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Comparisons Of Muskrat (ondatra Zibethicus) Trapping Efficiency And Incidental Take Of Non-Target Water Birds Using Covered And Uncovered Float Sets

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COMPARISONS OF MUSKRAT (*ONDATRA ZIBETHICUS*) TRAPPING EFFICIENCY AND INCIDENTAL TAKE OF NON-TARGET WATER BIRDS USING COVERED AND UNCOVERED FLOAT SETS

by

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This thesis, submitted by Rodney Gross Jr. in partial fulfillment of the requirements for the Degree of Master of Science from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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ABSTRACT

Muskrats (*Ondatra zibethicus*) have been a highly sought after furbearer species in North Dakota because of recent pelt prices. In 2011, regulation changes allowed trappers to use float sets to trap muskrats during the spring season. The current regulations require float sets used during the spring trapping season to have a covering made of either wire mesh, wood, or plastic and must not have an opening exceeding 20.32 cm (8 in) to attempt to minimize the incidental take of non-target species. The primary goals of this project were to determine if muskrat float set covers are effective in eliminating incidental take of non-target species and to compare trapping efficiency at covered and uncovered float sets. The study was conducted over a two year period in an area used heavily by migrating waterfowl in eastern North Dakota. Float sets used included uncovered, 2.54 cm by 2.54 cm (1 in x 1 in) wire mesh, and 15.24 cm by 15.24 cm (6 in x 6 in) wire mesh float sets. Trapping efforts were focused to four areas: Devils Lake Basin, Arrowwood National Wildlife Refuge (NWR) and Chase Lake Wetland Management Districts (WMD), and Tewaukon NWR. During the study, 490 muskrats (157 on uncovered, 124 on 1 in x 1 in, and 209 on 6 in x 6 in) and seven non-targets species (three black-crowned night heron (*Nycticorax nycticorax*), two blue-winged teal (*Anas discors*), and two painted turtles (*Chrysemys picta*)) were captured over 4,245 trap nights. All non-targets were captured on uncovered float sets except for the painted turtles (1 in x 1 in and 6 in x 6 in). Although we found relatively low non-target captures, the birds were all captured on uncovered floats suggesting some vulnerability to these floating sets. In addition to float sets, cameras were placed at each float set to evaluate behaviors of muskrats and non-target species as they encounter float sets. Cameras captured 9,356 encounters with float sets from 311,377 one minute video recordings. We found that cover type did not influence encounter rates of water birds at float sets. Water birds in general were 7.5 times more likely to encounter a float in the spring as compared to the fall. When examining behaviors at the floats, we found non-duck water birds were 10.1 times more likely to contact float sets as compared to puddle and diving ducks. Regardless of guild, birds were 2.3 times less likely to contact a float set with a 1 in x1 in cover as compared to an uncovered float set, suggesting covers with smaller mesh sizes may be less attractive to birds. We captured 490 muskrats over 4,245 trap nights (0.115 muskrat per trap night) during fall and spring trapping season at all study locations over the two year study period. We evaluated 1,149 muskrat encounters with float sets over the two year study period from the video collected by trail cameras at each float set. Muskrats had a daily encounter rate of 0.27 encounters per day. Most muskrats would simply swim by the float without contacting it in any way (45.3%). Muskrats would also contact float by bumping the sides (14.6%) or climb onto the float which may or may not have resulted in getting trapped (40.1%). We found that there was no influence from a 1x1 or 6x6 cover type on whether a muskrat contacted or went on top/was trapped at a float set. Further, we found that the use of covered float sets did not negatively impact trapping efficiency. In fact, larger mesh size (6 in x 6 in) showed a slight increase in efficiency compared to an uncovered float set. Further research is needed on different designs of float sets to better understand the impact on muskrat trapping efficiency and non-target incidental take.

CHAPTER I

BACKGROUND AND LITERATURE REVIEW: MUSKRAT TRAPPING AND INCIDENTAL TAKE OF WATER BIRDS

Muskrat Trapping in North Dakota

Muskrats (*Ondatra zibethicus*) are one of the most widely distributed and sought after species of furbearer in North America (Boutin and Birkenholz 1987, Roberts and Crimmins 2010). However, modern farming practices in the Midwestern United States have altered muskrat habitat by draining wetlands and channelizing small streams to transport excess water away from drain-tiled agriculture fields. Loss of critical wetland habitat has shifted the distribution of muskrats and condensed populations into larger groups (Ahlers et al. 2010). Recently, fur prices have increased to the highest they have been in decades (Tucker 2014). This has led to more trappers being on the landscape to take advantage of the pelt price increase. The increase in pelt prices, in particular muskrats, along with the increase in trapping pressure has led to managing wildlife agencies and researchers to question whether or not specific trap designs such as float sets (Figure 1) are a threat to avian non-target incidental captures (e.g. waterfowl and water birds).

