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Evaluation of the Effects of Single Season Wild-Strain Mallard Releases on Local Breeding Population Densities

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EVALUATION OF THE EFFECTS OF SINGLE SEASON WILD-STRAIN MALLARD RELEASES ON LOCAL BREEDING POPULATION DENSITIES

by

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ABSTRACT

Evaluation of the Effects of Single Season

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by

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In 1993, to determine if wild-strain mallard releases could be used as a management practice to increase local mallard breeding populations, I released 2,344, 4.5-week-old mallard ducklings (1,200 females and 1,144 males) to wetlands on 12, 10.4-km^2 sites (approximately 200 per site, 100 females, 100 males) in the North Dakota Prairie Pothole Region. I monitored the release sites to determine if any relationship existed between site characteristics and time of release to duckling survival estimates. I conducted breeding pair surveys during 1994 and 1995 on treatment and paired control sites to compare post-release population levels. Lastly, I analyzed return data and habitat use, and conducted behavioral experiments to determine if wild-strain mallards experienced higher mortality rates and if any observed differences could be explained by behavior.

In 1994, I observed 55 of the nasal saddled ducklings returning as adult females to the release sites. In 1995, only 5 nasal saddled females were observed, both on treatment and control sites. No difference was observed in breeding pair populations on treatment and control sites in 1994 ($P = 0.18$) and 1995 ($P = 0.59$).

Hard-released wild-strain mallard females had lower survival rates than wild ($P = 0.01$) and modified gentle-release wild-strain females ($P = 0.05$). All wild-strain females were virtually eliminated from the population by year 4. This suggests that these birds may have been more vulnerable to predation and other mortality factors than wild females. Breeding wild and wild-strain mallard females reacted similarly to human approach, but when flushed, wild females flew farther than wild-strain females ($P = 0.0002$). Wetlands used by wild-strain females differed from wild females during breeding by type ($P < 0.0001$) and cover ($P = 0.0003$) classification. Wild-strain females selected larger, more permanent wetlands exhibiting less emergent vegetation than did wild counterparts. These differences may help to explain why wild-strain mallard releases did not increase local breeding populations. The lack of band recoveries for wild-strain females during the latter years when viewed in the context of the observed behavioral differences suggests that these birds were unable to adapt to conditions in the wild.

(129 pages)

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CHAPTER 1

INTRODUCTION

Prior to 1993, long-term continental waterfowl surveys indicate a decline in overall duck numbers (Dubovsky et al. 1993). A reduction in mallard (*Anas platyrhyncos*) populations has been particularly apparent (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986). May aerial surveys of the primary waterfowl breeding areas (Martin et al. 1979) show a decline in breeding mallard numbers through the 1970's of 8.7 million to a 1985 low of 4.8 million (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1994). By 1993 this number increased to 5.7 million (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1994).

During the mid-1950's breeding pair densities in the Drift Prairie and Coteau regions of North Dakota were estimated at 12-15 per km^2 and 25-35% nesting success was common. During the mid-1980's estimated densities in this area declined to 3-9 pairs per km^2 with nest success of 5-7% (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986). Beauchamp et al. (1996) reported a declining trend in nest success in upland nesting ducks from 33% in 1935 to 10% in 1992, approximately 0.5% per year.

FACTORS CONTRIBUTING TO MALLARD POPULATION DECLINE

A number of factors have contributed to the decline in mallard numbers. One factor frequently implicated in the long-term decline of dabbling duck populations is the conversion of upland nesting habitats in arable grassland areas to cropland (Lynch et al.

1963, Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986). In addition to eliminating nesting cover, >50% of the historical wetlands have been lost because of conversion to agriculture uses (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986, Prairie Pothole Joint Venture Board 1995). This further impacts the ability of the landscape to provide habitat for breeding ducks. These habitat losses were further exacerbated with improvements in agricultural technology which resulted in more efficient farming methods and created large blocks of crop monocultures (Ward 1982).

Increased grazing of domestic livestock, especially under season-long or continuous grazing regimes, also has negatively impacted upland breeding birds by reducing upland nesting cover (Kirsch et al. 1978, Sedivic et al. 1990). In addition, fire suppression has lead to an accumulation of dead vegetation in wetlands, reducing their attractiveness to waterfowl (Kantrud 1986). An increase in more aggressive hybrid cattail (*Typha latifolia x T. agustifolia*) species that now dominate many wetlands (Stewart and Kantrud 1971) has further reduced the attractiveness of many remaining wetlands to breeding waterfowl.

Predation on nesting females (Johnson and Sargeant 1977, Sargeant et al. 1984), eggs (Cowardin et al. 1985, Klett et al. 1988, Greenwood et al. 1995) and ducklings (Talent et al. 1983, Cowardin et al. 1985, Orthmeyer and Ball 1987) also has significantly impacted mallard recruitment. The effect of predation on the breeding grounds was magnified as the predator community changed from one dominated by large predators that concentrated on ungulates to smaller generalist predators (Sargeant et al. 1993). However, Beauchamp et al. (1996) reported a decline in nest success with and without predator management, thus suggesting that other factors contributed more to the decline. They noted the decline was greater in ducks such as mallards that nest early when cover is limited, than in later nesting ducks that have the benefit of increased cover.

More recently, a prolonged drought occurred from the mid-1980's into the early 1990's throughout both the Canadian (Greenwood and Sovada 1996) and U.S. portion of the Prairie Pothole Region (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1994). This drought further exacerbated the long-term declines observed in mallard numbers, negating any population increases that may have resulted because of changes in agricultural or waterfowl management practices which increased regional habitat bases (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1994).

CONTEMPORARY MALLARD MANAGEMENT STRATEGIES

Over the years, a number of aggressive management programs have been implemented by agencies to restore continental waterfowl population. These programs focused on enhancing and creating habitat for breeding waterfowl, protecting waterfowl on the breeding grounds, and regulating harvests. Lokemoen (1984) examined the economic efficiency of techniques commonly used to enhance waterfowl production. He found the most economically efficient practices, in terms of cost per young fledged, were predator management on mixed farmland ($2.00), electric fences around grass-legume cover ($2.38), predator management at grass-legume cover ($3.37), and establishing grass-legume cover ($7.89) and nest baskets ($8.54). The estimated cost associated with constructing small rock islands ($23.26), planting native grass cover ($24.05), construction of level ditch ponds ($76.55), impoundment construction ($129.77), and constructing man-made islands ($223.00) exceeded the $10.00 per young fledged assumed efficiency threshold.

Although predator management may be one of the most cost efficient management techniques, direct removal of predators remains controversial (Messmer and Rohwer 1996, Beauchamp et al. 1996). This controversy is fueled largely by inconsistent results from studies conducted to evaluate the effects of predation management on waterfowl recruitment (U.S. Fish and Wildlife Service 1988b, 1990). In general, methodologies that incorporate nonlethal means or reduce predator efficiency are more acceptable to the public although they may be more costly (Messmer et al. 1997). Nonlethal techniques used to increase waterfowl nest success include nest baskets (Lee 1982, Marcy 1986), elevated nesting covers (Zenner et al. 1992), island construction (Lokemoen 1984), electric fences (Lokemoen et al. 1982), and cover establishment (Duebbert and Lokemoen 1976).

Lokemoen's (1984) examination of the economic efficiency of the waterfowl management practices did not include wild-strain releases. Wild-strain mallards can be reared for approximately $15.00 per 4.5-week-old duckling in an existing facility at Valley City, North Dakota, that is operated by the Dakota Wildlife Trust, Inc. (pers com. G. Reed, Dakota Wildlife Trust). Additional costs would be incurred in releasing the ducklings. Lee and Kruse (1973) and Gatti (1981) compared the economic and biological aspects of direct and gentle wild-strain mallard releases.

Recent agency emphasis has been on managing land purchased specifically for waterfowl production and agriculture lands set aside to reduce crop production (Madsen 1989). The most recent program, The North American Waterfowl Management Plan (NAWMP), signed in 1986 by the U.S. and Canada, emphasizes habitat management by state and federal agencies (Canadian Wildlife Service and U.S. Fish and Wildlife Service 1986).

In the U.S., the Conservation Reserve Program (CRP), a provision under the 1985 Farm Security Act, provided a mechanism whereby 14.5 millions hectares of farmland in North Dakota were retired from production for 10 years and planted to permanent cover (Bjerke 1991). As much as 25% of some North Dakota counties and 1.5 million hectares statewide were enrolled in the program (U.S. Department of Agriculture 1992). Also, waterfowl managers have worked to restore drained wetlands on private land enrolled in the CRP (Madsen 1989). In addition, the U.S. Bureau of Reclamation, as part of the mitigation plan under the Garrison Diversion Reformulation Act of 1986, obtained approximately 23,000 hectares of North Dakota agricultural land. The uplands were converted to permanent cover and drained wetlands restored (Garrison Diversion Conservancy District 1992).

While these programs resulted in increased waterfowl habitat, duck numbers continued to decline. Part of the failure of waterfowl populations to respond has been attributed to a persistent drought that prevented the simultaneous improvement in wetland conditions. However, beginning in June of 1993 precipitation exceeded long-term averages for 14 of 19 consecutive months (National Oceanic and Atmospheric

Administration 1993, 1994). Thus, water conditions may have been the best in recent history for breeding ducks in the portions of the Prairie Pothole Region for the 1993 through 1995 breeding seasons (U.S. Fish and Wildlife Service and Canada Wildlife Service 1995).

Johnson and Shaffer (1987) concluded mallards no longer fill the available habitat to the extent they had previously. Between 1955 and 1970 the average correlation coefficient of the mallard breeding pairs to pond numbers was 0.47. For the period 1971 to 1985 this correlation coefficient declined to 0.27. Prior to 1993, suitable habitat conditions in the mallard's breeding range did not result in the expected increase in mallard populations (Johnson and Shaffer 1987). From 1982 through 1986 the pond projection index for mallard populations based on breeding pair indices was higher than the observed mallard population index (U.S. Fish and Wildlife Service 1988a).

Given these improved water and habitat conditions, some authors who support these arguments suggested that augmentation or restoration of local breeding populations to suitable habitats could be an efficient strategy to rapidly increase continental mallard populations (Burger 1984, Lee et al. 1985). These authors argued that such releases could be used to "jump start" local breeding populations in areas where habitat improvements have been made, but populations failed to respond.

THE ROLE OF PROPAGATION IN WILDLIFE MANAGEMENT

The practice of releasing wildlife to establish or supplement local breeding populations or for put-and-take hunting was used extensively before wildlife management became a recognized scientific discipline. One of the earliest reports of mallards raised in captivity comes from a letter written in England in 1631 (Maxwell 1913). The letter accompanied a shipment of eggs for propagation in connection with the sport of hawking. Maxwell (1913) noted that pheasant (*Phasianus colchicus*) rearing in England became well established sometime after 1800. The United States was slow to begin artificial propagation possibly because of the wealth of native game (Hunt et al. 1958). The first state game farm for the propagation of game birds to supplement dwindling wild populations in the United States was established in Illinois in 1905 (Leopold 1933).

Wild-strain releases have been used to augment bird populations of many species. Endangered peregrine falcons (*Falco peregrinus*) were bred in captivity and subsequently released. The releases boosted the local breeding population (Cade et al. 1988). Numbers of breeding Giant Canada geese (*Branta canadensis maxima*) in both North and South Dakota were below 800 in the mid-1950's. By 1982, through releases and other management efforts, geese populations in North and South Dakota increased to 8,500 and 20,000, respectively (Lee et al. 1990). Pen-reared wood ducks, released at Patuxent Wildlife Research Center in Maryland, proved to be as successful as wild wood ducks at rearing young and had higher survival rates than their wild counterparts (McGilvrey 1972). However, not all such releases have been successful.

Springer et al. (1986) reported endangered wild-strain Aleutian Canada Geese (*Branta canadensis leucopareia*) released on Agattu Island remained segregated from wild geese and failed to migrate to the traditional California wintering grounds. Scattered colonies of the released geese have been seen on other Aleutian islands and the eastern coast of Russia. Biologists were unsuccessful in producing wild-strain whooping cranes (*Grus americana*) for release to the wild, but were more successful with the foster parent program using sandhill cranes (*Grus canadensis*) (Robinson and Bolen 1989).

THE ROLE OF PROPAGATION IN MALLARD MANAGEMENT

Waterfowl biologists discouraged the use of hand-reared mallards to supplement wild populations because of low band recovery reports from releases conducted in California, Connecticut, New York, and Pennsylvania (Lincoln 1934). Errington and Albert (1936) reported only 1% recovery from mallards released in Iowa. Pirnie (1935) suggested that stocking hand-reared mallards to supplement wild populations could only be effective if conducted in conjunction with other wildlife management techniques. Hunt et al. (1958) reported band recovery rates of 27% for birds released to the wild at 4-weeks of age in Wisconsin. However, 94% of the recoveries were in the first year after release, and 87% were recorded within a 30 km radius of the release site. The researchers estimated the breeding contribution of the released birds to be minimal and stated that pre-season releases of mallards were essentially for hunting purposes.

Releases of game farm ducks have not been found to significantly increase or establish local breeding populations in New York (Foley 1954, Foley et al. 1961), Ohio (Bednarik and Hanson 1965), Wisconsin (Zohrer 1969), south Texas (Kiel 1970), Minnesota (Schladweiler and Tester 1972), North Dakota (Greenwood 1976), or Illinois (Burger 1984). As Kozickey (1987) noted, pen-reared mallards more than 2 generations removed from the wild do not migrate with their wild counterparts.

Largely because of the failure of game farm mallards to migrate, survive, and supplement local breeding populations, managers and researchers began to look at using birds raised from wild stock eggs. Brakhage (1953) reported that the migration patterns and rate of mallards, pintails (*Anas acuta*), redheads (*Aythya americana*), and canvasbacks (*Aythya valisineria*) hand-reared at the Delta Waterfowl Research Station (DWRS) from wild eggs (i.e., wild-strain) did not differ from those of wild birds. Although the homing rate for wild-strain mallards and pintails was actually higher than for their wild counterparts, these ducks experienced higher juvenile mortality. Sellers (1973) reported a 25% and 20% return rate for female wild-strain mallards (F^1 generation) released near Delta in 1969 and 1970, respectively. Lee and Kruse (1973) reported that 306 of 319 ducklings released into a gentle-release pen fledged and 89 of 270 (33%) remaining, after known hunting mortality was subtracted, returned to the refuge the following spring. They reported nest success rates for returning released ducklings similar to that of wild birds. Bailey (1979) reported 26-28% homing of yearlings and a 53% return rate for 2-year-old wild-strain female mallards released as ducklings on the Delta marsh in 1971 and 1972. However, the wild-strain females returned later than their wild counterparts and were less successful at producing broods. He did report the return of at least one released male. Yerkes and Bluhm (1998) reported the return of 5-8% of wild-strain mallards believed alive following hard-releases made in 1992-94.

Given these mixed results, wildlife managers and waterfowl hunters still disagree regarding the role that wild-strain mallard releases can serve in restoring mallard numbers. These results prompted Batt and Nelson (1990) to conclude that duck populations can recover under improved conditions and the focus should be on increasing the recruitment rate of existing populations, not through propagation. However, they noted that if releases were continued, wild-strain instead of game-farm mallards should be used.

Lee et al. (1985) recommended that an evaluation of the release of wild-strain mallards in conjunction with habitat development and other intensive management projects was needed to determine if these methodologies have merit in helping to restore mallard populations. The goal of such releases would be to rapidly build up local breeding populations to habitat carrying capacities, allowing mallards to move from release sites to surrounding habitats, thus increasing overall mallard production.

SUMMARY OF PREVIOUS WILD-STRAIN MALLARD RESEARCH

Mallard ducklings released as part of past studies migrated (Lee and Kruse 1973, Sellers 1973) and exhibited natal philopatry. Sellers (1973) reported the higher density of returning wild-strain mallards on his 2.6 $km.^2$ release site. Returning mallard densities decreased as the distance from the release site increased. These results suggested that released wild-strain mallards would pioneer.

Doty and Lee (1974) and Bishop et al. (1978) observed a tendency of female mallards to return to breeding grounds used the previous year. In both studies, females who successfully nested in elevated nesting structures returned in subsequent years to re-nest in the same structure. Rohwer and Anderson (1988) agreed that female ducks returning to familiar areas may increase their reproductive success. Paired males generally follow their mate from the wintering grounds to the breeding grounds, and are less likely to show philopatry than unpaired males (Rohwer and Anderson 1988). Dwyer et al. (1973) observed a marked pair of mallards returning to and establishing a home range that overlapped their home range of the previous year. Lokemoen et al. (1990), working with wild mallards, observed young-of-year mallard females returned at a rate of 29%. Second year and older females, that nested successfully, returned 52% of the time while those that were unsuccessful had a return rate of only 17%. Barclay (1970) reported that 2 of 7 marked mallard drakes returned to the marsh where they were banded the previous spring.

PREVIOUS BAND RECOVERY RECORDS FOR WILD-STRAIN MALLARDS

Band recovery records have been used by researchers to evaluate survival, migration, and other aspects of avian ecology. Nichols et al. (1984) used band recovery data to conclude that the effects of hunting on mallard survival are primarily compensatory. Davenport (1977) described methods to display and tabulate band recovery data. Cowardin (1977) described how to map and evaluate the spatial distribution of band recoveries using computer modeling techniques. Brownie et al. (1985), Conroy et al. (1989), and White (1983) developed computer programs to evaluate survival of birds from band recovery data. The techniques also have been used to map migration of released mallards. The results of this research suggest there is no difference in the migration patterns of wild-strain and wild mallards (C. K. Bluhm 1984. Delta Waterfowl Research Station, unpublished report). However, these techniques have not been used to compare survival rates of wild-strain mallard ducklings to wild cohorts. Some authors have suggested that because wild-strain mallards are raised in close association with humans, they may imprint and thus be more susceptible to harvest than their wild counterparts. Additionally, the lack of exposure of wild-strain ducklings to a wild female "role model" during early development and imprinting may contribute to behavioral differences which may make them more susceptible to predation. Although release of wild-strain mallards to increase population size have been previously evaluated (Brakhage 1953, Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998), none of these studies have been conducted at the landscape level under optimum habitat conditions using techniques that would be used by a waterfowl manager. Lastly, none of the previous studies have evaluated whether wild-strain or wild mallard behavior patterns contribute to differences in susceptibility to harvest.

