HERONS, EGRETS			
American Bittern*	Common	Common	Fish
Least Bittem	Rare	Rare	Fish
Great Blue Heron	Common	Common	Fish
Great Egret	Common	Common	Fish
Snowy Egret	Rare	Rare	Insects
Little Blue Heron	Rare	Rare	Fish
Cattle Egret	Rare	Uncommon	Insects
Green Heron*	Rare	Rare	Fish
Black-crowned Night-Heron*	Common	Common	Fish
NEW WORLD VULTURES			
Turkey Vulture	Not Present	Rare	Carrion
SWANS, GEESE, DUCKS			
Tundra Swan	Not Present	Common	Plants
Greater White-fronted Goose	Rare	Uncommon	Plants
Snow Goose*	Rare	Common	Plants
Ross's Goose	Not Present	Rare	Plants
Brant	Not Present	Rare	Plants
Canada Goose*	Common	Common	Plants
Brant	Not Present	Rare	Plants
Wood Duck*	Common	Common	Insects
Gadwall*	Common	Common	Plants

Family/Species	Summer Status* (June - August)	Fall Status* (September - November)	Primary Diet**
American Wigeon*	Common	Common	Plants
American Black Duck*	Uncommon	Uncommon	Insects
Mallard*	Common	Common	Seeds
Blue-winged Teal*	Common	Common	Seeds
Cinnamon Teal*	Rare	Rare	Seeds
Northern Shoveler*	Common	Common	Plants
Northern Pintail*	Common	Common	Seeds
Green-winged Teal*	Uncommon	Common	Seeds
Canvasback*	Common	Common	Plants
Redhead*	Common	Common	Plants
Ring-necked Duck*	Rare	Uncommon	Plants
Greater Scaup	Not Present	Uncommon	Insects
Lesser Scaup*	Rare	Common	Insects
White-winged Scoter*	Not Present	Rare	Insects
Bufflehead	Not Present	Common	Insects
Common Goldeneye	Not Present	Uncommon	Insects
Hooded Merganser	Common	Common	Fish
Common Merganser	Not Present	Common	Fish
Ruddy Duck*	Uncommon	Common	Insects
OSPREYS, HAWKS, AND EAGLES			
Osprey	Not Present	Rare	Fish
Bald Eagle#	Not Present	Common	Fish/Carrion
Northern Harrier*	Common	Common	Mammals
Sharp-shinned Hawk	Not Present	Uncommon	Birds
Cooper's Hawk*	Rare	Uncommon	Birds
Northern Goshawk	Not Present	Rare	Birds
Broad-winged Hawk	Not Present	Rare	Mammals
Swainson's Hawk*	Common	Common	Mammals
Red-tailed Hawk*	Common	Common	Small Animals
Ferruginous Hawk*	Rare	Uncommon	Mammals
Rough-legged Hawk	Not Present	Common	Mammals
Golden Eagle	Rare	Uncommon	Mammals
FALCONS AND CARACARAS			
American Kestrel*	Uncommon	Common	Insects/Small Mammals
Merlin	Not Present	Uncommon	Birds
Peregrine Falcon#	Not Present	Rare	Birds
Prairie Falcon	Rare	Uncommon	Birds
GALLINACEOUS BIRDS			
Gray Partridge*	Common	Common	Seeds
Ring-necked Pheasant*	Common	Common	Seeds
Sharp-tailed Grouse*	Common	Common	Plants
Greater Prairie-Chicken*	Rare	Rare	Seeds
Wild Turkey	Uncommon	Uncommon	Omnivore

Family/Species	Summer Status*	Fall Status*	Primary Diet**
	(June - August)	(September - November)	
RAILS			
King Rail	Rare	Rare	Insects
Virginia Rail*	Uncommon	Uncommon	Insects
Sora*	Common	Common	Seeds/Insects
American Coot*	Common	Common	Plants
CRANES			
Sandhill Crane	Rare	Common	Omnivore
Whooping Crane#	Not Present	Rare	Omnivore
PLOVERS			
Black-bellied Plover	Not Present	Rare	Insects
American Golden Plover	Not Present	Rare	Insects
Semipalmated Plover	Not Present	Uncommon	Insects
Piping Plover*#	Rare	Rare	Insects
Killdeer*	Common	Common	Insects
AVOCETS			
American Avocet*	Common	Common	Insects
SANDPIPERS AND PHALAROPES			
Greater Yellowlegs	Uncommon	Uncommon	Insects
Lesser Yellowlegs	Uncommon	Common	Insects
Solitary Sandpiper	Uncommon	Uncommon	Insects
Willet*	Common	Common	Insects
Spotted Sandpiper*	Uncommon	Common	Insects
Upland Sandpiper*	Common	Not Present	Insects
Marbled Godwit*	Common	Rare	Insects
Sanderling	Not Present	Rare	Insects
Semipalmated Sandpiper	Not Present	Uncommon	Insects
Western Sandpiper	Rare	Common	Insects
Least Sandpiper	Rare	Common	Insects
White-rumped Sandpiper	Not Present	Rare	Insects
Baird's Sandpiper	Not Present	Uncommon	Insects
Pectoral Sandpiper	Not Present	Uncommon	Insects
Dunlin	Not Present	Rare	Insects
Stilt Sandpiper	Not Present	Uncommon	Insects
Short-billed Dowitcher	Uncommon	Uncommon	Insects
Long-billed Dowitcher	Uncommon	Common	Insects
Common Snipe*	Uncommon	Common	Insects
American Woodcock	Rare	Rare	Insects/Earthworm
Wilson's Phalarope*	Uncommon	Uncommon	Insects
Red-necked Phalarope	Not Present	Uncommon	Insects