The North Dakota Game and Fish Department manages muskrats with annual hunting and trapping seasons from late October until late April each year. Approximately 30,000 muskrats are harvested annually in North Dakota (Seabloom 2011). However, the number of muskrats harvested fluctuates based on population abundance, pelt values, and weather conditions. For example, during the 2010-2011 North Dakota muskrat season, there were over 50,000 muskrats trapped or shot (Tucker 2012b). In North Dakota, the most commonly used methods of trapping include footholds, body gripping traps, colony traps, or float sets. On average a trapper will capture at least one muskrat per day of trapping in North Dakota, although there is considerable variability (Tucker 2012b). Trapping during the spring has become popular due to the efficiency of open water traps, including float sets (Figure 1). A float set usually consists of a flat wooden base that floats just above the water's surface with either foothold or body gripping traps placed on the top.

In the spring trapping season, float sets for muskrats are required to have a covering made of wire mesh, wood, or plastic and must not have an opening that exceeds 20.32 cm (8 inches) in height, width, or diameter to attempt to minimize the capture of non-target species. Covers may force muskrats to enter the float set from the ends where traps are placed potentially increasing muskrat capture rates, while some trappers suggest the covers will have a negative impact on muskrat captures. Traps are triggered when the muskrat steps on a pressure sensitive pan that triggers the jaws of the trap, capturing the muskrat, and resulting in immediate death or drowning after retreating to the water. Some floats have body gripping traps at the end, as opposed to the footholds commonly used. The purpose of this study was to determine the effect, if any, of the interactions between humans, muskrat, and water birds in response to the use of covered and uncovered muskrat float sets.

Ecology of Muskrats

Muskrats are semi-aquatic mammals found throughout most of the United States and Canada. Primary habitat for muskrats is semi-permanent wetland with a cattail (*Typha* sp.) buffer. Populations experience fluctuations, based upon wetland water levels, but may also exhibit cyclic variation depending on environmental factors, such as disease outbreaks and droughts (Erb et al. 2000). Muskrat have a high reproductive potential which allows them to quickly respond to more water on the landscape based on population densities (Errington 1963). Research suggests potential population declines in North America are associated with loss of habitat resulting from drain tiling, burning of cattails, and encroaching urbanization (Roberts and Crimmins 2010). However, other research suggests muskrats are tolerant of urbanization and may even benefit from the reduced risk of predation and trapping pressure in these areas (Cotner and Schooley 2011).

Muskrats are primarily herbivorous. They consume shoots, roots, bulbs, and leaves of a variety of aquatic plants. Cattails and bulrush (*Scirpus* sp.) are used by muskrats as they are readily available and can constitute as much as 80% of the muskrat's diet (O'Neil 1949). These aquatic plants are located at wetlands that both muskrats and water birds use frequently. Cultivated crops such as carrots (*Daucus carota*), corn (*Zea mays*), alfalfa (*Medicago sativa*), and soybeans (*Glycine max*) are also eaten (Dozier 1950, Errington 1963). In some cases, muskrats will also consume clams, mussels, fish, and other available animal material (Schwartz and Schwartz 1959).

Humans are a common source of muskrat mortality, with the majority of that mortality coming from trapping (Wilner et al. 1980). However, Clark (1987) found the impact of harvest on muskrats from trapping practices to be compensatory. Another source of mortality is predation from predators such as mink (*Neovison vison*), coyotes (*Canis latrans*), raccoons (*Procyon lotor*) and red foxes (*Vulpes vulpes*) (Cotner and Schooley 2011, Seabloom 2011).

Despite being a popular furbearer species, muskrats often are known for being a pest species to humans. High densities of muskrats can consume large amounts of emergent vegetation in wetlands and damage agricultural crops (Seabloom 2011). Muskrats can impact vegetative communities (Wilner et al. 1980) through feeding on vegetation and thereby altering the number of invertebrates in the wetland (de Szalay and Cassidy 2001). Through these behaviors, research suggests muskrats may control the bird density of wetland communities they inhabit (Bishop et al. 1979). Furthermore, burrowing by muskrats can damage roads, dikes, and river banks (Seabloom 2011) as well as disturbing nesting habitat of other species (i.e., waterfowl).