STUDY PURPOSE

I evaluated the success of single-season, site-specific, wild-strain releases on increasing local breeding populations over a large geographic area. I compared the modified gentle-release method of releasing ducklings to other types of releases of wild-strain mallards found in the reviewed literature. I also evaluated wild-strain mallard fledgling and return rates by release sites relative to temporal, environmental, and behavioral factors. In addition, I evaluated the effect of the releases on local breeding population size by comparing the number of observed and expected breeding mallard pairs on treatment and control sites. Expected breeding pair densities were determined using the mallard model (Cowardin et al. 1988).

I compared the behavior of wild-strain mallards with their wild counterparts. I also evaluated wariness to humans by comparing reaction distance, flushing distance, and flight distance of the female wild and wild-strain mallards. I compared wetland use by type, cover, and flooding between female wild and wild-strain mallards. Lastly, I evaluated vulnerability to hunting by comparing band recovery records from young-of-year wild mallards who were banded during the same year the wild-strain mallards were released.

My study differed from previous studies in that replicated releases were conducted. Wild-strain mallard releases of equal numbers of female and male ducklings were conducted by the modified gentle-release at 12 sites across an area of the North Dakota Prairie Pothole Region with large expanses of improved nesting habitat.

The following chapters are written in Journal of Wildlife Management style. In Chapter 2, I evaluate the survival of released wild-strain mallard ducklings in relation to release and release site characteristics. In Chapter 3, I compare the difference between the number of breeding pairs observed on treatment and control sites, the number of breeding pairs observed on all sites in 1994 and 1995, and the number of breeding pairs predicted to occur on sites by the mallard model and observed population levels in 1995. In addition, I evaluated the return of wild-strain females to release sites in 1994 in relation to release and release site characteristics. In Chapter 4, I compare band recoveries for hard- and modified gentle-released wild-strain and wild mallards. In addition, I compared habitat use and reaction to human approach for wild and wild-strain mallard females.

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CHAPTER 2

EFFECT OF RELEASE SITE CHARACTERISTICS ON WILD-STRAIN DUCKLING SURVIVAL ESTIMATES

Abstract: In 1993, to determine if any relationship existed between release site characteristics, time of release, and duckling survival, I compared survival rates for approximately 2,400, 4.5-week-old, F_1 generation wild-strain mallard (*Anas platyrhyncos*) ducklings using the modified gentle-release method, on 12 wetland sites (100 female and 100 male per site) located in east-central North Dakota. Ducklings were transported to release sites during early morning hours to minimize heat stress and released on type 3, 4, and 5 wetlands ranging in size from 3 to 143 ha. Release sites were visited and systematically searched every 3 days until the ducklings fledged. Two hundred sixty-one duckling mortalities (11% of the released individuals) were recorded during the searches. More duckling mortalities were observed on wetlands exhibiting higher percentages of emergent cover ($P = 0.029$); thus, fewer released ducklings were observed on wetlands with greater vegetation cover. Pond permanence was positively related to the number of ducklings observed at fledging ($P = 0.0007$). More ducklings survived and were observed when releases were made on open, more permanent wetlands. The total cost per released duckling was $18.00 and $20.30 to $43.90 per fledged duckling.

Burger (1984) and Lee et al. (1985) suggested that augmentation or restoration of local breeding duck populations by releasing wild-strain ducklings (the F_1 generation from wild parents hatched from nest-salvaged eggs) to suitable habitats is an effective technique to increase continental mallard populations. Numerous studies have shown that wild-strain mallard ducklings, when released to the wild, demonstrate migration patterns similar to wild mallards with females returning to areas near their release location (Brakhage 1953, Foley et al. 1961, Zohrer 1969, Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998). In addition, upon returning in the spring, wild-strain mallards have successfully nested and produced broods (Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998).

Lee et al. (1985) suggested that wild-strain release was a viable option to reverse declining mallard populations. They based their optimism on the increased breeding pairs observed following wild-strain releases (Lee and Kruse 1973, Sellers 1973). Although Batt and Nelson (1990) acknowledged that wild-strain releases can increase local mallard populations, they discounted their potential in contributing to the broader goals of waterfowl and wetland conservation. They concluded that waterfowl populations can only truly recover if habitat and wetland conditions are improved. Lee et al. (1985) concluded additional experimental releases were warranted in conjunction with habitat development or enhancement and other intensive management, including predator control.

The success of such releases may also depend on achieving economic and biological efficiency (i.e., maximum number of birds fledged per cost) and increased recruitment. In 1993, wild-strain mallards could be reared for approximately $15.00 per 4.5-week-old duckling (pers. com. G. Reed, Dakota Wildlife Trust).

Lee and Kruse (1973) and Gatti (1981) compared the economic and biological aspects of the direct or "hard releases" and "gentle" wild-strain mallard releases. Hard releases (i.e., the ducklings are released directly into suitable wetland habitats without any additional care) were the least expensive with only transportation plus minimal labor costs incurred. Costs associated with gentle releases included additional labor for exclosure construction and materials, maintenance, feed, additional personnel, and transportation costs. Lee and Kruse (1973) estimated the production costs of rearing wild-strain mallards to be $1.50 to $3.00 per bird, depending on the size of the operation. Gatti (1981) estimated that this production cost would double if the birds were released using gentle-release as opposed to hard-release methods. Gatti and Lee's estimate did not include the labor costs which were borne as an overhead cost in a state operated facility.

My study differed from these earlier studies in several aspects. First, my research concentrated on evaluating the survival of wild-strain mallard duckling released in groups of approximately 200 individuals (50:50 ratio of male to female) using techniques employed by wildlife managers. The ducklings were released on 12 geographically separated wetland complexes surrounded by large contiguous, improved blocks of nesting cover. Releases were conducted on a variety of wetland types exhibiting diverse emergent vegetation cover types to determine the relationship of these variables to duckling survival. This differed from Sellers' (1973) study in that they released ducklings in brood-sized groups, and from the studies by Brakhage (1953), Lee and Kruse (1973), Gatti (1981), and Yerkes and Bluhm (1998), who released large numbers of ducklings in only 1 or 2 locations.

Wild mallard females typically select wetlands that exhibit suitable open water to vegetation cover interspersion ratios as brood habitat. The preferred rate is 50:50 open water to vegetation. This condition is referred to as a hemi-marsh (Kaminski and Prince 1981). Hemi-marsh provides a mix of escape cover and feeding areas that offer protection from both terrestrial and avian predators. The question that remains to be answered about released wild-strain ducklings is whether or not these hemi-marsh conditions would afford them similar protection given their lack of an adult female role model.

Lastly, the ducklings in this study were released using the modified gentle-release methods similar to those used by Yerkes and Bluhm (1998). Lee and Kruse (1973) used the gentle-release method, Brakhage (1953) and Gatti (1981) released ducklings by both the gentle- and hard-release methods, while Sellers (1973) and Bailey (1979) employed only hard-release methods. The modified gentle-release method used in this study afforded the ducklings partial protection from predators and allowed for supplemental nourishment.

I evaluated the survival of wild-strain mallard ducklings from release to fledging in high-quality upland and wetland complexes relative to wetland type, amount of emergent vegetation, timing of the release, and amount of supplemental feed eaten at release sites. I compared observed survival rates and costs to those published by Lee and Kruse (1973) and Gatti (1981).

STUDY AREA

The research was conducted on 12, 10.4-km^2 sites located in the Missouri Coteau and Drift Prairie portions of the Prairie Pothole Region (Stewart and Kantrud 1974) of east-central North Dakota (Figure 2.1). Study sites were located in Foster, Kidder, Nelson, Ramsey, Sheridan, Stutsman, and Wells Counties. Each site contained core areas consisting of a minimum of 2.6 km^2 of contiguous nesting cover.

Nine of the study sites were located entirely on private lands and included large tracts that were enrolled in the Conservation Reserve Program (CRP) under the 1985 Farm Bill. The land enrolled in the CRP was cropland that had been converted to permanent grass cover, primarily wheatgrasses (*Agropyron spp.*) and smooth brome (*Bromus inermus*), between 1987 and 1990. The other 3 sites were largely public land. Two sites included portions of the state-owned Lonetree Wildlife Management Area (WMA), managed by the North Dakota Game and Fish Department (NDGFD) and one was of newly acquired USFWS Waterfowl Production Area (WPA). The contiguous nesting cover and portions of the surrounding upland areas on these 3 sites was recently planted to dense nesting cover (DNC) containing a mixture of largely wheatgrasses, alfalfa (*Medicago sativa*), and ungrazed native grasslands.

METHODS

Between June 8 until August 3, 1993, approximately 200 (100 male, 100 female) 4.5-week-old wild-strain mallard ducklings were released on wetlands in the core 2.6

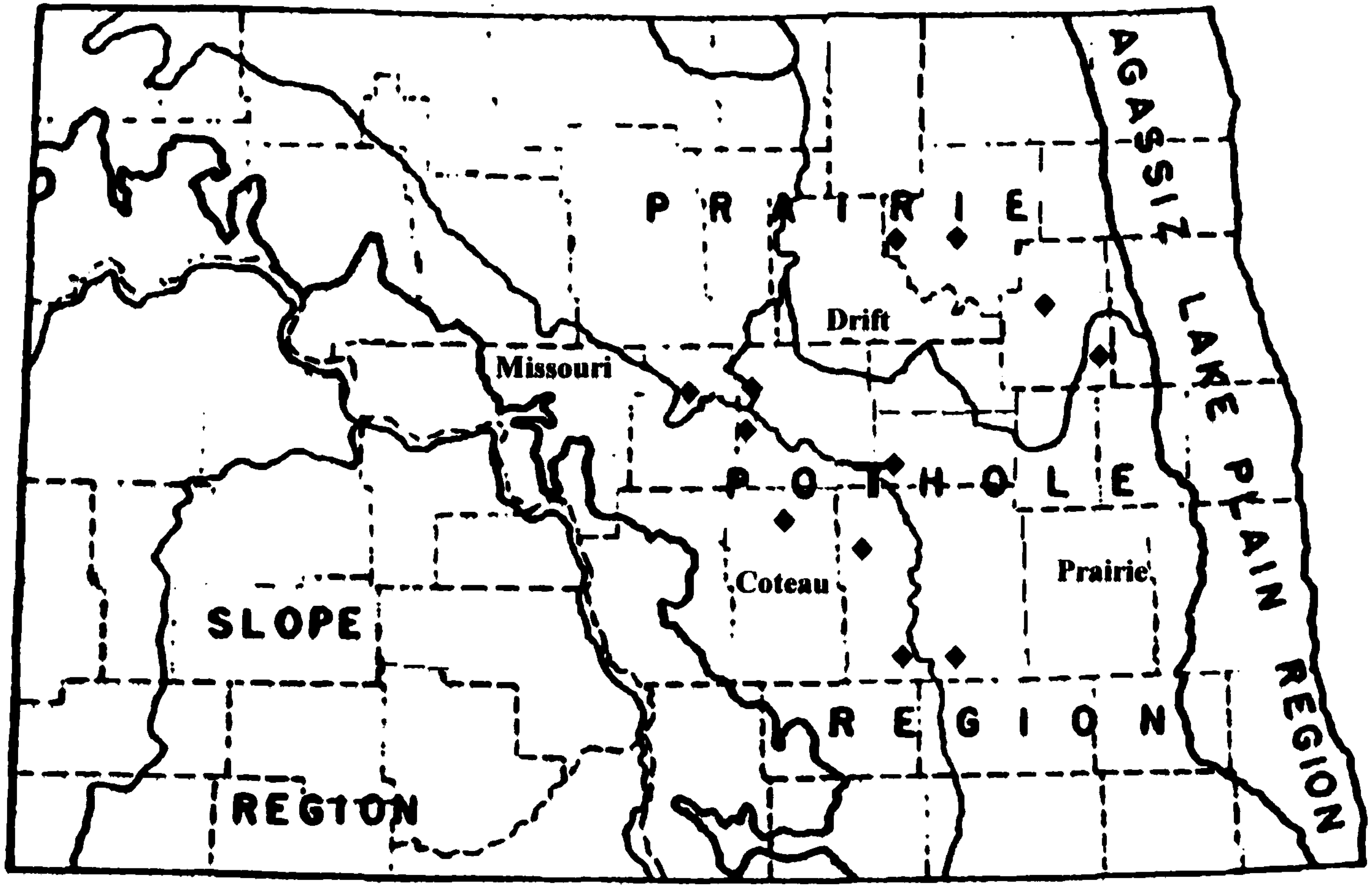

Figure 2.1. Physiographic map of North Dakota (modified from Stewart and Kantrud 1974) showing the location of 12, 10.4-km², modified gentle-release sites in the Prairie Pothole Region. ◆ = release sites.

km^2 of 12 randomly selected sites. The control sites consisted of 6 wetlands, one per site, that exhibited hemi-marsh conditions of 26-75% emergent vegetation cover. The other 6 release sites consisted of wetlands that exhibited <26% (3) and >75% (3) emergent vegetation cover. Approximately equal numbers of male and female were released on these wetlands to closely mimic natural population sex ratios. Released ducklings were F_1 offspring from a captive flock of approximately 400 adult mallards maintained by the Dakota Wildlife Trust, Inc., Valley City, North Dakota. The parental mallards were hatched and reared from eggs salvaged in the wild. At 4-weeks of age, the ducklings were sexed by cloacal examination (Hochbaum 1942), and fitted with USFWS leg bands and nylon nasal markers color-coded to specific release sites. The markers were held in place by 0.16-cm diameter stainless steel rods, 2.86 cm long, inserted through the nares and bound by stainless steel washers with 0.17-cm holes. The rods were bent slightly to allow the colored markers to lay closer to the bill and each end of the rod was crimped to hold the washers in place.

At 4.5-weeks of age, the ducklings were released using a modified gentle-release method to release pens approximately 225 m^2 in size. These release pens were constructed of 1.22-m high wooden-lathe snow fence. Approximately one half of the area enclosed by the pen consisted of uplands and one half was water (Figure 2.2). The fence was secured with lengths of baling wire to 1.68-m tall steel posts driven into the ground at 3-m intervals. The bottom 0.61 m of the fence was lined with 2.54-cm wide poultry wire to restrict terrestrial predators access to the ducklings and prevent ducklings from

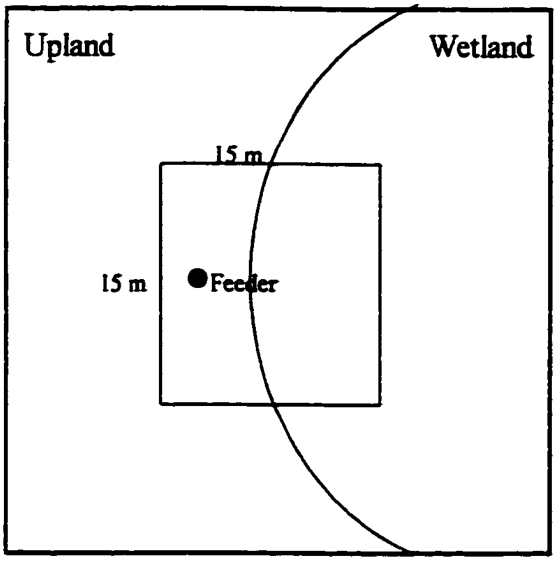

Figure 2.2. Diagram of pre-release pen.

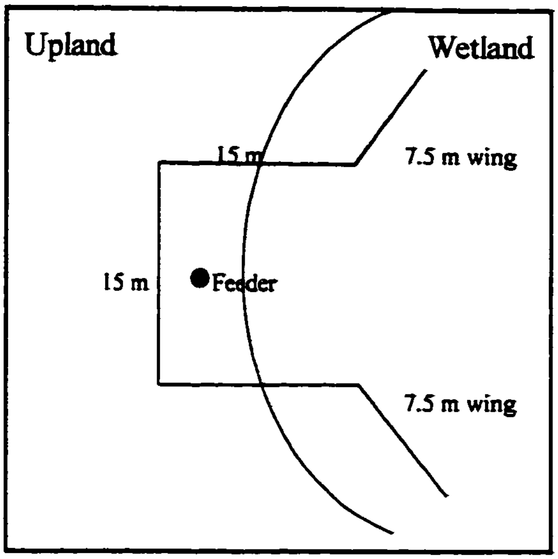

Figure 2.3. Diagram of post-release pen.

escaping during their acclimation period. One 4-bushel poultry feeder was placed in the upland portion of each pen and filled with small grain screenings.

The ducklings were confined to the pen upon release for a 4-hr period to allow them to acclimate to their surroundings (Figure 2.2). After 4 hr, the portion of the pen in the water was opened to create two 7.5-m wings that extended at 45° angles into the wetland. This allowed the ducklings to disperse freely into the wetland (Figure 2.3). The fence afforded the ducklings protection from terrestrial predators while feeding and loafing in the pen. The ducklings were allowed to feed on the screenings ad libitum. Each site was revisited once every 3 days post-release to monitor food levels and duckling survival. Searches of the wetland and upland areas around the release site were conducted during each visit to record live ducklings, locate remains of dead ducklings, bands, and nasal saddles. The visits were discontinued after the ducklings fledged. At that time, both the pen and feeder were removed.

The maximum estimate of ducklings fledged was determined by subtracting the number found dead from the total number released. The minimum estimated number of ducklings fledged was determined by subtracting mortalities from the number of ducklings observed during the last week of post-release surveys.