Family/Species	Summer Status*	Fall Status*	Primary Diet**
	(June - August)	(September - November)	
GULLS, AND TERNS			
Franklin's Gull	Common	Common	Omnivore
Bonaparte's Gull	Not Present	Uncommon	Fish/Insects
Ring-billed Gull	Common	Common	Omnivore
California Gull	Common	Common	Omnivore
Caspian Tem	Not Present	Rare	Fish
Common Tem	Common	Common	Fish
Forster's Tem*	Uncommon	Not Present	Fish
Black Tern*	Common	Common	Insects
DOVES			
Rock Pigeon*	Common	Common	Seeds
Mourning Dove*	Common	Common	Seeds
CUCKOOS			
Black-billed Cuckoo*	Common	Uncommon	Insects
BARN OWL			
Barn Owl*	Rare	Rare	Mammals
TYPICAL OWLS			
Eastern Screech-Owl*	Common	Rare	Insects/Small Mammals
Great Horned Owl*	Common	Common	Mammals
Snowy Owl	Not Present	Uncommon	Mammals
Burrowing Owl	Rare	Not Present	Insects/Small Mammals
Long-eared Owl*	Rare	Rare	Mammals
Short-eared Owl	Common	Common	Mammals
NIGHTJARS			
Common Nighthawk*	Uncommon	Uncommon	Insects
SWIFTS			
Chimney Swift	Rare	Rare	Insects
HUMMINGBIRDS			
Ruby-throated Hummingbird	Uncommon	Rare	Nectar
KINGFISHERS			
Belted Kingfisher	Common	Common	Fish
WOODPECKERS			
Red-headed Woodpecker*	Rare	Rare	Omnivore
Yellow-bellied Sapsucker	Not Present	Uncommon	Insects
Downy Woodpecker*	Common	Common	Insects/Seeds
Hairy Woodpecker*	Common	Common	Insects/Seeds
Northern Flicker*	Common	Common	Insects/Seeds

Family/Species	Summer Status* (June - August)	Fall Status* (September - November)	Primary Diet**
TYRANT FLYCATCHERS			
Olive-sided Flycatcher	Not Present	Rare	Insects
Eastern Wood-Pewee*	Uncommon	Uncommon	Insects
Willow Flycatcher*	Common	Uncommon	Insects
Least Flycatcher*	Common	Rare	Insects
Eastern Phoebe	Rare	Uncommon	Insects
Say's Phoebe*	Uncommon	Uncommon	Insects
Great Crested Flycatcher	Rare	Rare	Insects
Western Kingbird*	Common	Common	Insects
Eastern Kingbird*	Common	Common	Insects
SHRIKES			
Loggerhead Shrike	Uncommon	Rare	Insects, Small Birds/Mammals
Northern Shrike	Not Present	Uncommon	Insects, Small Birds/Mammals
VIREOS			
Blue-headed Vireo	Not Present	Rare	Insects
Yellow-throated Vireo	Not Present	Rare	Insects
Warbling Vireo*	Common	Uncommon	Insects
Philadelphia Vireo	Not Present	Rare	Insects
Red-eyed Vireo	Uncommon	Uncommon	Insects
CROWS, JAYS, AND MAGPIES			
Blue Jay*	Common	Common	Omnivore
Black-billed Magpie*	Common	Common	Omnivore
American Crow*	Uncommon	Common	Omnivore
LARKS			
Horned Lark*	Common	Common	Seeds
SWALLOWS			
Purple Martin*	Common	Uncommon	Insects
Tree Swallow*	Common	Common	Insects
Northern Rough-winged Swallow*	Uncommon	Not Present	Insects
Bank Swallow*	Common	Uncommon	Insects
Cliff Swallow*	Common	Common	Insects
Barn Swallow*	Common	Common	Insects
TITMICE AND CHICKADEES			
Black-capped Chickadee*	Common	Common	Insects/Seeds