All wetlands on each study site were classified after Stewart and Kantrud (1971). Type 2 wetlands were temporary, type 3 wetlands were seasonal, type 4 wetlands were semi-permanent, and type 5 wetlands were permanent. Wetland type and percent vegetation cover (by categories ≤ 25, 26 to 50, 51 to 75 and 76 to 100%) were estimated and recorded.

I compared the survival rates of the wild-strain ducklings from release to fledging to time of release, wetland type, amount of wetland vegetative cover, wetland size, and feed consumption to determine which factors most influenced duckling mortality, and subsequent survival estimates. I used stepwise multiple regression analysis (SAS Institute 1989) to determine the effect of release site characteristics on duckling mortality and survival to fledging at an inclusion level of $\alpha = 0.15$.

RESULTS

The remains of 266 ducklings (11.1%) were found during post-release searches (Table 2.1). Of these, 260 were killed by predators, 3 died from release-related activities, 2 died from eating moldy grain, and 1 drowned when the nasal saddle become entangled in wire at the release site. The sex of 198 duckling mortalities could be determined; 95 (48%) were female and 103 (52%) were male. The maximum number of ducklings

Table 2.1. Actual duckling mortalities observed and number of birds fledged by release date, wetland site characteristics, and food consumption, 1993.

Site	Release date	Mortalities[a] recorded	Wetland size (ha)	Wetland[b] type	Cover[c] classification	Feed[d] consumed	Observed at fledging
Foster	6-30	22 (13.2%)	39	3	3	1	70
Lonetree 1	6-23	11 (5.1%)	36	4	3	1	121
Lonetree 2	6-30	22 (11%)	29	4	2	3	157
Nelson 1	7-7	7 (3.5%)	5	4	3	1	51
Nelson 2	7-7	52 (26%)	3	3	4	1	25
Ramsey 1	7-14	13 (4.5%)	73	4	2	1	42
Ramsey 2	7-14	5 (2.5%)	143	5	1	2	195
Sheridan 1	7-21	5 (2.5%)	63	5	1	4	194
Stutsman 1	6-25	67 (37%)	14	3	4	1	16
Stutsman 2	7-21	5 (2.5%)	15	3	2	4	23
Stutsman 3	7-28	27 (13.5%)	16	3	4	1	6
Wells	7-14	30 (15%)	17	4	1	1	61
TOTALS		266 (11%)					961

[a] First number is the total number found dead, in ( ) is the % of those released represented by those found dead.
[b] 2 = temporary, 3 = seasonal, 4 = semi-permanent, 5 = permanent (Steward and Kantrud 1971).
[c] 1 = ≤ 25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%
[d] 1 = 4, 2 = 8, 3 = 12 and 4 = 16 bu of supplemental feed consumed

Table 2.2. Actual mortalities and estimated maximum and minimum survival rates for wild-strain ducklings released using modified gentle-release techniques, June to August 1993.

Site	Date released	# Released			Bands recovered			Saddles recovered	Total recovered	Maximum possible survival[1]		Minimum possible survival[2]	
		F	M	Total	F	M	Total			%	#	%	#
Foster	6/30/93	100	067	167	08	09	17	05	22	86.8	145	41.9	70
Lonetree 1	6/23/93	100	096	196	01	06	07	04	11	94.4	185	61.7	121
Lonetree 2	6/30/93	100	100	200	10	06	16	06	22	89.0	178	78.5	157
Nelson 1	7/7/93	100	100	200	01	03	04	03	07	96.5	193	25.5	51
Nelson 2	7/7/93	100	100	200	20	21	41	11	52	74.0	148	12.5	25
Ramsey 1	7/14/93	100	100	200	03	02	05	08	13	92.5	187	21.0	42
Ramsey 2	7/14/93	100	100	200	00	02	02	03	05	97.5	195	97.5	195
Sheridan 1	7/21/93	100	100	200	01	04	05	00	05	97.5	195	97.0	194
Stutsman 1	6/25/93	100	081	181	27	32	59	08	67	63.0	114	8.8	16
Stutsman 2	7/21/93	100	100	200	03	02	05	02	05	96.5	195	11.5	23
Stutsman 3	7/28/93	100	100	200	07	06	13	14	27	86.5	173	3.0	6
Wells	7/14/93	100	100	200	14	10	24	06	30	85.0	170	30.5	61
Totals		1200	1144	2344	95	103	198	70	266	88.3	2078	40.8	961

[1]Number released - number found dead
[2]Actual number observed to be alive within one week of fledging minus any found dead after count.

of ducklings observed during the last week of post-release surveys. The number of remains found per site ranged from 5 to 67 ($\bar{x} = 21.8$, SE = 5.7).

Emergent vegetative cover ($F_{1,10} = 6.49$, $P = 0.029$) explained 39% of the variation in estimates of the maximum number of ducklings fledged. As the emergent cover on the release pond increased, the number of duckling mortalities found by survey crews increased. Wetland type ($F_{1,10} = 23.30$, $P = 0.0007$) explained 70% of the variation in estimates of the minimum number of ducklings fledged. Pond permanence was positively related to the number of ducklings observed at fledging. Total cost per duckling released was $18.00 ($15.00 production cost release to fledge and $3.00/duckling release expense). Cost per fledged duckling fell between $20.30 to $43.90 per duckling.

DISCUSSION

The duckling releases evaluated in this study were conducted using techniques similar to those which would be used by managers (Lee et al. 1985). Wild-strain ducklings were used because they have proven superior to game-farm ducklings (Burger 1984). In addition, ducklings were released in groups of approximately 200 (100 males, 100 females) to approximate natural sex ratios (Brakhage 1953, Foley et al. 1961, Zohrer 1969, Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998).

The modified gentle-release method was used because this methodology was believed to yield higher survival rates of released ducklings than hard-release methods and be more cost effective from a management standpoint than the gentle-release methods (Lee et al. 1985).

Although duckling survival rates (from release to fledging) observed in this study were lower than those reported by Lee and Kruse (1973) and Gatti (1981) under gentle-release methods, this reduction was offset by greater cost efficiencies. One disadvantage of the modified gentle-release method was a reduction in the ability to accurately assess pre-fledgling mortality rates. Because post-release searches were confined to areas in and around release and adjoining ponds where cover was often dense, all the mortalities were never recorded. Thus, the maximum fledging rate reported overestimates survival. However, the minimum reported rate may also underestimate the actual survival rate. Visibility of surviving birds released to wetlands which contained a high percent of emergent vegetation was further reduced as the season progressed and birds became more mobile. Band recovery data confirmed greater numbers of ducklings fledged on some sites than were actually observed during post-release surveys.

Zohrer (1969) reported that 74% of the ducklings released to wetlands in his New York study area survived to fledge. These ducklings were released by the hard-release method primarily on ponds constructed for livestock and recreational use. Vegetation cover on these ponds was generally limited. The difference in the number of ducklings observed in the present study on natural ponds, some of which were densely vegetated, and by Zohrer (1969) could be explained by the effect of vegetation on observability. My findings suggest that the number of ducklings observed decreased as wetland vegetative cover increased and the ducklings became more mobile. Although pre-fledging overland movements, as reported by Sellers (1973), were not observed during this study, some movement to adjacent wetlands occurred as heavy rains resulted in wetlands overflowing into adjacent ponds.

Although expected, survival from release to fledge of the ducklings in the present study was lower than the 96.8% reported by Lee and Kruse (1973). However, rates of duckling survival to fledging observed are comparable to those reported in the literature for wild birds (Anderson 1975).

Ducklings released using the gentle-release method experienced relatively predator-free environments. Predation in most cases was limited to avian predators. The following potential duckling predators were observed on all sites: coyote (*Canis latrans*), red fox (*Vulpes vulpes*), racoon (*Procyon lotor*), badger (*Taxidea taxus*), striped skunk (*Mephitis mephitis*), mink (*Mustela vision*), red-tailed hawk (*Buteo jamaicensis*), Northern harrier (*Circus cyaneus*), and great horned owl (*Bubo virginianus*). The wetlands I used as release sites were surrounded by upland and wetland complexes exhibiting good cover. Thus, the ducklings in my study were exposed to a diverse community of predators present in the area. Although care was taken to restrict terrestrial predator access, some of the ducklings could have been killed and carried from release sites. However, this method still provided reasonable means of estimating duckling mortality when compared to hard-release methods.

In summary, the ponds that provide preferred escape cover for wild birds (Johnson and Grier 1988) became killing fields for released wild-strain ducklings. In contrast, ducklings released to permanent wetlands with little emergent vegetative cover experienced greater survivability to fledging. This result may suggest that wild-strain ducklings raised in the absence of a wild female role model may lack the appropriate behavioral escape response found in wild birds.

MANAGEMENT IMPLICATIONS

Kaminski and Prince (1981) reported an affinity of dabbling ducks for hemi-marsh with a 50:50 interspersion of open water and emergent vegetation. However, my releases on wetlands exhibiting these characteristics were less successful than those on wetlands with more open water. If the use of wild-strain mallards to increase local breeding populations is necessary, these releases should be confined to type 5 wetlands (Stewart and Kantrud 1971) that exhibit more permanent water, deeper shorelines, and <25% emergent cover. These are generally larger more permanent wetlands. The ducklings released in these areas were better able to avoid predation given the ability to escape into open water. On numerous occasions ducklings were observed moving into open water upon human approach.

The use of the modified gentle-release method proved cost effective at rearing ducklings to fledging. The total cost of release at $18.00 per duckling was only 20% above the cost of production, much less than the double cost of release estimated by Gatti (1981).

In summary, findings from my study indicate that employing the modified gentle-release method and releasing wild-strain mallard ducklings to permanent ponds in late July and early August will maximize the number of released ducklings that survive to fledging.

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CHAPTER 3

EFFECTS OF WILD-STRAIN MALLARD RELEASES ON LOCAL BREEDING POPULATIONS

Abstract: To determine if releases of wild-strain ducklings could be used on a practical management basis to increase local breeding populations, I released 2,344 mallard ducklings in the spring of 1993 fitted with nasal saddles (1,200 females, 1,144 males) to wetlands on 12 randomly selected 10.4-km^2 sites (approximately 200 per site, 100 females, 100 males) in the North Dakota Prairie Pothole Region. In the spring of 1994 and 1995, field crews conducted mallard breeding pair surveys to compare populations on treatment and paired control sites. All mallards observed were recorded by pond number where they were observed and breeding pair indices calculated for each site. Wetland surveys also were conducted annually to determine wetland type and percent emergent vegetation cover for each basin. In 1995, near-infrared aerial videography was procured for all sites to assess wetland habitat conditions and model mallard populations. In 1994, 55 nasal saddled mallard females were observed ($\bar{x} = 4.6$ site). In 1995, only 5 marked females were observed. The number of marked mallards observed was positively correlated with wetland size ($r^2 = 0.59$). There was no difference in mallard pairs observed between treatment and control sites in 1994 ($t_{11} = 0.97$, $P = 0.18$) or 1995 ($t_{11} =$ -0.22, $P = 0.59$). There was no difference in estimates of breeding pair population predictions using the mallard pond-pair regression model and those observed on treatment ($t_{11} = -1.83$, $P = 0.09$) and control sites ($t_{11} = 0.59$, $P = 0.56$), as well as for all sites

combined (t_{23} = -1.6, P = 0.12). Although some female wild-strain mallards did return to the site they were released on to mate, nest, and produce broods, overall, the releases did not increase the local mallard breeding populations.

Leopold (1933) defined ecological carrying capacity as the maximum number of animals that can inhabit a given area. Edwards and Fowle (1955) refined the concept when they identified several environmental components that interact to place upper limits on populations. These limiting factors are in flux, often independently, making carrying capacity a dynamic environmental attribute. The factors limiting North American mallard populations include water, food, predators, land use, juxtaposition of ponds and nesting cover, weather, pond numbers, and social interactions (Dzubin 1969). Of these environmental factors, pond numbers, surface water area, and concomitant social interactions have been modeled to predict carrying capacity (e.g., Cowardin et al. 1983, 1988, 1995; Johnson et al. 1986).

Cowardin et al. (1983) developed a regression model based on surface water area to estimate the number of breeding mallard pairs that could potentially occupy a specific habitat area. Mallard density estimates are made for single ponds, then summed to provide breeding pair population indices for landscapes. The model assumed mallard populations were adequate to fill existing habitats (Cowardin et al. 1988). A correction factor was later added to adjust for annual differences in wetland conditions and continental mallard population size estimates (Cowardin et al. 1995). For management purposes, this model was assumed to provide a reliable estimate of mallard breeding pairs for 10.4 km^2 of wetland and upland habitat complexes in the Prairie Pothole Region of North America.

However, Johnson and Schaffer (1987) argued that continental mallard populations had declined to levels that were no longer able to fill the available habitat to the extent they had in the past. Their conclusion invalidated the basic model assumption that mallard populations are adequate to fill existing habitats. Regional evidence cited in further support of Johnson and Schaffer's (1987) conclusions was provided by the failure of aggressive habitat management efforts implemented under the North American Wildlife Management Plan to restore continental mallard populations (Canada Wildlife Service and U. S. Fish and Wildlife Service 1986). For example, in North Dakota, the conversion of 14.5 million hectares of farmland to permanent cover (Bjerke 1991) under the 1985 Conservation Reserve Program (CRP), and the acquisition of 23,000 hectares of land and subsequent planting to permanent cover under the Garrison Diversion Project (Garrison Diversion Conservation District 1992) failed to restore localized breeding mallard populations in the Prairie Pothole Region to past, long-term averages by the early 1990's (Dubovsky et al. 1993).

If mallard populations had declined to levels, or equilibrium points, below those observed in the past, as described for other wildlife populations by Hollings (1973) and Peterman et al. (1978), they may no longer be able to respond to improved habitat conditions. Peterman (1977) suggested that when a population has drifted below its equilibrium point, only heroic management measures would restore populations to a current carrying capacity.

The release of wild-strain mallard ducklings into improved habitat has been proposed as an example of a heroic management measure that could be used to restore local mallard breeding populations to carrying capacity (Brakhage 1953, Sellers 1973, Lee et al. 1985). Previous research yielded results that suggest that wild-strain mallard ducklings released to the wild exhibit migration patterns similar to wild mallards with females exhibiting philopatry (Brakhage 1953, Foley et al. 1961, Zohrer 1969, Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998). In addition, upon returning in the spring, wild-strain mallards have successfully nested and produced broods (Lee and Kruse 1973, Sellers 1973, Bailey 1979, Gatti 1981, Yerkes and Bluhm 1998).

If wild-strain mallard releases proved successful as a management tool on a local level, this technique might also be used to test the Johnson and Schaffer (1987) theory that breeding pair populations were below historic equilibrium points, therefore unable to respond to improving habitat conditions. Further, if successful, wild-strain mallard releases replicated across landscapes exhibiting similar wetland and upland habitat characteristics could be used to test mallard model predictions. If release or treatment sites exhibited higher breeding pair indices than paired control sites, and these counts were higher than predicted by the mallard model (Cowardin et al. 1995), this may suggest that such releases could be used to restore local breeding populations. If the observed mallard breeding pair indices on control and treatment sites were universally lower than predicted, this also could suggest that breeding pairs are below habitat carrying capacity in support of Johnson and Schaffer (1987). Lastly, if the predicted populations were in any way different (i.e., lower or higher) than observed populations, this would suggest that the model may be wrong.

To test these hypotheses, I released and monitored post-release mallard populations on 24, 10.4-km^2 sites (12 release and 12 control) and compared breeding pair population indices in following years. I also compared observed breeding pair indices to those estimated by the mallard model. Lastly, I compared the return rates of released wild-strain mallard females and males and monitored reproductive efforts of returning wild-strain mallard females.

STUDY AREA

The research was conducted in 1993-95 on 24, 10.4-km^2, paired sites located in the Missouri Coteau and Drift Prairie portions of the Prairie Pothole Region of east-central North Dakota (Stewart and Kantrud 1972). The study boundaries were latitude 46° 40' to 48° 20' and longitude 098° 00' to 100° 30' (Figure 3.1).

Study sites were distributed across 36,000 km^2 and included sites in Eddy, Foster, Kidder, Nelson, Ramsey, Sheridan, Stutsman, and Wells Counties. Each site contained core areas consisting of a minimum of 2.6 km^2 of contiguous nesting cover. Eighteen of the study sites were located primarily on private land portions that were enrolled in the CRP under the 1985 Farm Bill between 1987 and 1990. The land enrolled in the CRP was cropland that had been converted to permanent grass cover, primarily wheatgrasses (*Agropyron spp.*), smooth brome (*Bromus inermus*), and alfalfa (*Medicago sativa*). The

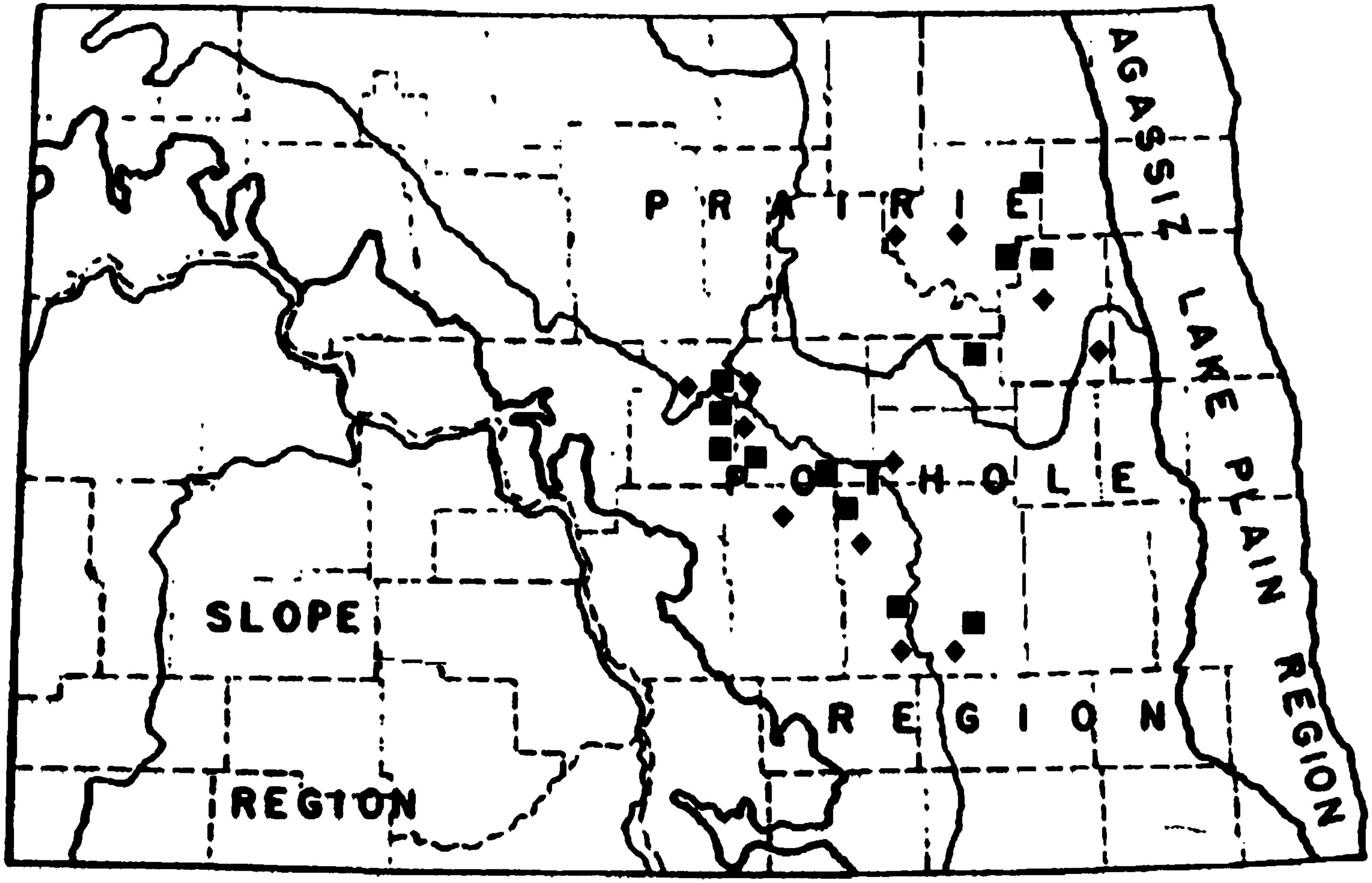

Figure 3.1. Physiographic map of North Dakota (modified from Stewart and Kantrud 1974) showing the location of 24, 10.4-km², paired sites in the Missouri Coteau and Drift Prairie portions of the Prairie Pothole Region. ■ = control sites, ◆ = treatment sites.

other 6 sites were largely public land. Four sites included portions of the state-owned Lonetree Wildlife Management Area (WMA) and two consisted of newly acquired U.S. Fish and Wildlife Service waterfowl production areas. The core area and other portions of these 6 sites were comprised of lands recently planted for dense nesting cover (DNC), consisting of a mixture of primarily wheatgrasses and alfalfa and ungrazed native grasslands.

Beginning in June 1993, precipitation exceeded long-term averages for 14 of 19 consecutive months (National Oceanic and Atmospheric Administration 1993, 1994). Wetland numbers for May 1994-95 for the eastern Dakotas were 59 and 99% above average, respectively, and July pond numbers for 1994-95 were 68 and 138% above average, respectively (U.S. Fish and Wildlife Service and Canadian Wildlife Service 1994, 1995).

METHODS

During the fall of 1992, study personnel visited Natural Resource Conservation Service (NRCS) offices (formerly Soil Conservation Service) in eastern North Dakota and identified 70 possible 10.4-km^2 sites that met the minimum established habitat criteria (center 2.6 km^2 in contiguous cover, adequate water and exhibiting high-quality wetland complexes). After preliminary field visits, 30 sites were selected having met the above criteria. The study sites were paired based on number of wetland complexes, wetland densities, upland habitat and located in the same physiographic region (Stewart and Kantrud 1974). Selected sites, in addition to meeting the contiguous cover criteria, exhibited wetland complexes that could be used as release sites and open water to attract breeding waterfowl. Lastly, the areas selected did not conflict with on-going research efforts and were spatially separated by at least 6 km. Twelve of the 15 matched pairs of 10.4-km^2 sites were then selected for use in the study. The sites did not undergo additional management from the time the ducklings were released until the research was completed. The number of wetlands per site varied from approximately 45 to 350 and wetlands ranged in size from <1 to approximately 150 ha. Field crews subsequently contacted >600 private landowners by telephone, postcard, and in person to obtain walking access to private land to conduct breeding mallard surveys. Access was granted by >98% of the private landowners. Special use permits were obtained from the North Dakota Game and Fish Department and U. S. Fish and Wildlife Service to access Wildlife Management Areas and Waterfowl Production Areas for purposes of the study.

Duckling Releases

In 1993, from June to August, 2,344 (1,144 males, 1,200 females), 4.5-week-old wild-strain mallard ducklings were released on wetlands in the core 2.6 km^2 of 12 sites randomly selected from the paired areas. Approximately equal numbers of males and females were released to more closely mimic natural sex ratios (approximately 100 male, 100 female per site). Released ducklings were F_1 offspring from a wild captive breeding flock of 400 adult mallards maintained by the Dakota Wildlife Trust, Inc., Valley City, North Dakota. The breeding flock were hatched and reared from eggs salvaged from the wild. The number of ducklings released each week was limited by the egg production of the captive mallards. At 4-weeks of age, ducklings were sexed by cloacal examination (Hochbaum 1942), and fitted with U.S. Fish and Wildlife Service leg bands and nylon nasal markers (Lee 1958, Lokemoen and Sharp 1985) color-coded to the specific release site. The markers were held in place by 0.16-cm diameter stainless steel rods 2.86 cm long inserted through the nares bounded by stainless steel washers with 0.17-cm diameter holes. The rods were bent slightly to allow the colored markers to lay closer to the bill and each end of the rod was crimped to hold the washers in place. At 4.5-weeks of age the ducklings were released using a modified gentle-release method into release pens approximately 225 m^2 in size, built on suitable wetlands.

Mallard Surveys

Total ground counts of breeding mallards were conducted on all sites following techniques described by Hammond (1969) and Dzubin (1969). The techniques were modified as outlined by Cowardin (1991. U. S. Fish and Wildlife Service, unpublished report) for estimating released breeding pair densities. The surveys were conducted by 2 crews, each typically consisted of 3-4 trained personnel with each crew assigned half the sites. The same crew surveyed both treatment and control sites using standardized protocols to control observer bias (Faanes and Bystrak 1981). Surveys were conducted between April 20 and May 31, 1994-95. The surveys were conducted daily between 0600 (or 1 hr after sunrise) and 1200 h. Crew members followed predetermined routes on foot using binoculars and spotting scopes to identify mallards. Hand-held radios were carried for notifying other crew members that mallards had flushed and re-landed within the survey area (i.e., roll-up), to avoid counting individual ducks multiple times (Cowardin and Bluhm 1992). Observations of wild and wild-strain mallards were recorded on survey forms designed for this purpose. Wetland type was recorded for each pond on every study site using the Stewart and Kantrud (1971) classification system. Percent vegetation cover was recorded using the following classes: ≤ 25, 26 to 50, 51 to 75, 76 to 100%. All mallards were recorded by the assigned number of the wetland they were observed using and by other associated mallards. A male-based breeding pair index was used to account for lone males, pairs, and males in groups of 2-5 (Dzubin 1969).

Surveys were not conducted under weather conditions of moderate to heavy rain or snow or when wind speeds exceeded 40 km/h. Pairs of sites were surveyed in random order; first, the order in which the pairs were to be surveyed was randomized and then the order within pairs. All sites were surveyed once before any site was surveyed a second time. Each site was surveyed 3 times within the survey period. Only 1 site was surveyed per crew each day. The highest number of mallard pairs counted was used to compare populations by sites. Afternoon searches for the marked males were conducted as needed to determine breeding status. These searches were concentrated around the areas where the marked males were originally observed.

To assess dispersal of released mallards from the release site, roadside surveys were conducted from vehicles on transects along existing county section-line roads. Roadside transects were 10.4 km in length, starting 2.6 km from a site, extending through and concluding 2.6 km beyond the site. These transects were approximately 400 m wide (200 m on each side of the vehicle). Binoculars and window-mounted spotting scopes were used to survey all wetlands within the transects (Sauder et al. 1971). Wetlands with >50% of their area within the transect were surveyed completely. For wetlands with >50% of their area outside the boundaries, portions within the transect were surveyed (Sauder et al. 1971, U.S. Fish and Wildlife Service and Canadian Wildlife Service 1987, unpublished data).

Nest searches of upland cover were not conducted; however, when the nest of a marked mallard female was discovered incidental to other activities, the location was marked and recorded. All located nests were subsequently revisited to determine their fate. In 1994 and 1995, brood surveys were conducted starting the first week of June. Surveys were conducted by a 2-person crew walking the perimeter of ponds and observing ponds from elevated positions using binoculars and spotting scopes to determine if observed brooding mallard females wore nasal markers. To maximize the likelihood of locating marked mallards, brood surveys were concentrated on ponds where marked females were observed during pair counts and on adjacent ponds. Treatment sites were surveyed 3 times in 1994 and twice in 1995.

Predicted Mallard Numbers

During 1995, near-infrared aerial video images (videography) of all sites were obtained from the USFWS. These video images were transferred to digital raster format at 1-m resolution and corrections were made for the earth's curvature and the aircraft's pitch and roll. ERDAS IMAGE software (ERDAS Inc. 1995) was used to delineate wetland borders. This allowed wetland surface water area measures to be obtained for all sites. This information was used to estimate mallard breeding pair numbers for all sites using the pond-pair regression model (Cowardin et al. 1983, 1995).

I analyzed the return rate of the wild-strain mallard females to determine if any differences existed for sites relative to time of release, wetland type, amount of wetland vegetative cover, wetland size, amount of feed eaten post-release and observed pre-fledging mortality at release sites using multiple stepwise regression (SAS Institute 1989) at an inclusion level of $\alpha = 0.15$. I compared band recovery rates for juvenile wild and wild-strain mallards. I used a 1-tailed paired t-test to determine if any differences existed between the number of breeding mallards observed on control and treatment sites. A 2-tailed paired t-test was used to evaluate differences between the number of breeding pairs observed on all sites in 1994 and 1995. A 2-tailed paired t-test was also used to evaluate differences between the mallard model generated estimates and the observed numbers of breeding pairs. All data were Log_{10} transformed to obtain a more normal distribution prior to conducting paired t-tests. The paired t-tests were evaluated at the $\alpha = 0.05$.

RESULTS

Return Rates

In 1994, 55 marked wild-strain females were observed on their original release sites (Table 3.1). This represented an average return rate of 5.1% to 11.2% (based on the maximum and minimum number of females known to have fledged, respectively). Assuming a 95% survival rate from fledging to the opening of hunting season and a 55.5% over-winter survival rate for juvenile female mallards in Eastern North Dakota (Anderson

Table 3.1. Mallard breeding pairs (TP), indicated pairs (IP), and marked females (MF) observed by treatment site based on wetland size (WS) and type (WT), release week, observed mortality, feed consumed (Feed), emergent vegetation on wetlands (Cover), and estimated maximum (MAX) and minimum (MIN) number of fledged females, 1994-95.

	1994			1995										
Site	TP	IP	MF	TP	IP	MF	WS (ha)	WT[a]	Release week	Mortality	Feed[b]	Cover[c]	MAX	MIN
Foster	29	54	5	50	81	1	39	3	2	22	1	3	89	42
Lonetree 1	39	59	6	63	53	2	36	4	1	10	1	3	97	62
Lonetree 2	18	44	7	92	73	0	29	4	2	22	3	2	87	78
Nelson 1	34	97	5	148	160	0	5	4	3	7	1	3	98	26
Nelson 2	104	148	3	168	157	0	3	3	3	52	1	4	75	13
Ramsey 1	72	86	7	100	222	1	73	4	4	9	1	1	93	21
Ramsey 2	62	71	12	79	111	0	143	5	4	5	2	1	98	97
Sheridan	26	33	2	47	90	0	63	5	5	5	4	1	99	97
Stutsman 1	23	55	1	79	87	1	14	3	1	67	1	4	69	9
Stutsman 2	37	45	3	74	110	0	15	3	5	5	4	2	96	12
Stutsman 3	20	44	2	101	80	0	16	3	6	27	1	4	86	3
Wells	24	37	2	77	82	0	17	4	4	30	1	1	83	30
Totals	488	773	55	1078	1306	5				261			1070	490

[a] = type (Steward and Kantrud 1971)
[b] 1 = 4, 2 = 8, 3 = 12 and 4 = 16 bu of supplemental feed consumed
[c] 1 = ≤ 25%, 2 = 26-50%, 3 = 51-75%, 4 = 76-100%

1975), this represents an average return rate of 9.8% to 21.3%, respectively, for the maximum and minimum released populations estimated to have survived. Returning females were observed on all release sites in 1994. The mean number of female wild-strain mallards observed on release sites in 1994 during breeding pair surveys was 4.6 $\pm$ 0.9. Pond size ($r^2_{partial} = 0.54$) and week of release ($r^2_{partial} = 0.16$, $F_{1,10} = 5.02$, $P = 0.052$) explained 70% of the variation in the number of returning marked mallard females. As ducklings were released on large ponds, later in the season, more marked females returned to breed on release sites.

In 1995, only 3 marked females were observed on their original release site. Assuming a 58.7% survival rate for adult mallards in eastern North Dakota, this would represent from 0.9% to 2%, respectively, of the maximum and minimum of the released population to have survived. Two additional marked female wild-strain mallards were observed on study sites >50 km from the wetland areas where they were originally released.

During the first fall and winter period post-release the bands of 23 female mallards and 51 males were recovered representing 1.9% and 4.5% of the released population, respectively. During the second year post-release the bands of 6 females and 24 males were recovered representing an additional 0.5% and 2.1% of the released population, respectively.

Only one solitary marked wild-strain male was observed on a release site during a breeding pair survey in 1994. This male was not observed again throughout the duration of the study. No wild-strain males were observed in 1995. Only 1 mallard female was observed off a release site during a roadside survey. This female was observed approximately 6.5 km from its original release site and it was paired with a wild male.

Reproduction

The nests of 2 marked wild-strain females were found. Neither nest was successful. One was abandoned and the other predated. Only 2 marked females were observed with broods on release sites during brood surveys. Broods consisted of >5 ducklings each, and both were observed on the female's original release pond.

Breeding Pair Indices

No difference was found between mallard pair numbers observed on treatment (87.8 ± 11.1) and control (85.3 ± 14.6) (Table 3.2) sites in 1994 (t_{11} = 0.97, P = 0.18, 1- β = 0.23). Although the number of breeding pairs observed on control sites (97.8 ± 16.8) in 1995 was higher than treatment sites (89.8 ± 10.4) (Table 3.2), the differences were not significant (t_{11} = -0.22, P = 0.59, 1- β = 0.08).

In addition, no difference was found between the number of breeding pairs observed on all sites in 1994 (86.6 ± 8.99) and 1995 (93.8 ± 9.75), (t_{23} = -1.82, P = 0.08, 1- β = 0.54). No difference was found between 1995 mallard breeding pair indices predicted by the mallard model and number of breeding pairs observed on treatment sites (t_{11} = -1.83, P = 0.09, 1-β = 0.38), control sites (t_{11} = 0.59, P = 0.56, 1-β = 0.14), or all sites combined (t_{23} = -1.6, P = 0.12, 1-β = 0.34) (Table 3.3).

Table 3.2. Indicated breeding pairs observed on treatment and control sites, 1994-95.

	1994		1995	
Site	Treatment	Control	Treatment	Control
Foster	61	51	50	57
Lonetree 1	62	52	63	60
Lonetree 2	72	43	92	58
Nelson 1	139	171	148	229
Nelson 2	187	142	168	194
Ramsey 1	96	182	100	104
Ramsey 2	78	55	79	73
Sheridan 1	63	73	47	93
Stutsman 1	75	72	79	74
Stutsman 2	85	41	74	47
Stutsman 3	83	90	101	128
Wells 1	53	52	77	57

DISCUSSION

The wild-strain mallard ducklings released in this study did not increase the local mallard breeding population. These releases were conducted using protocols similar to those that might be used by a wildlife manager attempting to increase the number of breeding mallard pairs in a localized management area. If wild-strain releases are to be a viable tool for wildlife managers, they must not only increase local breeding mallard populations at a landscape level, but also be cost effective.

The wide range between the calculated maximum and minimum number of ducklings fledged for this study suggest strong observability bias. The reported maximum

Table 3.3. Number of indicated mallard breeding pair observed during breeding pair surveys and predicted by the mallard model by treatment and control sites, 1995.

	Mallard breeding pair population					
	Treatment			Control		
Site	Observed	Predicted	Wetland surface water (ha)	Observed	Predicted	Wetland surface water (ha)
Foster 1	50	81	151.3	57	76	203.8
Lonetree 1	63	53	74.7	60	47	221.5
Lonetree 2	92	73	117.2	58	40	114.2
Nelson 1	148	160	182.4	229	170	491.9
Nelson 2	168	157	190.0	194	156	257.3
Ramsey 1	100	222	320.6	104	164	317.7
Ramsey 2	79	111	369.4	73	64	251.9
Sheridan 1	47	90	190.8	93	148	196.8
Stutsman 1	79	87	184.9	74	91	192.0
Stutsman 2	74	110	129.3	47	101	127.2
Stutsman 3	101	80	186.7	128	68	167.7
Wells 1	77	82	155.3	57	107	186.3
Totals	1078	1306	2252.6	1174	1232	2728.3

number of ducklings fledged is high because all predated ducklings were not found [i.e., carcasses of some ducklings were probably cached by fox (*Vulpes vulpes*) and others carried from the area by raptors]. Similarly, the minimum numbers reported for some sites are too low because over the first 5 years post-release band recoveries on these sites were higher than the minimum estimated fledged number (Table 3.1) (ex: on Stutsman 3 the minimum number estimated to have fledged was 6 and 17 bands were recovered from mallards released on the site).