Family/Species	Summer Status* (June - August)	Fall Status* (September - November)	Primary Diet**
NUTHATCHES			
Red-breasted Nuthatch	Not Present	Uncommon	Insects/Seeds
White-breasted Nuthatch*	Uncommon	Common	Insects/Seeds
CREEPERS			
Brown Creeper	Not Present	Uncommon	Insects/Seeds
WRENS			
House Wren*	Common	Common	Insects
Sedge Wren*	Common	Rare	Insects
Marsh Wren*	Common	Uncommon	Insects
KINGLETS			
Golden-crowned Kinglet	Not Present	Rare	Insects
Ruby-crowned Kinglet	Not Present	Uncommon	Insects
THRUSHES			
Eastern Bluebird*	Uncommon	Uncommon	Insects/Berries
Mountain Bluebird	Not Present	Uncommon	Insects/Berries
Veery	Not Present	Uncommon	Insects/Berries
Gray-cheeked Thrush*	Not Present	Uncommon	Insects/Berries
Swainson's Thrush	Not Present	Uncommon	Insects/Berries
Hermit Thrush	Not Present	Rare	Insects/Berries
American Robin*	Common	Common	Insects/Berries
Gray Catbird*	Common	Uncommon	Insects/Berries
Brown Thrasher*	Common	Uncommon	Omnivore
STARLINGS			
European Starling*	Uncommon	Uncommon	Insects/Seeds/Berries
PIPITS			
American (Water) Pipit	Not Present	Uncommon	Insects/Seeds
Sprague's Pipit*	Uncommon	Uncommon	Insects/Seeds
WAXWINGS			
Bohemian Waxwing	Not Present	Uncommon	Insects/Fruit
Cedar Waxwing*	Common	Common	Fruit/Insects
WOOD WARBLERS			
Tennessee Warbler	Not Present	Uncommon	Insects
Orange-crowned Warbler	Not Present	Uncommon	Insects
Nashville Warbler	Not Present	Rare	Insects
Yellow Warbler*	Common	Uncommon	Insects
Chestnut-sided Warbler	Not Present	Uncommon	Insects
Magnolia Warbler	Not Present	Uncommon	Insects

Family/Species	Summer Status*	Fall Status*	Primary Diet**
	(June - August)	(September - November)	
Cape May Warbler	Not Present	Rare	Insects
Yellow-rumped Warbler	Common	Rare	Insects
Black-throated Green Warbler	Not Present	Rare	Insects
Blackburnian Warbler	Not Present	Rare	Insects
Pine Warbler	Rare	Not Present	Insects
Palm Warbler	Not Present	Uncommon	Insects
Bay-breasted Warbler	Not Present	Rare	Insects
Blackpoll Warbler	Not Present	Uncommon	Insects
Black-and-White Warbler	Not Present	Uncommon	Insects
American Redstart	Rare	Uncommon	Insects
Ovenbird	Not Present	Uncommon	Insects
Northern Waterthrush	Not Present	Uncommon	Insects
Connecticut Warbler	Not Present	Not Present	Insects
Mourning Warbler	Not Present	Rare	Insects
Common Yellowthroat*	Common	Common	Insects
Wilson's Warbler	Not Present	Uncommon	Insects
Canada Warbler	Not Present	Rare	Insects
Yellow-breasted Chat	Not Present	Rare	Insects
SPARROWS AND TOWHEES			
Eastern Towhee	Not Present	Rare	Omnivore
American Tree Sparrow	Not Present	Common	Seeds/Insects
Chipping Sparrow*	Common	Uncommon	Seeds/Insects
Clay-colored Sparrow*	Common	Uncommon	Seeds/Insects
Field Sparrow	Rare	Uncommon	Seeds/Insects
Vesper Sparrow	Common	Uncommon	Seeds/Insects
Lark Sparrow*	Rare	Uncommon	Seeds/Insects
Lark Bunting*	Uncommon	Not Present	Seeds/Insects
Savannah Sparrow*	Common	Uncommon	Insects/Seeds
Grasshopper Sparrow*	Common	Rare	Insects/Seeds
Baird's Sparrow*	Rare	Rare	Seeds/Insects
Le Conte's Sparrow*	Common	Uncommon	Seeds/Insects
Nelson's Sparrow*	Uncommon	Uncommon	Insects/Seeds
Fox Sparrow	Not Present	Rare	Insects
Song Sparrow*	Common	Common	Seeds/Insects
Swamp Sparrow	Rare	Uncommon	Seeds/Insects
Lincoln's Sparrow	Not Present	Uncommon	Seeds/Insects
White-throated Sparrow	Not Present	Common	Seeds/Insects
Harris' Sparrow	Not Present	Common	Seeds
White-crowned Sparrow	Not Present	Common	Seeds/Insects
Dark-eyed Junco	Not Present	Common	Seeds
Lapland Longspur	Rare	Common	Seeds/Insects
Smith's Longspur	Not Present	Rare	Seeds/Insects
Chestnut-collared Longspur*	Uncommon	Uncommon	Seeds/Insects
Snow Bunting	Not Present	Uncommon	Seeds