Several factors affected survival estimates. First, the observability of returning marked females and broods on release and adjacent study site ponds was affected by emergent vegetation cover. The percent emergent vegetation on release and adjacent wetlands was highly variable. In addition, late season heavy rains during the release period increased the size and depth of some release wetlands. This may have resulted in increased duckling mobility between wetland basins on the study sites, further compounding observability bias.

The first-year post-release recovery rates observed in this study (9.8-21.3%) differed from those reported by others. Gatti (1981) reported 33% for gentle and 4% for hard-releases, Yerkes and Bluhm (1998) reported 5.1-7.8%, Bailey (1979) reported 26-28%, Sellers (1973) reported 25%, and Lee and Kruse (1973) reported 29%. However, second-year recovery rates for females in the present study (0.9-2%) were lower than those reported by Gatti (1981) for gentle-releases (14%) and Yerkes and Bluhm (1998) (5.5-8.2%), but similar to returns from hard-releases reported by Gatti (1981) of 2%. These differences may be explained by methodologies used to determine returning rates of wild-strain mallard females. Ducklings released in previous studies were marked for individual identification (Sellers 1973, Lee and Kruse 1973, Bailey 1979, Gatti 1981, Yerkes and Bluhm 1998), whereas the birds used in this study were marked to be identified only to specific release study sites. Thus, numbers reported in the previous studies were cumulative totals of all wild-strain females observed rather than based on single highest counts.

Post-release surveys in the previous studies, because of the use of fewer replications, were more intense (i.e., involved more direct hours of observation) than in the present study. The most intense surveys were conducted during the Lee and Kruse (1973) study where food was provided at the original release pen and ducklings were observed from a nearby blind throughout the spring and summer. These efforts were supplemented by trapping conducted in October to identify marked females that had lost their nasal markers. Methodology employed by Gatti (1981), [i.e., weekly ground searches (April-June), nest searching, and bait trapping] was more representative of that used by other researchers. The use of individually marked mallards and the more intense surveys would be expected to result in the more complete count of the wild-strain females visiting a site and higher return rates.

Bailey (1979) reported a discrepancy between the number of returning yearling wild-strain females returning to the release site and the number estimated during standard breeding pair surveys. Bailey's (1979) birds were individually marked and cumulative numbers were greater than the number counted on any individual breeding pair survey. Adjustment of return numbers upward in accordance with the findings of the Bailey

(1979) study would result in return estimates for homing yearling wild-strain mallards similar to those reported by Lee and Kruse (1973) and Gatti (1981).

Sellers (1973) reported more of the ducklings released late in the summer were on the release site at the beginning of hunting season, but these ducklings returned the following spring at a significantly lower rate than did earlier released ducklings. I did not survey sites after fledge in 1993. My findings differed from Sellers' (1973) and indicated a tendency of later released ducklings to return to the site the following spring at a higher rate than early released ducklings; however, my releases ended earlier than did Sellers' (1973).

In 1993, expenses incurred by employing the modified gentle-release method added $3.00 to the cost of releasing each wild-strain duckling; $1.50 was attributed to travel to and from sites to monitor feed levels and conduct searches for released ducklings. When added to the $15.00 cost of rearing the ducklings to 4.5-weeks of age (G. Reed, Dakota Wildlife Trust, personal communication), the cost of the releases totaled $18.00 per released duckling. Gatti (1981) estimated using the gentle-release method would double the cost. After adjusting for inflation (from 1973 to 1993) and adding the expenses for labor and capital, the cost per released duckling in this study was still $9.00 less per duckling than the cost reported by Lee and Kruse (1973).

Unlike Sellers' (1973) study, field crews conducting roadside surveys did not detect substantial dispersal of marked females to the areas around the release sites. Sellers (1973) reported that 97 wild-strain mallard females returned to an area surrounding the 10.4-km^2 release site. Returning mallard densities decreased as the distance from the release site increased. Sellers (1973) released >600 birds on the same study site, annually. These large releases may have contributed substantially to the number of marked females observed off site. However, Yerkes and Bluhm (1998), employing a similar design in the same study area as Sellers (1973), reported only 3 marked females were observed >2 km from the release site. Additional evidence of female dispersal are the 2 marked female mallards observed on sites other than their release sites and band recoveries from states and provinces within the Central and Mississippi Flyways.

The low return rates of marked wild-strain mallard males I observed in this study are consistent with other studies (Lee and Kruse 1973, Gatti 1981). Because mallards pair on the wintering grounds, and males follow females to their natal area, males were not expected to home to release sites (Sowles 1955). Biologists had expressed concerns about the release of wild-strain mallard males (Lee personal communication) hypothesizing they would be less fit than their wild cohort, unable to attract a mate, and return to their site of release unpaired elevating indicated pair estimates.

Returning wild-strain females in previous studies had access to and used artificial nesting structures (Lee and Kruse 1973, Yerkes and Bluhm 1998). The returning females in the Yerkes and Bluhm (1998) study demonstrated a preference for the nesting structures with all observed nests of wild-strain females in artificial nesting structures.

The 2 nests of marked females indicated nesting activity by wild-strain females. One nest was located in dense nesting cover, and the other in a fence row with sparse cover. The wild-strain mallard broods observed provided additional evidence that these females are capable of successfully reproducing on upland sites. These broods contained fewer ducklings than the 36 wild mallard broods observed during surveys (7.3 $\pm$ 4.2). All the marked females with broods were observed on their original release site indicating a strong homing instinct and site fidelity.

Although some released wild-strain females did demonstrate an ability to home to natal areas and successfully reproduce, the overall releases did not increase local breeding populations on treatment sites above those observed on control sites. These results indicate mallard populations observed on the study sites, post-release, based on mallard model predictions may have been at carrying capacity.

MANAGEMENT IMPLICATIONS

My results do not support the use of wild-strain mallard releases to increase local breeding populations. Mallard populations in my study area demonstrated high elasticity in their ability to respond to favorable habitat conditions. Thus, my study supports spending available funds on habitat improvement, creating conditions mallards can exploit when precipitation is adequate to provide suitable pond conditions for reproduction to boost populations, rather than for mallard propagation. Also, habitat management will benefit other waterfowl and wildlife species. In addition, at the water condition present throughout my study, the mallard model appeared to accurately predict spring mallard breeding pair densities for all sites.

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CHAPTER 4

BEHAVIORAL ASPECTS OF WILD-STRAIN MALLARDS RELEASED INTO THE PRAIRIE POTHOLE REGION OF NORTH DAKOTA

Abstract: In 1994, I monitored the responses of wild and wild-strain (F_1) mallard females to approaching humans and their habitat use patterns during the breeding season to determine if wild-strain mallards exhibited behaviors which might increase their susceptibility to harvest or predation. I hypothesized that wild-strain mallard females, because of their close association with humans during imprinting periods, would be less wary of humans, and therefore experience higher mortality rates than wild birds. In addition, I analyzed 5 years of band recovery data for male and female wild and wild-strain mallards banded in 1993 to determine if any temporal or spatial differences existed in survival indices. No differences were observed for wild and wild-strain mallard females in reaction distances to human approach ($H_1 = 0.14$, $P = 0.71$) or flight initiation ($H_1 = 1.11$, $P = 0.29$). However, once flight was initiated, wild mallard females flew farther to escape ($H_1 = 14.11$, $P = 0.0002$). Wild-strain mallard females preferred larger, more permanent wetlands ($H_3 = 53.78$, $P < 0.0001$) with less emergent vegetation ($H_3 = 18.72$, $P = 0.0003$) than wild mallard females. Bands from 172 wild-strain modified gentle-release, 173 hard-release wild-strain, and 307 wild mallards were recovered between 1993-98. Regional band recoveries for hard-released wild-strain differed from modified gentle-release wild-strain ($x^2_5 = 23.70$, $P < 0.001$) and wild mallards ($x^2_5 = 15.37$, $P = 0.009$). A higher percentage of the band recoveries from hard-released wild-strain mallards came

from North Dakota. Concomitantly, a greater percentage of the gentle-released wild-strain and wild mallard bands that were recovered came from the winter range. The slope of regression lines representing cumulative band recoveries for all males studied (F_2 = 0.57, P = 0.58) was not different. However, the slope for cumulative band recovery did differ for females (F_2 = 5.26, P = 0.03) with hard-released female mortality greater than wild (t = 3.14, P = 0.01) and modified gentle-released wild-strain females (t = 2.28, P = 0.05). In addition, wild-strain females were lost from the population at faster rates than their wild counterparts. These results suggest that wild-strain mallard females may have been more susceptible to hunting and other forms of mortality as a consequence of their close association to humans during imprinting periods. This may indicate an increased risk to predation on the breeding grounds.

Although release of wild-strain mallard ducklings (i.e., F_1 from a captive wild mallard breeding flock) has been evaluated as a means of supplementing wild mallard populations (Brakhage 1953, Foley et al. 1961, Zohrer 1969, Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998), the results have been mixed. Wild-strain ducklings experience higher survival rates than game farm mallards (captive mallards >2 generations removed from wild birds). In addition, game farm mallards have lost the ability to migrate (Kozicky 1987). Wild-strain mallards do migrate and return to areas near their release sites (Brakhage 1953, Foley et al. 1961, Zohrer 1969, Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998) to nest and produce broods

(Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998). Lee and Kruse (1973) and Sellers (1973) reported significant post-release increases in local breeding pair numbers. However, numbers declined drastically in subsequent years. Thus, these previous wild-strain releases have not resulted in an increased recruitment in the areas surrounding release sites. Unfavorable habitat conditions in the release areas have been reported as the reason why these populations have been unable to sustain themselves (Lee and Kruse 1973, Sellers 1973, Bailey 1979, Yerkes and Bluhm 1998).

The poor success reported for using wild-strain mallard releases to boost local breeding populations and enhance recruitment may be linked to behavioral differences between female wild-strain mallard and their wild counterparts. Bailey (1979) reported lower reproduction in yearling wild-strain mallards than their wild counterparts, thus providing some evidence of behavioral differences. Although wild-strain and wild ducklings differ greatly in early life experiences (i.e., human contact vs wild female contact during imprinting), the effect of these differences on survival has not been examined.

In general, animals reared in captivity respond differently to human stimuli than wild animals. Increased exposure to humans or human activity during developmental periods may reduce animal wariness in future encounters with humans and other potential predators. Lorenz (1952) demonstrated that geese and other birds raised in captivity would imprint on their human care giver. Thus, any difference observed in long-term survival, hence recruitment, between wild and wild-strain mallard cohorts could be an artifact of the wild-strain ducklings exposure to humans and lack of an adult female role model in early development. I hypothesized that female wild-strain mallards, because of their close association with humans, would experience higher annual mortality than wild birds. Their association with humans during imprinting could make them less wary, increasing their risk to hunting and/or predation.

To determine if there were any differences in behavior of wild and wild-strain female mallards on the breeding grounds which could offset survival rates, I evaluated female responses to an approaching human. In addition, to determine if differences in this response might make them more susceptible to hunting, I compared band recoveries for released wild-strain mallards to a cohort of wild birds banded the same year. I also compared band recoveries of wild-strain mallards released under modified gentle-release techniques to birds that were hard-released to determine if method of release also may have affected their susceptibility to hunting. Lastly, I compared breeding habitat use patterns to determine if wild-strain mallards differed from their wild counterparts.

STUDY AREA

The wild-strain mallard ducklings used during this study were released in 1993, on 21 study sites located in the Prairie Pothole Region of east-central North Dakota (Stewart and Kantrud 1973) (Figure 4.1). Using the modified gentle-release method, wild-strain mallards (2,344) were banded and released on 12 paired, 10.4-km^2, sites located in the Missouri Coteau and Drift Prairie. The behavioral observations were conducted on the 6 northernmost sites. During this same year, wild-strain mallards were released (2,063) using the hard-release technique described by Lee and Kruse (1973) and Gatti (1981) on 9 additional sites in the Drift Prairie and Agassiz Lake Plain portions of the Prairie Pothole

Region of east-central North Dakota (Stewart and Kantrud 1973) (Figure 4.1). The study sites were selected based on number of wetland complexes, wetland densities, and upland habitat. Selected sites, in addition to containing a core area consisting of contiguous cover, exhibited wetland complexes containing high numbers of ponds to attract breeding waterfowl. The wetland habitat utilization study was conducted only on sites where modified gentle-releases were made. The sites did not undergo additional management from the time the ducklings were released until the research concluded.

During the summer of 1993, 2,198 wild young-of-year mallard cohorts were banded at J. Clark Salyer National Wildlife Refuge. This refuge is also located in the Drift Prairie portion of the Prairie Pothole Region of north-central North Dakota (Figure 4.1).

METHODS

Female Mallard Behavioral Experiments

Between June and August of 1993, 2,344 (1,144 male and 1,200 female), 4.5-week-old wild-strain mallard ducklings were released on wetlands located in the center of the 12 randomly selected sites. Approximately equal numbers of males and females were released on each site (200 per site, 100 male, 100 female). Released ducklings were the F_1 offspring from a wild captive breeding flock maintained by the Dakota Wildlife Trust, Inc., Valley City, North Dakota. Prior to their release, at 4 weeks of age, the ducklings were sexed by cloacal examination (Hochbaum 1942), and fitted with U.S. Fish and Wildlife Service (USFWS) leg bands and nylon nasal markers color coded to the specific release

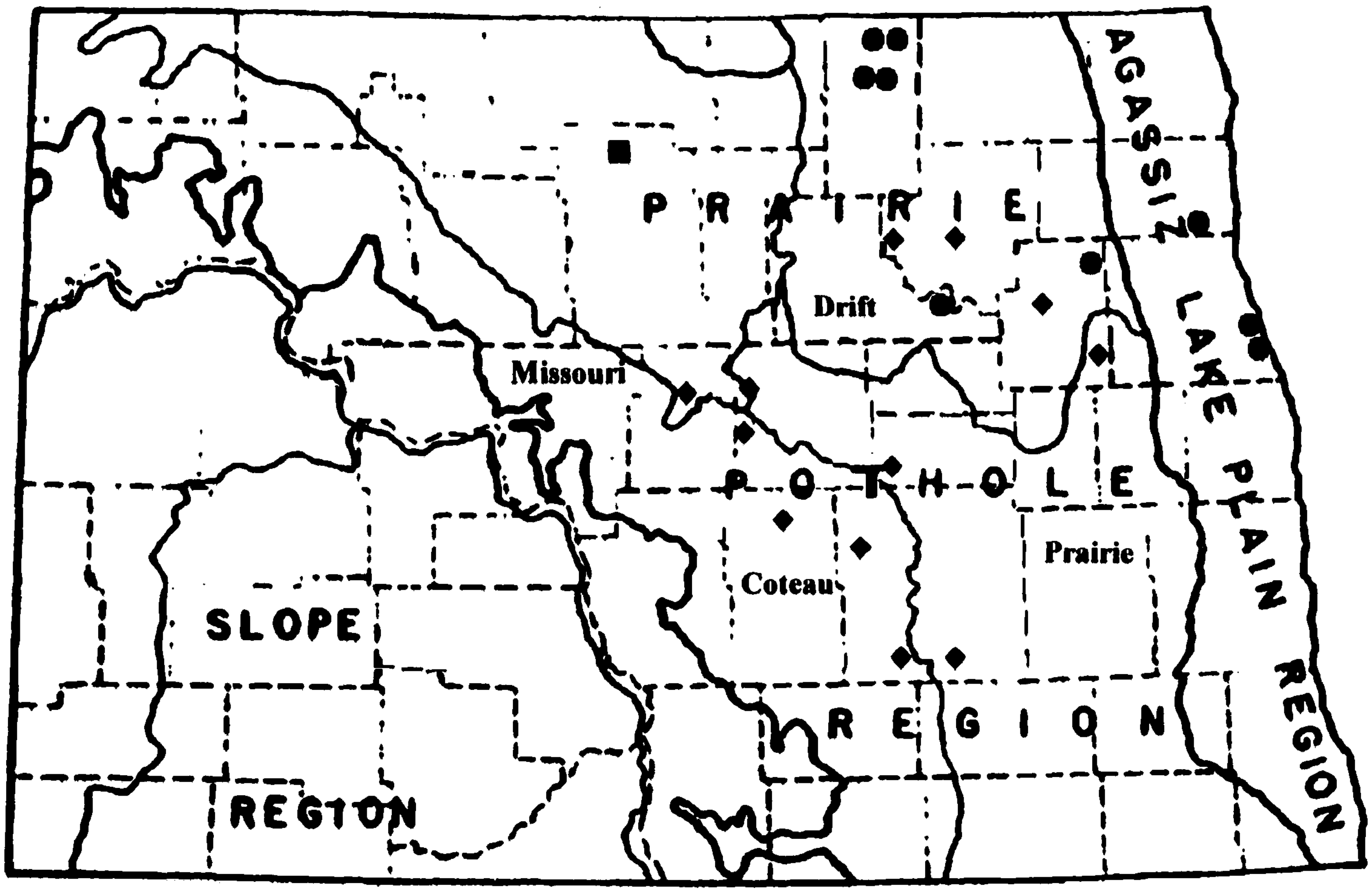

Figure 4.1. Physiographic map of North Dakota (modified from Stewart and Kantrud 1974) showing the location of 12, 10.4-km^2, modified gentle-release (treatment) sites and 9 hard-release sites in the Prairie Pothole Region. ◆ = modified gentle-release sites, ● = hard-release sites, ■ = J. Clark Salyer National Wildlife Refuge.

site (Lee 1958, Lokemoen and Sharp 1985). The ducklings were released at 4.5 weeks of age using a modified gentle-release method into release pens approximately 225 m^2 in size built on suitable wetlands.

In 1994, in conjunction with breeding pair surveys (Dzubin 1969, Hammond 1969), I documented the response of wild-strain and wild mallards to an approaching human. Based on previous personal observations of mallard breeding pairs, I identified three basic reaction behaviors: (1) alertness, (2) flight initiation, and (3) flight termination. Alertness was defined as an abrupt change from loafing or feeding behavior to an alarm posture. I measured the reaction distance of wild-strain and wild mallards to my approach for each of these behaviors. Alert reaction and flight initiation distances were estimated using 7 categories: (1) $\leq$ 25 m, (2) 26-50 m, (3) 51-75 m, (4) 76-100 m, (5) 101-150 m, (6) 150-200 m, (7) > 200 m. Distances from flight initiation to termination (i.e., flight termination distance) were estimated using 7 categories: (1) $\leq$ 25 m, (2) 26-50 m, (3) 51-100 m, (4) 101-200 m, (5) 201-300 m, (6) 301-400 m, (7) > 400 m. Only data from days when both wild and wild-strain females were concurrently observed were used. A Kruskal-Wallis Test (Zar 1984) was used to test for differences in response to approaching humans and behavioral and wetland use for wild and wild-strain mallard females ($P < 0.05$).

Band Recovery Data Analysis

An additional 2,063 (933 male and 1,130 female) wild-strain mallard ducklings were released on 9 other sites using the hard-release method between July 17 and August

30, 1993. All were sexed by cloacal examination (Hochbaum 1942) and fitted with USFWS leg bands and green nylon nasal markers at 4 weeks of age, then released directly to wetlands at 4.5 weeks of age.

Band recovery data collected between 1993-98 from wild-strain mallard ducklings released by both methods were compared to a cohort of 2,198 (1,199 males and 999 females) young-of-year wild mallard ducklings banded in early September 1993 by personnel at J. Clark Salyer National Wildlife Refuge. Band recoveries were compared by time period, recovery site, and percent of banded population represented to determine if any difference existed in population harvest rates, hence susceptibility to harvest. Chi-square analysis was used to test for differences in regional band recoveries for wild, modified gentle-release, and hard-released wild-strain mallards with differences evaluated at the $\alpha = 0.05$. Regions consisted of Canada, Great Plains, Southeast, Northeast, and West. In addition, North Dakota was analyzed as a separate region to better assess site fidelity. Regions West and Canada were combined for analysis purposes because of the small of number of returns in the areas.

Cumulative percent band recoveries were compared by linearly regressing band recovery (Y) on age class (X) for the three duck types. The relationship between cumulative percent band recovery (following a log-arcsine-square root transformation) and age class (following a log transformation) appeared suitably linear and analysis of covariance (Zar 1984) tests were performed. Data from females and males were analyzed separately. Differences were evaluated at $\alpha = 0.05$. Simple linear regression was used to evaluate the relationship between time of release and return from within 64 km of the release site.

Mallard Female Habitat Use Patterns

I compared female wetland use during the breeding season for wild-strain female mallards released using modified gentle techniques to wild birds. In 1994, in conjunction with breeding pair surveys, I recorded the type and percent emergent cover of the wetlands on which wild and wild-strain female mallards were observed. I conducted chi-square analyses to determine if habitat use patterns differed for wild and wild-strain mallard females ($P < 0.05$).

RESULTS

Band Recovery Data

Between 1993-98, 652 band recoveries were received (Table A.1). These recoveries consisted of 307 (205 males and 102 females) wild, 172 (128 males, 44 females) modified gentle-release, and 173 (94 males, 79 females) hard-release wild-strain mallards (Table 4.1). For the banded populations, this represents 7.3% (11.2% of males, 3.6% of females) of the modified gentle-releases, 8.3% (10.1% of males, 7.0% of females) of the hard-releases, and 14.0% (17.1% of males, 10.2% of females) of the wild mallards. Annual band recoveries for modified gentle-released wild-strain mallards as a percentage of the total recoveries were 43.0% (52.3% of females, 39.8% of males), 17.4% (13.6% of females, 22.7% of males), 20.9% (27.3% of females, 22.7% of males), 11.6% (6.8% of females, 13.6% of males), and 7.0% (0% of females, 9.4% of males) for 1993-98, respectively (Table 4.1). Annual band recoveries for hard-released wild-strain mallards as a percentage of the total recoveries were 51.4% (69.6% of females, 36.2% of males), 20.2% (15.2% of females, 24.5% of males), 19.1% (13.9% of females, 23.4% of males), 4.6% (0% of females, 8.5% of males), and 4.6% (1.3% of females, 7.4% of males) for 1993-98, respectively. Annual band recoveries for wild mallards as a percentage of the total recoveries were 35.5% (36.3% of females, 35.1% of males), 23.5% (25.4% of females, 22.4% of males), 17.9% (14.7% of females, 19.5% of males), 16.4% (13.7% of females, 18.0% of males), and 6.5% (9.8% of females, 4.9% of males) for 1993-98, respectively.

Slopes for cumulative band recovery percentages (depicting rates of return over time) for wild, wild-strain modified gentle-, and wild-strain hard-release mallard males did not differ during the 5-year recovery period ($F_2 = 0.57$, $P = 0.58$). However, slopes for cumulative band recovery percentages for wild, wild-strain modified gentle-release, and wild-strain hard-release mallard females did differ ($F_2 = 5.26$, $P = 0.03$). Mortality rates for wild-strain females released under hard-release techniques were higher than wild ($t = -3.14$, $P = 0.01$) and females released under the modified gentle-release techniques ($t = -2.28$, $P = 0.05$). However, mortality rates for wild-strain females released under the modified gentle technique were no different than those for wild birds ($t = 0.86$, $P = 0.41$). Higher percentages of the total bands recovered from wild-strain females were reported during the first-year post-release than for wild mallard females and all mallard males. In effect wild-strain mallard females appeared to have been lost from the population at rates faster than their wild counterparts.

Band recoveries for modified gentle-release wild-strain and wild mallards did not differ by regions ($x^2_4 = 7.42$, $P = 0.12$, $1\text{-}\beta = 0.82$). However, a higher proportion of bands from hard-release wild-strain mallards was reported from North Dakota and the Northeast region and a smaller proportion from the Southeast region than wild ($x^2_4 = 22.45$, $P < 0.001$) and modified gentle-release wild-strain ($x^2_4 = 13.93$, $P = 0.008$) mallards (Table 4.2).

Band recoveries from within 64 km of the release site were received for 20 modified gentle- (13 male, 7 female), 35 hard-release (18 male, 17 female), and 21 wild mallards (12 male, 9 female). Of these, 75% of the recoveries for modified gentle (11 male and 4 female) and 90% of hard-release (15 male, 17 female) wild-strain, and all bands of wild mallards were recovered the same year they were banded. The recoveries for wild-strain mallards within 64 km of the release site were positively correlated to week of release ($r^2 = 0.65$, $F = 12.9$, $P = 0.009$). Seven modified gentle-, 6 hard-release wild-strain, and 38 wild mallards (6 at locations away from J. Clark Salyer) were recaptured and released during subsequent banding efforts. Band recovery information was received from 24 states and 4 Canadian provinces from 1993-98 (Table A.2 and A.3).

Female Mallard Behavioral Experiment

Alertness reaction for modified gentle-released wild-strain ($\bar{x} = 81.3 \pm 21.9$) and wild ($\bar{x} = 131.2 \pm 18.7$) female mallards did not differ ($H_1 = 0.14$, $P = 0.71$). In addition, flight initiation distance for modified gentle-released wild-strain ($\bar{x} = 52.8 \pm 13.5$) and wild ($\bar{x} = 70.5 \pm 10.5$) female mallards did not differ ($H_1 = 1.11$, $P = 0.29$). However, wild

Table 4.1. Percent of the total band recoveries by year for modified gentle- and hard-release wild-strain and wild mallards banded in 1993.

	Wild-strain mallards								Wild mallards			
	Modified gentle-release				Hard-release							
Year	Males	% of total	Females	% of total	Males	% of total	Females	% of total	Males	% of total	Females	% of total
93-94	51	39.8	23	52.3	34	36.2	55	69.6	72	35.12	37	36.3
94-95	24	18.8	6	13.6	23	24.5	12	15.2	46	22.44	26	25.5
95-96	24	18.8	12	27.3	22	23.4	11	13.9	40	19.51	15	14.7
96-97	17	13.3	3	6.8	8	8.5	0	0.0	37	18.05	14	13.7
97-98	12	9.4	0	0.0	7	7.4	1	1.3	10	4.88	10	9.8
Total	128	100.0	44	100.0	94	100.0	79	100.0	205	100.00	102	100.0

Table 4.2. Location and percentage of total[1] band recoveries by region for wild-strain and wild mallards recovered between 1993 and 1998.

	North Dakota				Canada[2]				Great Plains[3]				Southeast[4]				Northeast[5]				West[6]				
	Bands Recovered				Bands Recovered				Bands Recovered				Bands Recovered				Bands Recovered				Bands Recovered				
Category	M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%	M	F	T	%	Total
Wild-strain modified gentle-release	17	11	28	16.5%	3	0	3	1.8%	12	4	16	9.4%	80	26	106	62.4%	11	4	15	8.8%	2	0	2	1.2%	170
Wild-strain hard-release	23	27	50	28.9%	6	1	7	4.0%	5	2	7	4.0%	43	32	75	43.4%	16	17	33	19.1%	1	0	1	0.6%	173
Wild mallards	34	38	72	23.5%	5	2	7	2.3%	23	13	36	11.7%	115	37	152	49.5%	24	12	36	11.7%	4	0	4	1.3%	307
Totals			150	23.1%			17	2.6%			59	9.1%			333	51.2%			84	12.9%			7	1.1%	650

[1]2 bands from wild-strain modified gentle-release were recovered from unknown locations
[2]Canada = Alberta, Manitoba, Ontario, Saskatchewan
[3]Great Plains = Texas, Oklahoma, Kansas, Nebraska, South Dakota
[4]Southeast = Arkansas, Mississippi, Louisiana, Tennessee, South Carolina, Kentucky, Missouri, Alabama
[5]Northeast = Ohio, Michigan, Wisconsin, Minnesota, Iowa, Illinois
[6]West = Idaho, Montana, Washington, Oregon

female mallards did engage in longer escape flights and flew greater distances from the source of disturbance than did female wild-strain mallards ($H_1 = 14.11$, $P = 0.0002$).

During the breeding season wild-strain mallard females used larger, more permanent wetlands ($x^2_3 = 53.78$, $P < 0.0001$, Table 4.3) exhibiting more open water ($x^2_3 = 18.72$, $P = 0.0003$, Table 4.4) than did wild females.

DISCUSSION

Although cumulative band recoveries for males did not differ over the 5-year period, they did differ by band recovery location. In addition, ducklings that were released later in the season were more likely to be harvested near the release site. In particular, a higher proportion of band recoveries for hard-release wild-strain males and females released later in the season were returned near the release sites in the first year. These findings are similar to those reported by Sellers (1973).

The cumulative band recoveries for wild females and all males through the 5-year band recovery period was similar, although the number of bands recovered declined over time as the population decreased. However, band recovery data indicated that most wild-strain females did not survive beyond the third year post-release. I believe that the more rapid disappearance of wild-strain mallard females from the population cannot be solely attributed to hunting. The number of bands recovered for wild-strain females represented a smaller proportion of the banded population than represented by recoveries for wild females (3.7% for modified gentle-releases, 7.0% for hard-releases, 10.2% for wild). The differences in these band recovery data suggest the wild-strain females also may have been

Table 4.3. Comparison of wetland habitat during the breeding season by wild and wild-strain female mallards by pond type, 1994.

	Wild females			Wild-strain females			
Pond type classification[1]	Actual	x^2 Expected	x^2 Values	Actual	x^2 Expected	x^2 Values	Total actual
2	235	227.31	0.260	8	15.69	3.767	243
3	421	409.72	0.310	17	28.28	4.496	438
4	71	80.45	1.110	15	5.55	16.079	86
5	41	50.51	1.792	13	3.49	25.966	54
Totals	768		3.472	53		50.308	821

[1]Pond type classifications: 2 = temporary, 3 = seasonal, 4 = semi-permanent, 5 = permanent. (Stewart and Kantrud 1971)
Note: $x^2_3 = 53.78$, $P = < 0.0001$

Table 4.4. Comparison of wetland habitat during the breeding season by wild and wild-strain female mallards by pond cover type, 1994.

	Wild females			Wild-strain females			
Pond cover type[1]	Actual	x^2 Expected	x^2 Values	Actual	x^2 Expected	x^2 Values	Total actual
1	245	257.25	0.583	30	17.75	8.449	275
2	155	146.86	0.451	2	10.14	6.530	157
3	148	149.67	0.019	12	10.33	0.270	160
4	220	214.22	0.156	9	14.78	2.262	229
Totals	768		1.209	53		17.511	821

[1]Pond cover types: 1 = 0-25% cover, 2 = 26-50% cover, 3 = 51-75% cover, 4 = 76-100% cover.
Note: $x^2_3 = 18.72$, $P = 0.0003$

more vulnerable to predation through the nesting period. Because of the lack of a wild female role model, the wild-strain females did not learn an appropriate escape response to avoid hunters and possibly predators. The low overall survivability of wild-strain females, because of increased risk to hunting and predation, could explain the rapid and significant reductions in released populations observed during the second year on the study areas. Similar observations have been reported by Lee and Kruse (1973), Sellers (1973), Bailey (1979), and Yerkes and Bluhm (1998).

Band recoveries for wild-strain mallards consistently represented smaller proportions of those than were recovered from the wild population. Lee and Kruse (1973) and Yerkes and Bluhm (1998) suspected higher recoveries for mallards wearing nasal markers than for other mallards because of their novelty. Assuming equal vulnerability to hunting and reporting of bands to those of the wild mallards banded at J. Clark Salyer, the band recoveries for wild-strain modified gentle and hard-released mallards represented estimated populations of 1,235 (919 males, 316 females) and 1,236 (672 males, 564 females), respectively, at the beginning of hunting season. The 1,235 figure is substantially below the maximum number of 1,982 for modified gentle-release mallards estimated to be alive at the beginning of hunting season, but substantially above the minimum estimate of 913 (Anderson 1975). Total band recoveries for all wild-strain males (10.7%) were higher than those reported by Anderson (1975) (7.6%). Band recoveries for hard-release females (6.9%) were similar to those reported for wild birds by Anderson (1975) (6.8%). However, band recoveries for modified gentle-release females (3.7%) were approximately 50% lower. These low band recoveries observed for modified gentle-release females (3.7%) in this study were, however, similar to those reported by Gatti (1981) (3% for hard-release females, 5% for gentle-release females) and Yerkes and Bluhm (1998) (1.7% for females, 1.6% for males). However, Lee and Kruse (1973) and Sellers (1973) reported first-year band recoveries of 11.3% and 9.7%, respectively, for wild-strain mallard females during a period of liberal bag limits. The lower bag and possession limit and shorter seasons in place during my study as compared to the time period of the Lee and Kruse (1973) and Sellers (1973) studies (Sharp and Moser 1999) could explain a portion of the differences in band recoveries.

Wild and wild-strain mallard females reacted similarly to human approach; however, once flight was initiated the wild females flew farther before settling. Possibly the difference in environment conditions during the first 4.5 weeks of life can explain this difference. Wild-strain ducklings did not experience natural settings until released. Prior to release they were exposed to daily human contact while confined at the rearing facility in the absence of adult mallards. The wild mallards had little direct contact with humans until they were banded. As Lorenz (1952) demonstrated, early environments result in learned behavior, which can have a significant effect on adult behavior.

Returning wild-strain females were observed using semi-permanent and permanent wetlands with more open water than wild birds. Returning marked females tended to use the wetlands on which they were released and similar wetlands, with minimal amounts of emergent vegetation, instead of the temporary and seasonal wetlands with hemi-marsh characteristics preferred by wild, dabbling ducks (Kaminski and Prince 1981). This could be a result of imprinting on release sites or a consequence of arriving later on the breeding grounds as reported by Bailey (1979). Late arrivals could be forced into poorer unclaimed habitat. Lokemoen et al. (1990) found this true for returning wild yearling females, although Sellers (1973) did not find late arrival to hold true for wild-strain females yearlings.

MANAGEMENT IMPLICATIONS

Genetically wild-strain mallards are similar to wild mallards. Thus, any behavioral differences observed are most likely due to differences in early life experiences. If wild-strain releases are to be continued, efforts must be made to minimize these differences. Human contact should be minimized by utilizing automated feeding and watering systems. Ducklings also should spend some or all of their pre-release lives in an outdoor hardening pen with wary adult female role models. Ideally these would be wild, wing-clipped females that could then be released with the ducklings into the wild.

Based on this study, the use of mallard releases appears to be best used when the goal is to increase local harvest. Such releases should be made in large numbers, late in the season and include large numbers of males. These releases also may result in some contribution to the local breeding population by easing hunting pressure on wild birds.

However, in areas where American black ducks (*Anas rubripes*) breed, releases for the purpose of increasing local hunting opportunities should not include wild-strain mallard ducklings as they are more likely to survive to breed in the area than game farm ducks. Individual mallards homing to the area could hybridize with black ducks, thus further diluting the black duck gene pool and accelerating the decline in American black duck numbers (Ankney et al. 1987, McAuley et al. 1998).

Wild-strain releases could possibly be useful with ducks species that do not pioneer readily and have high homing rates such as canvasbacks (*Aythya valisineria*) (Bellrose 1980). If good habitat is identified, restored or created in areas where canvasbacks are absent, wild-strain releases could prove effective in creating local breeding populations. However, in this study the release of wild-strain mallards to increase local breeding populations did not work. This reinforces the need to maintain aggressive wetland and upland habitat management programs in their primary breeding areas.