Family/Species	Summer Status*	Fall Status*	Primary Diet**
	(June - August)	(September - November)	
GROSBEAKS, AND ALLIES			
Rose-breasted Grosbreak	Rare	Uncommon	Insects/Seeds
Indigo Bunting	Not Present	Rare	Insects/Berries
Dickcissel	Uncommon	Uncommon	Seeds/Insects
BLACKBIRDS AND ORIOLES			
Bobolink*	Common	Uncommon	Insects/Seeds
Red-winged Blackbird*	Common	Common	Insects/Seeds
Western Meadowlark*	Common	Common	Insects/Seeds
Yellow-headed Blackbird*	Common	Uncommon	Insects/Seeds
Rusty Blackbird	Not Present	Uncommon	Insects/Seeds
Brewer's Blackbird*	Uncommon	Uncommon	Seeds/Insects
Common Grackle*	Common	Common	Omnivore
Brown-headed Cowbird*	Common	Common	Seeds/Insects
Orchard Oriole*	Uncommon	Rare	Insects/Fruit
Baltimore Oriole*	Common	Uncommon	Insects/Fruit
FINCHES			
Pine Grosbeak	Not Present	Rare	Seeds
Purple Finch	Not Present	Uncommon	Seeds
House Finch	Rare	Rare	Seeds
Red Crossbill	Not Present	Rare	Seeds
White-winged Crossbill	Not Present	Rare	Seeds
Common Redpoll	Not Present	Uncommon	Seeds
Pine Siskin*	Rare	Common	Seeds
American Goldfinch*	Common	Common	Seeds
Evening Grosbeak	Not Present	Rare	Seeds
OLD WORLD SPARROWS			
House Sparrow*	Common	Common	Seeds

* Information from Northern Prairie

** Information from Cornell Lab of Ornithology All About Birds Page

APPENDIX C: TAKE MODEL INFORMATION

Take model information of the breakdown for species and sex observed during each time period during the 2008 field season. A) The actual observed Number, B) The percentage of observations within that period, and C) the overall estimated take for each category of target species.

	Species	COGR	COGR	COGR	EUST	EUST	EUST	RWBL	RWBL	RWBL	YHBL	YHBL	YHBL
Date Period	Sex	Ob-served	Per-cent	Esti-mate	Ob-served	Per-cent	Esti-mate	Ob-served	Per-cent	Esti-mate	Ob-served	Per-cent	Esti-mate
1	M	220	0.75	243	0	0.00	NA	2	0.01	2	4	0.01	4
1	F	66	0.23	73	0	0.00	NA	1	0.00	1	0	0.00	0
1	UNK	0	0.00	0	0	0.00	NA	0	0.00	0	0	0.00	0
2	M	25	0.30	484	0	0.00	NA	51	0.61	988	0	0.00	0
2	F	0	0.00	0	0	0.00	NA	4	0.05	77	3	0.04	58
2	UNK	0	0.00	0	0	0.00	NA	0	0.00	0	0	0.00	0
3	M	5	0.01	35	3	0.01	NA	239	0.41	1673	10	0.02	70
3	F	3	0.01	21	2	0.00	NA	145	0.25	1015	2	0.00	14
3	UNK	6	0.01	42	161	0.28	NA	0	0.00	0	1	0.00	7
4	M	8	0.02	154	5	0.01	NA	326	0.73	6290	7	0.02	135
4	F	0	0.00	0	4	0.01	NA	89	0.20	1717	0	0.00	0
4	UNK	0	0.00	0	5	0.01	NA	0	0.00	0	0	0.00	0
5	M	0	0.00	0	1	0.00	NA	637	0.81	7971	25	0.03	313
5	F	0	0.00	0	0	0.00	NA	111	0.14	1389	0	0.00	0
5	UNK	1	0.00	13	8	0.01	NA	0	0.00	0	0	0.00	0
6	M	0	0.00	0	0	0.00	NA	259	0.77	1571	19	0.06	115
6	F	0	0.00	0	0	0.00	NA	47	0.14	285	12	0.04	73
6	UNK	0	0.00	0	1	0.00	NA	0	0.00	0	0	0.00	0
7	M	0	0.00	0	0	0.00	NA	162	0.52	649	17	0.05	68
7	F	0	0.00	0	0	0.00	NA	62	0.20	248	11	0.04	44
7	UNK	1	0.00	4	60	0.19	NA	0	0.00	0	0	0.00	0