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CHAPTER 5

CONCLUSION

I evaluated temporal and spatial effects of a single-season release of wild-strain mallard ducklings on local mallard breeding populations in the Prairie Pothole Region of North Dakota. Releases were conducted using techniques similar to those that would be used by a wildlife manager. In the summer of 1993, I released 2,344 wild-strain mallard ducklings fitted with nasal saddles and USFWS leg bands on 12 randomly selected, 10.4-km^2 sites (approximately 100 female and 100 male per site). I evaluated duckling survival to fledging relative to wetland size, percent emergent vegetation cover, wetland type, timing of release, and amount of supplemental feed eaten at release sites. I compared my observed survival rates and cost of releases to those reported by Lee and Kruse (1973) and Gatti (1981) to determine relative cost efficiencies.

The modified gentle releases used in this study were more cost effective than gentle releases although they resulted in lower fledging rates. Wild-strain duckling survival to fledging was higher on more permanent wetlands (type 4 and 5) that also exhibited less emergent cover. My findings suggest that to obtain maximum fledging survival, releases of wild-strain ducklings should be restricted to semi-permanent and permanent wetlands with <25% emergent cover instead of the hemi-marsh preferred by wild dabbling ducks (Kaminski and Prince 1981). This observation could be related to their early experiences in the absence of a wild female role model.

During 1994 and 1995, I conducted breeding pair surveys to monitor local mallard breeding populations on treatment and paired control sites (Hammond 1969, Dzubin 1969). During these surveys, I also recorded the number of nasal-saddled wild-strain mallards that were observed. In 1995, I compared observed mallard breeding pair populations on treatment and control sites to estimates predicted by the pond-pair regression model (Cowardin et al. 1983, 1995).

In 1994, 55 wild-strain mallard females were observed during breeding pair surveys. Only 5 females were observed on the study sites in 1995. Only 1 marked wild-strain mallard male was observed during a breeding pair survey in 1994. For 1994 the number of wild-strain female mallards observed was positively correlated to the size of wetland on which the ducklings were released and the week of release. No difference was found in the number of breeding mallard pairs observed on treatment and control sites or mallard model predictions. Wild-strain duckling releases did not increase local breeding populations above populations observed on control sites or contribute to enhancing recruitment on treatment sites. Post-release mallard population levels on treatment, control, and all sites combined were not different than levels predicted by the mallard model. These results suggest that wetland habitats in the Prairie Pothole Region of North Dakota during this study were at carrying capacity for mallard pair breeding populations. Thus, to increase continental mallard populations, the existing wetland habitat base must be enhanced or expanded. My results support the conclusions reached by Brakhage (1953), Bailey (1979), Batt and Nelson (1990), and Yerkes and Bluhm (1998) that wild-strain mallard releases are not a viable management technique for increasing local mallard breeding populations, and thus contribute little to continental restoration efforts.

I compared 5 years of band recovery data for 3 cohorts of mallard, each containing >2,000 birds, to determine if temporal or spatial differences existed in band recovery rates and hunting mortality. The 3 cohorts consisted of wild-strain ducklings released using modified gentle- and hard-release techniques and young-of-year wild birds banded at J. Clark Salyer National Wildlife Refuge. In addition, in 1994, I monitored the responses of wild and wild-strain mallard females on the breeding grounds to human approach and the habitat use patterns during the breeding season to determine if the birds exhibited behaviors that may have influenced their survivability.

Upon initial human approach, breeding female wild and wild-strain mallards reacted similarly. However, once flight was initiated, wild females flew farther to escape than did wild-strain females. Paired wild-strain females preferred larger, more permanent wetlands that exhibited <25% emergent cover. Paired wild mallard females preferred temporary and seasonal wetlands and were more evenly distributed across wetlands of all cover types. No difference was observed in the slope of regression lines representing cumulative band recoveries for wild-strain and wild mallard males. However, the slope for regression lines representing cumulative band recoveries for hard-released wild-strain females differed from that of modified gentle-released wild-strain and wild females. Band recoveries indicate wild-strain females were eliminated from the population before wild females and all males.

The escape behavior exhibited by wild-strain females was different from that of their wild counterparts. This observation, and the minimal number of band recoveries for wild-strain mallard females during years 4 and 5, suggests these birds experienced higher mortality. The higher mortality rate for wild-strain females could not be solely attributed to hunting because the number of bands recovered for wild-strain females represented a smaller proportion of the banded population than represented by recoveries for wild females. Because of the differences in escape behaviors exhibited by wild-strain females as compared to their wild counterparts, they may also have been more vulnerable to predation during the nesting period. Subsequently, most of the wild-strain mallard females may have been eliminated from the population prior to having the opportunity to contribute to recruitment.

This observation could have been a consequence of their close association to humans during imprinting periods. To address this situation, studies that evaluate the effects of minimizing human contact with ducklings on adult survival rates should be initiated. Included in this study should be evaluations of the effects of hardening in outdoor pens prior to release and association with a wild female role model. In addition, studies should include species such as canvasbacks (*Aythya valisineria*) that have stronger homing instincts (Bellrose 1980).

The release of wild-strain mallard ducklings using the modified gentle-release method did not result in population increases at the local level. This result was likely a consequence of the differences in adult breeding behavior which were an artifact of early experiences with humans in a confined rearing facility.

Hunters have suggested releasing wild-strain birds on registered hunting areas on the east coast. They argue that wild-strain mallards would provide an enhanced hunting opportunity and experience over game farm birds (Smith and Rohwer 2000). However, releases of wild-strain mallards should not be made in areas where the American black ducks (*Anas rubripes*) occur. Wild mallards and black ducks initially pair away from breeding grounds (Rohwer and Anderson 1988). Since wild-strain mallards migrate and exhibit all the breeding behaviors of wild birds, such releases would increase the likelihood or risk of hybridization. In areas where this may occur, releases should be restricted to game farm birds, which do not migrate. If mallards migrate, they would use the same wintering areas, thus possibly pair. Since game farm mallards do not migrate, the hybridization problem would be limited to forced copulations and repairing on the breeding areas (Ankney et al. 1987).

Outside areas where American black ducks occur, modified gentle releases of wild-strain mallards to large semi-permanent and permanent wetlands with <25% emergent vegetation late in the season could be used to increase or augment local hunting opportunities for mallards. In addition, these releases could reduce harvest of wild mallard females in heavily hunted areas. However, when the goal is increased breeding mallard populations, the limited funds for managing mallards should be used to improve wetland and associated upland habitats, thus benefitting a host of species including mallards.

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APPENDIX

Table A.1. A 5-year summary of band recovery data identifying cause of mortality to wild-strain mallards released using modified gentle- and hard-released wild-strain techniques and a cohort of young-of-year wild mallards banded in 1993.

	Modified gentle-release wild-strain				Hard-release wild-strain				Wild			
Year	Males	Females	Total	% of total annual recoveries	Males	Females	Total	% of total annual recoveries	Males	Females	Total	% of total annual recoveries
1993-94												
Mortality due to: Hunting	47	22	69	93.24%	34	54	88	98.88%	71	31	102	98.08%
Non-Hunting	4	1	5	6.76%	0	1	1	1.12%	1	1	2	1.92%
Total Mortality for 1993-94	51	23	74	100.00%	34	55	89	100.00%	72	32	104	100.00%
Recaptures	0	1	1		1	2	3		1	0	1	
1994-95												
Mortality due to: Hunting	24	6	30	100.00%	23	12	35	100.00%	45	25	70	97.22%
Non-Hunting	0	0	0	0.00%	0	0	0	0.00%	1	1	2	2.78%
Total Mortality for 1994-95	24	6	30	100.00%	23	12	35	100.00%	46	26	72	100.00%
Recaptures	1	0	1		1	2	3		5	9	14	

Table A.1. (continued)

Year	Modified gentle-release wild-strain				Hard-release wild-strain				Wild			
	Males	Females	Total	% of total annual recoveries	Males	Females	Total	% of total annual recoveries	Males	Females	Total	% of total annual recoveries
1995-96												
Mortality due to:												
Hunting	23	12	35	97.22%	22	11	33	100.00%	40	15	55	100.00%
Non-Hunting	1	0	1	2.78%	0	0	0	0.00%	0	0	0	0.00%
Total Mortality for 1995-96	24	12	36	100.00%	22	11	33	100.00%	40	15	55	100.00%
Recaptures	1	0	1		0	0	0		2	7	9	
1996-97												
Mortality due to:												
Hunting	17	3	20	100.00%	8	0	8	100.00%	37	13	50	98.04%
Non-Hunting	0	0	0	0.00%	0	0	0	0.00%	0	1	1	1.96%
Total Mortality for 1996-97	17	3	20	100.00%	8	0	8	100.00%	37	14	51	100.00%
Recaptures	0	0	0		0	0	0		2	6	8	

	Modified gentle-release wild-strain				Hard-release wild-strain				Wild			
Year	Males	Females	Total	% of total annual recoveries	Males	Females	Total	% of total annual recoveries	Males	Females	Total	% of total annual recoveries
Table A.1. (continued)												
1997-98												
Mortality due to:												
Hunting	12	0	12	100.00%	6	1	7	87.50%	10	10	20	100.00%
Non-Hunting	0	0	0	0.00%	1	0	1	12.50%	0	0	0	0.00%
Total Mortality for 1997-98	12	0	12	100.00%	7	1	8	100.00%	10	10	20	100.00%
Recaptures	1	0	1		0	0	0		1	3	4	
5-Year Totals:												
Mortality due to:												
Hunting	123	43	166	162.75%	93	78	171	164.42%	203	94	297	169.71%
Non-Hunting	5	1	6	5.88%	1	1	2	1.92%	2	3	5	2.86%
Total Mortality 1993-98	128	44	102	168.63%	94	79	104	166.35%	205	97	175	172.57%
Recaptures	3	1	4		2	4	6		11	25	36	

Table A.2. Total number of band recoveries by region and reporting states over five year period, 1993-1998.

	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
Recoveries by state	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
Alabama	1	0	1	0.58%	0	0	0	0.00%	0	0	0	0.00%	1	0.15%
Arkansas	45	18	63	36.63%	25	17	42	24.28%	56	22	78	25.41%	183	28.07%
Iowa	3	1	4	2.33%	4	0	4	2.31%	8	4	12	3.91%	20	3.07%
Idaho	0	0	0	0.00%	0	0	0	0.00%	1	0	1	0.33%	1	0.15%
Illinois	8	0	8	4.65%	8	7	15	8.67%	11	0	11	3.58%	34	5.21%
Kansas	4	0	4	2.33%	1	1	2	1.16%	6	1	7	2.28%	13	1.99%
Kentucky	1	0	1	0.58%	2	2	4	2.31%	3	0	3	0.98%	8	1.23%
Louisiana	8	4	12	6.98%	3	4	7	4.05%	13	7	20	6.51%	39	5.98%
Michigan	0	0	0	0.00%	1	0	1	0.58%	0	1	1	0.33%	2	0.31%
Minnesota	0	1	1	0.58%	2	10	12	6.94%	2	7	9	2.93%	22	3.37%
Missouri	18	1	19	11.05%	6	5	11	6.36%	10	3	13	4.23%	43	6.60%
Mississippi	4	2	6	3.49%	3	3	6	3.47%	23	4	27	8.79%	39	5.98%
Montana	1	0	1	0.58%	0	0	0	0.00%	3	0	3	0.98%	4	0.61%
North Dakota	17	11	28	16.28%	23	27	50	28.90%	34	38	72	23.45%	150	23.01%
Nebraska	1	0	1	0.58%	0	0	0	0.00%	2	3	5	1.63%	6	0.92%

	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
Recoveries by state	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
Table A.2. (continued)														
Oklahoma	4	1	5	2.91%	1	1	2	1.16%	4	1	5	1.63%	12	1.84%
Ohio	1	0	1	0.58%	0	0	0	0.00%	1	0	1	0.33%	2	0.31%
Oregon	0	0	0	0.00%	1	0	1	0.58%	0	0	0	0.00%	1	0.15%
South Carolina	0	0	0	0.00%	0	0	0	0.00%	1	0	1	0.33%	1	0.15%
South Dakota	0	0	0	0.00%	3	0	3	1.73%	9	3	12	3.91%	15	2.30%
Tennessee	3	1	4	2.33%	4	1	5	2.89%	9	1	10	3.26%	19	2.91%
Texas	3	3	6	3.49%	0	0	0	0.00%	2	5	7	2.28%	13	1.99%
Washington	1	0	1	0.58%	0	0	0	0.00%	0	0	0	0.00%	1	0.15%
Wisconsin	0	1	1	0.58%	1	0	1	0.58%	2	0	2	0.65%	4	0.61%
Alberta, Canada	0	0	0	0.00%	1	0	1	0.58%	0	0	0	0.00%	1	0.15%
Manitoba, Canada	2	0	2	1.16%	2	1	3	1.73%	3	2	5	1.63%	10	1.53%
Ontario, Canada	0	0	0	0.00%	1	0	1	0.58%	0	0	0	0.00%	1	0.15%
Saskatchewan, Canada	1	0	1	0.58%	2	0	2	1.16%	2	0	2	0.65%	5	0.77%
Unknown	2	0	2	1.16%	0	0	0	0.00%	0	0	0	0.00%	2	0.31%
Totals	128	44	172	100.00%	94	79	173	100.00%	205	102	307	100.00%	652	100.00%

Table A.3. Location and year of band recoveries by region and reporting states, 1993-1998.

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1993-94														
Alabama	1	0	1	1.35%	0	0	0	0.00%	0	0	0	0.00%	2.01	0.74%
Arkansas	16	9	25	33.78%	2	14	16	17.98%	25	12	37	33.95%	78	28.57%
Iowa	2	0	2	2.70%	2	0	2	2.25%	2	0	2	1.83%	6	2.20%
Idaho	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Illinois	3	0	3	4.05%	2	3	5	5.62%	6	0	6	5.50%	14	5.13%
Kansas	1	0	1	1.35%	0	0	0	0.00%	3	1	4	3.67%	5	1.83%
Kentucky	0	0	0	0.00%	0	1	1	1.12%	1	0	1	0.92%	2	0.73%
Louisiana	1	1	2	2.70%	1	2	3	3.37%	3	2	5	4.59%	10	3.66%
Michigan	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Minnesota	0	1	1	1.35%	2	5	7	7.87%	1	1	2	1.83%	10	3.66%
Missouri	7	1	8	10.81%	3	4	7	7.87%	4	3	7	6.42%	22	8.06%
Mississippi	1	2	3	4.05%	1	1	2	2.25%	4	3	7	6.42%	12	4.40%
Montana	1	0	1	1.35%	0	0	0	0.00%	0	0	0	0.00%	1	0.37%
North Dakota	12	7	19	25.68%	18	24	42	47.19%	16	10	26	23.85%	87	31.87%
Nebraska	1	0	1	1.35%	0	0	0	0.00%	0	1	1	0.92%	2	0.73%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1993-94 (continued)														
Oklahoma	0	0	0	0.00%	0	0	0	0.00%	1	0	1	0.92%	1	0.37%
Ohio	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Oregon	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Carolina	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Dakota	0	0	0	0.00%	2	0	2	2.25%	1	1	2	1.83%	4	1.47%
Tennessee	0	0	0	0.00%	0	0	0	0.00%	4	1	5	4.59%	5	1.83%
Texas	3	1	4	5.41%	0	0	0	0.00%	0	2	2	1.83%	6	2.20%
Washington	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Wisconsin	0	1	1	1.35%	0	0	0	0.00%	0	0	0	0.00%	1	0.37%
Alberta, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Manitoba, Canada	0	0	0	0.00%	0	1	1	1.12%	1	0	1	0.92%	2	0.73%
Ontario, Canada	0	0	0	0.00%	1	0	1	1.12%	0	0	0	0.00%	1	0.37%
Saskatchewan, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Unknown	2	0	2	2.70%	0	0	0	0.00%	0	0	0	0.00%	2	0.73%
Total 1993-94	51	23	74	100.00%	34	55	89	100.00%	72	37	109	100.00%	273	100.00%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1994-95														
Alabama	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Arkansas	10	0	10	33.33%	10	1	11	31.43%	15	3	18	25.00%	39	28.47%
Iowa	0	1	1	3.33%	1	0	1	2.86%	3	1	4	5.56%	6	4.38%
Idaho	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Illinois	2	0	2	6.67%	2	2	4	11.43%	1	0	1	1.39%	7	5.11%
Kansas	1	0	1	3.33%	1	0	1	2.86%	2	0	2	2.78%	4	2.92%
Kentucky	1	0	1	3.33%	1	0	1	2.86%	1	0	1	1.39%	3	2.19%
Louisiana	2	2	4	13.33%	1	1	2	5.71%	1	2	3	4.17%	9	6.57%
Michigan	0	0	0	0.00%	1	0	1	2.86%	0	1	1	1.39%	2	1.46%
Minnesota	0	0	0	0.00%	0	3	3	8.57%	0	2	2	2.78%	5	3.65%
Missouri	2	0	2	6.67%	0	0	0	0.00%	0	0	0	0.00%	2	1.46%
Mississippi	3	0	3	10.00%	1	0	1	2.86%	5	0	5	6.94%	9	6.57%
Montana	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
North Dakota	2	2	4	13.33%	2	3	5	14.29%	7	12	19	26.39%	28	20.44%
Nebraska	0	0	0	0.00%	0	0	0	0.00%	1	1	2	2.78%	2	1.46%
Oklahoma	1	0	1	3.33%	0	1	1	2.86%	1	1	2	2.78%	4	2.92%

	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
Recoveries by state	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1994-95 (continued)														
Ohio	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Oregon	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Carolina	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Dakota	0	0	0	0.00%	0	0	0	0.00%	4	1	5	6.94%	5	3.65%
Tennessee	0	1	1	3.33%	2	1	3	8.57%	2	0	2	2.78%	6	4.38%
Texas	0	0	0	0.00%	0	0	0	0.00%	0	1	1	1.39%	1	0.73%
Washington	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Wisconsin	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.39%	1	0.73%
Alberta, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Manitoba, Canada	0	0	0	0.00%	1	0	1	2.86%	0	1	1	1.39%	2	1.46%
Ontario, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Saskatchewan, Canada	0	0	0	0.00%	0	0	0	0.00%	2	0	2	2.78%	2	1.46%
Unknown	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Total 1994-95	24	6	30	100.00%	23	12	35	100.00%	46	26	72	100.00%	137	100.00%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1995-96														
Alabama	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Arkansas	9	7	16	44.44%	9	2	11	33.33%	9	1	10	18.18%	37	29.84%
Iowa	0	0	0	0.00%	1	0	1	3.03%	1	1	2	3.64%	3	2.42%
Idaho	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.82%	1	0.81%
Illinois	2	0	2	5.56%	4	2	6	18.18%	3	0	3	5.45%	11	8.87%
Kansas	1	0	1	2.78%	0	1	1	3.03%	0	0	0	0.00%	2	1.61%
Kentucky	0	0	0	0.00%	0	1	1	3.03%	0	0	0	0.00%	1	0.81%
Louisiana	2	1	3	8.33%	0	1	1	3.03%	6	2	8	14.55%	12	9.68%
Michigan	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Minnesota	0	0	0	0.00%	0	2	2	6.06%	0	1	1	1.82%	3	2.42%
Missouri	4	0	4	11.11%	1	1	2	6.06%	2	0	2	3.64%	8	6.45%
Mississippi	0	0	0	0.00%	1	1	2	6.06%	6	1	7	12.73%	9	7.26%
Montana	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
North Dakota	0	1	1	2.78%	2	0	2	6.06%	7	7	14	25.45%	17	13.71%
Nebraska	0	0	0	0.00%	0	0	0	0.00%	0	1	1	1.82%	1	0.81%
Oklahoma	1	1	2	5.56%	1	0	1	3.03%	1	0	1	1.82%	4	3.23%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1995-96 (continued)														
Ohio	1	0	1	2.78%	0	0	0	0.00%	0	0	0	0.00%	1	0.81%
Oregon	0	0	0	0.00%	1	0	1	3.03%	0	0	0	0.00%	1	0.81%
South Carolina	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.82%	1	0.81%
South Dakota	0	0	0	0.00%	1	0	1	3.03%	0	0	0	0.00%	1	0.81%
Tennessee	1	0	1	2.78%	1	0	1	3.03%	2	0	2	3.64%	4	3.23%
Texas	0	2	2	5.56%	0	0	0	0.00%	0	0	0	0.00%	2	1.61%
Washington	1	0	1	2.78%	0	0	0	0.00%	0	0	0	0.00%	1	0.81%
Wisconsin	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Alberta, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Manitoba, Canada	1	0	1	2.78%	0	0	0	0.00%	1	1	2	3.64%	3	2.42%
Ontario, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Saskatchewan, Canada	1	0	1	2.78%	0	0	0	0.00%	0	0	0	0.00%	1	0.81%
Unknown	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Total 1995-96	24	12	36	100.00%	22	11	33	100.00%	40	15	55	100.00%	124	100.00%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1996-97														
Alabama	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Arkansas	7	2	9	45.00%	2	0	2	25.00%	6	4	10	19.61%	21	26.58%
Iowa	1	0	1	5.00%	0	0	0	0.00%	1	0	1	1.96%	2	2.53%
Idaho	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Illinois	1	0	1	5.00%	0	0	0	0.00%	1	0	1	1.96%	2	2.53%
Kansas	1	0	1	5.00%	0	0	0	0.00%	1	0	1	1.96%	2	2.53%
Kentucky	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.96%	1	1.27%
Louisiana	2	0	2	10.00%	1	0	1	12.50%	3	1	4	7.84%	7	8.86%
Michigan	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Minnesota	0	0	0	0.00%	0	0	0	0.00%	1	1	2	3.92%	2	2.53%
Missouri	2	0	2	10.00%	1	0	1	12.50%	4	0	4	7.84%	7	8.86%
Mississippi	0	0	0	0.00%	0	0	0	0.00%	5	0	5	9.80%	5	6.33%
Montana	0	0	0	0.00%	0	0	0	0.00%	2	0	2	3.92%	2	2.53%
North Dakota	0	1	1	5.00%	1	0	1	12.50%	3	6	9	17.65%	11	13.92%
Nebraska	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.96%	1	1.27%
Oklahoma	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.96%	1	1.27%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1996-97 (continued)														
Ohio	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Oregon	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Carolina	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Dakota	0	0	0	0.00%	0	0	0	0.00%	2	1	3	5.88%	3	3.80%
Tennessee	2	0	2	10.00%	1	0	1	12.50%	1	0	1	1.96%	4	5.06%
Texas	0	0	0	0.00%	0	0	0	0.00%	2	1	3	5.88%	3	3.80%
Washington	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Wisconsin	0	0	0	0.00%	0	0	0	0.00%	1	0	1	1.96%	1	1.27%
Alberta, Canada	0	0	0	0.00%	1	0	1	12.50%	0	0	0	0.00%	1	1.27%
Manitoba, Canada	1	0	1	5.00%	1	0	1	12.50%	1	0	1	1.96%	3	3.80%
Ontario, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Saskatchewan, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Unknown	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Total 1996-97	17	3	20	100.00%	8	0	8	100.00%	37	14	51	100.00%	79	100.00%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1997-98														
Alabama	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Arkansas	3	0	3	25.00%	2	0	2	25.00%	1	2	3	15.00%	8	20.00%
Iowa	0	0	0	0.00%	0	0	0	0.00%	1	2	3	15.00%	3	7.50%
Idaho	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Illinois	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Kansas	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Kentucky	0	0	0	0.00%	1	0	1	12.50%	0	0	0	0.00%	1	2.50%
Louisiana	1	0	1	8.33%	0	0	0	0.00%	0	0	0	0.00%	1	2.50%
Michigan	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Minnesota	0	0	0	0.00%	0	0	0	0.00%	0	2	2	10.00%	2	5.00%
Missouri	3	0	3	25.00%	1	0	1	12.50%	0	0	0	0.00%	4	10.00%
Mississippi	0	0	0	0.00%	0	1	1	12.50%	3	0	3	15.00%	4	10.00%
Montana	0	0	0	0.00%	0	0	0	0.00%	1	0	1	5.00%	1	2.50%
North Dakota	3	0	3	25.00%	0	0	0	0.00%	1	3	4	20.00%	7	17.50%
Nebraska	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Oklahoma	2	0	2	16.67%	0	0	0	0.00%	0	0	0	0.00%	2	5.00%

Recoveries by state	Modified gentle-release wild-strain				Hard-release wild-strain				Wild				State totals	
	M	F	Total	% of total	M	F	Total	% of total	M	F	Total	% of total	Total	% of total
1997-98 (continued)														
Ohio	0	0	0	0.00%	0	0	0	0.00%	1	0	1	5.00%	1	2.50%
Oregon	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Carolina	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
South Dakota	0	0	0	0.00%	0	0	0	0.00%	2	0	2	10.00%	2	5.00%
Tennessee	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Texas	0	0	0	0.00%	0	0	0	0.00%	0	1	1	5.00%	1	2.50%
Washington	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Wisconsin	0	0	0	0.00%	1	0	1	12.50%	0	0	0	0.00%	1	2.50%
Alberta, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Manitoba, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Ontario, Canada	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Saskatchewan, Canada	0	0	0	0.00%	2	0	2	25.00%	0	0	0	0.00%	2	5.00%
Unknown	0	0	0	0.00%	0	0	0	0.00%	0	0	0	0.00%	0	0.00%
Total 1997-98	12	0	12	100.00%	7	1	8	100.00%	10	10	20	100.00%	40	100.00%

CURRICULUM VITAE

Charles Elwin Dixon

EDUCATION

Bachelor of Science in Animal Science, December 1976. New Mexico State University. Las Cruces, New Mexico.

Bachelor of Science in Wildlife Sciences, May 1988. New Mexico State University. Las Cruces, New Mexico.

Master of Science Degree in Wildlife Science, July 1990. New Mexico State University. Las Cruces, New Mexico. Minors: Range Science and Agricultural Economics. Graduate Project: Wildlife Enterprise and Ranch Plan for the Bonito Ranch at Corona, New Mexico.

Ph.D. in Wildlife Management, May 2000. Utah State University. Logan, Utah. Graduate Research: Evaluation of a Single-Season Release of Wild-Strain Mallard in the Prairie Pothole Region of North Dakota.

EXPERIENCE

Wildlife Management Consultant, Wildlife Plus Ranch Management Consulting, Nogal, New Mexico. November 1999 to present. Self employed as a consultant to private landowners assisting them in initiating wildlife enterprises and managing the wildlife resource on their lands for recreational purposes. Services provided include but are not limited to: resource appraisal, management plan development, wildlife surveys, data collection on harvested animals, identify habitat management projects, analysis of survey and harvest data, identifing clients, and appraisal of wildlife damage concerns.

Extension Associate, Department of Forestry, Wildlife & Fisheries in the Institute of Agriculture, University of Tennessee at Knoxville. March 1997 to November 1999. Worked as Wildlife Specialist for the State of Tennessee. Responsibilities included, but were not limited to advising landowners and County Agents in all aspects of wildlife enterprises, wildlife damage, and working in the 4-H Wildlife and Shooting Sports programs. Conducted demonstrations of wildlife damage control techniques on Tennessee farm crops. For example: one demonstration involves controlling deer depredation on soybeans utilizing three types fencing to reduce deer damage to the crop. Other duties included development of publications, training materials and news releases to educate county agents, landowners, youth, and the general public.

Associate Wildlife Extension Specialist and Coordinator of the Wild-strain Mallard Release Project, Utah State University. April 1993 to March 1997. Worked as assistant to Dr. Terry Messmer, Extension Wildlife Specialist, Utah State University. Responsibilities included but were not limited to, assisting landowners with wildlife enterprises associated with the Utah Department of Wildlife Resources Cooperative Wildlife Management Units (CWMU). Duties with the CWMU program included teaching landowners survey techniques for wildlife populations, evaluation of population surveys, developing harvest survey forms, and evaluation of the harvest information. Developed educational materials and short courses for landowners involved in the Posted Hunting Unit Program. Organized activities and collected data for a $600,000 research project in the prairie pothole region of North Dakota, coordinated activities with personnel from the U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service, North Dakota Game and Fish Department, Utah State University, and up to 600 landowners. Assisted in the development of a rotational grazing systems for land owned by Utah Power Company. Assisted other graduate students with planning, designing, and implementing projects involving migratory mule deer herds, mule deer habitat use, and immuno-contraceptives for carnivores. Other responsibilities, Ex-officio member of the Utah Riparian Management Coalition, Shotgun Training Instructor for 4-H Shooting Sports and Program Coordinator for the state of Utah 4-H Shooting Sports Program. Assisted in organization and conducting of county, state, and national meetings and contests.

Research Coordinator. August 1992 to April 1993. Co-Principal Investigator and liaison between personnel from the United States Army Construction Engineers Research Laboratories (USA-CERL), Fort Bliss Environmental Office, New Mexico State University, and Texas Tech University on three research projects conducted on Fort Bliss McGregor Missile Range. Duties involved selection of methodologies and sites, quality control, coordination of housing and admission to ranges, supervised graduate students and technicians, and insured reports and milestone deadlines were met. The projects were designed to estimate carrying capacity of the McGregor Missile Range for tracked vehicles and to inventory the wildlife and plant species in riparian and uplands habitats.

Associate Wildlife Extension Specialist. August 1991 to August 1992. Worked as assistant to Dr. Jim Knight, Extension Wildlife Specialist at New Mexico State University. Established transects and monitored an aspen clearcut. Inventoried birds, mammals, reptiles and surveyed deer populations on private land. Worked extensively with the public concerning wildlife habitat, wildlife enterprises, and wildlife damage control. Prepared and coordinated the state 4-H and FFA Wildlife Contests. Prepared Extension publications by summarizing research findings.

Range Consultant. December 1991 and March 1992. Worked with Geo-Marine, Inc. on McGregor Range conducting endangered plant surveys and compiling a plant list for an

Environmental Impact Statement. Served as contact person for the consulting group to identify qualified workers to assist with the project.

Team Leader of the Vegetation Crew, White Sands Missile Range. May 1991 to August 1991. Worked as a team leader of the vegetation crew monitoring LCTA transects on the White Sands Missile Range determining species composition, ground cover, and disturbance. Worked from topographic maps and compasses locating the transects.

Self-Employed. August 1990 to April 1991. Worked with landowners advising them in determining harvest rates, booking hunts for white-tailed deer and bobwhite quail, advising them on management of native and exotic wildlife species. Conducted range, population, and utilization studies for landowners and federal land permitees. Advised potential ranch buyers on livestock carrying capacity and wildlife enterprise potential of ranches.

Associate Wildlife Extension Specialist. April 1988 to August 1990. Worked as assistant to Dr. Jim Knight, Extension Wildlife Specialist at New Mexico State University. Responsibilities included, but not limited to, dealing with the public concerning wildlife management, wildlife habitat, wildlife enterprises, damage control, aquaculture, wildlife and plant identification, etc. Assisted with short courses (*Riparian Habitat Short Courses*, Guides and Outfitters School) and the *First International Wildlife Ranching Symposium*. Wildlife and Nature Instructor at 4-H Camps and Range Camps. Wrote news releases concerning subjects related to wildlife management and damage control. Authored Extension publications concerning scaled quail and pheasant habitats.

Gould's Turkey Research. Summer 1987. Assistant Researcher on the Gould's Turkey Project in the Peloncillo Mountains of New Mexico under the supervision of Dr. Sanford Schemnitz, professor at New Mexico State University. During the summer I lived in the Peloncillo Mountains collecting data on habitat use, movement, and water use by Goulds turkeys.

Self-Employed. July 1978 to July 1986. Owner/operator of 120 acre farm in Fort Sumner, New Mexico. Raised mainly alfalfa and other hay crops and ran from 100-300 head of yearling cattle per year.

US Army. November 1972 to November 1974. Served in the US Army as a medic in the 82nd Airborne Division. Honorably discharged as a Specialist Fourth Class.

Heavy Equipment Operator. June 1970 to September 1971. Employed by Border Soil Water Conservation District in Elida, New Mexico. Operated a 950 Cat loader, D6 Cat dozer, and a road grader.

CERTIFICATIONS, SPECIAL ACTIVITIES and MEMBERSHIPS (continued)

Certified Wildlife Biologist

Member of National, Southwestern, and New Mexico Chapters of The Wildlife Society

Previous Member of Central Mountains and Plains, Southeastern, Utah, Tennessee, USU and NMSU

Chapters of the Wildlife Society

Member of the Society for Range Management

Life Member of the National Rifle Association; Member since 1979

Member of the Mule Deer Foundation

Member of Safari Club International

Member of Rocky Mountain Elk Foundation

Member of Quail Unlimited

Member of National Wild Turkey Federation

Member NMSU Ag College Ambassadors, 1988-90

Vice-President Wildlife Graduate Student Council, Agriculture and Home Economics Council Representative 1987-88

Member Plant Identification Team, 1988, 3rd place in International Competition

Member of New Mexico State University Fishery Society. Agriculture and Home Economics Council Representative 1987-88

Elected member of the Board of Directors of the Fort Sumner Irrigation District from December 1982 to June 1986. Served as President from January 1986 to June 1986

Member of Production Credit Association of Eastern New Mexico from 1980 to 1986. Served on the nominating committee in 1985

Member Highland Park Baptist Church, Jackson, TN

PUBLICATIONS

Dixon, Charles E. 1999. Single-Strand Fencing to Control Deer Damage in Tennessee. Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA. In Press.

Dixon, Charles E. 1999. Control of Vole Damage in No-Till Soybeans. Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA. In Press.

Dixon, Charles E. and Craig A. Harper. 1999. Managing Problem Vertebrates in the Suburban Landscape. Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA.

Harper, Craig A., Charles E. Dixon and James L. Byford. 1999. Controlling Pesky Critters Around Your Home. PB 1624, Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA.

Harper, Craig A., Charles E. Dixon, Paul M. Jakus, D. Alan Barefield. 1999. Earning Additional Income Through Hunt Leases on Private Land. PB 1627, Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA.

Byford, James L. and Charles E. Dixon. 1999. Mole Control in Tennessee. SP 293-A, Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA.

Messmer, T. A., Charles E. Dixon, Wes Shields, Scott C. Barras, and Susan A. Schroeder. 1998. Cooperative Wildlife Management Units: Achieving Hunter, Landowner, and Wildlife Management Agency Objectives. Wildlife Society Bulletin 26:325-332.

Dixon, Charles E. 1998. Evaluation of the Effectiveness of Deer Repellents and Electric Fences to Reduce Deer Damage on Soybeans: A Preliminary Report. R12-4910-12-001-99, Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA.

Messmer, T. A., Charles E. Dixon. 1997. Livestock Grazing: An Alternative Strategy for Managing Breeding Waterfowl Habitat. *In proceedings*, 1997 Montana/Wyoming Range Management Workshop; Ecology and Management of Grazing by Large Herbivores.

Dixon, Charles E. 1997. Control of Voles in No-Till Corn. PB1600, Agricultural Extension Service, University of Tennessee, Knoxville, Tennessee, USA.

Dixon, Charles E. and James E. Knight. 1993. Scaled Quail Habitat Management. Guide L-304, Cooperative Extension Service, New Mexico State University, Las Cruces, New Mexico, USA.

Dixon, Charles E. and James E. Knight. 1993. Mearn's Quail in New Mexico. Guide L-303, Cooperative Extension Service, New Mexico State University, Las Cruces, New Mexico, USA.

Knight, James E. and Charles E. Dixon. 1990. Managing Farm Habitat for Pheasants in New Mexico. Guide L-302, Cooperative Extension Service, New Mexico State University, Las Cruces, New Mexico, USA.