Waterfowl Ecology in the Prairie Pothole Region

The prairie pothole region in North Dakota is one of the most important breeding grounds for North American waterfowl, supporting approximately 50 percent of the continent's breeding duck population (Baldassarre and Bolen 2006). This area is primarily composed of grasslands, agriculture fields, and small wetlands (e.g., temporary, semi-permanent, and lake). Multiple species of waterfowl return to the prairie potholes each spring to establish breeding grounds. The selection of breeding grounds varies by species. Hen survival is vital to nest success, which determines population size in the mid-continent waterfowl population (PPJV report 2005). Females rearing broods usually select habitats with abundant invertebrate populations and dense vegetation cover, which is also considered prime muskrat habitat (Baldassarre and Bolen 2006). The availability of invertebrates is essential for the nutritional needs of ducklings in the first two weeks of life (Baldassarre and Bolen 2006). Waterfowl broods are known to seek loafing areas to dry themselves during feather production. Thus, any structures that might provide loafing and preening sites are heavily used by waterfowl. Structures that facilitate this behavior include muskrat huts and floating sets, which have been documented to cause mortality to both ducklings and hens (Gashwiler 1949).

Waterfowl behavior is of particular interest to this research. Behaviors vary from fall to spring seasons. In the fall, waterfowl are migrating south to the wintering grounds in large flocks. They use wetlands for a short time before moving south. Conversely, in the spring, waterfowl are returning from the wintering grounds and establishing a breeding ground. Waterfowl during this time of year use wetlands for a greater time period as compared to the fall. This could lead to an increased vulnerability to spring trapping practices.

With the recent decline in Conservation Reserve Program (CRP) acreage and wetland density in the prairie pothole region, waterfowl will be forced to concentrate into smaller areas. Given this changing landscape and loss of available wetland habitat, waterfowl could be forced into areas with high muskrat densities that also are being used by muskrat trappers, and potentially increase the chance of incidental capture from muskrat trapping practices.

Non-target capture from Muskrat Trapping

Commonly used trapping equipment such as footholds and body gripping traps are considered a threat to non-target species (Linscombe 1976, Parker 1983). Stocek and Cartwright (1983) surveyed trappers in New Brunswick Canada and found that 23-25% of trappers surveyed captured some type of bird in a furbearer trap during the season. Also, Wright (1954) suggested that muskrat trapping is a major mortality factor for American Black Ducks (*Anas rubripes*).

It is thought that waterfowl species are especially vulnerable to incidental capture in muskrat float sets during spring trapping seasons because they are found in similar habitat. This interaction can lead to negative impacts on waterfowl from incidental capture in muskrat traps. Waterfowl migration and muskrat trapping seasons occur during similar periods in North Dakota. Spring migration of waterfowl is important due to the breeding behaviors of waterfowl as they return to the region. The spring trapping season is also important in that muskrat pelt quality is at its peak, which leads to increased trapping pressure on the landscape. Past research in Maine found that muskrat trapping during the spring had negative impacts on waterfowl such as American Black Ducks (*Anas rubripes*) (Gashwiler 1949). This potential vulnerability is in part due to the breeding behavior of some water bird species that nest on floating structures in the springtime (Baldassarre and Bolen 2006). Also, some nesting structures (e.g., hen houses) for waterfowl are similar in appearance to muskrat float sets. For example, Bailey (1976) stated that spring muskrat trapping can reduce the number of productive Mallard (*Anas platyrhynchos*) hens in a waterfowl population as a result of incidental capture. Muskrat trappers were surveyed in a 10.4 km study block southeast of Minnedosa, Manitoba and found that from the estimated population of 144 breeding pairs of Mallards, 16 individuals were trapped by steel jawed traps place on muskrat huts, trails, and floating vegetation. Of these, 15 were females, which is significant due to the importance of hens to the breeding population (Bailey 1976). Gashwiler (1949) estimated that a total kill of 1,945 ducks from muskrat float sets during the 1946 trapping season, and an additional 2,220 ducks actively involved in breeding activities incurred injuries as a resulted of muskrat trapping during the spring. Mendall (1958) considered spring muskrat trapping practices as a prime cause of accidental mortality to breeding Ring-necked ducks (*Aythya collars*) in northeastern USA. Stout (1967) analyzed band recoveries from waterfowl caught by devices other than trapping related to leg banding activities and attributed 69 percent of spring band recoveries to muskrat trapping.

Research on the impacts of floating muskrat sets is limited to one study looking at the impacts of floats in the state of Maine in the 1940s (Gashwiler 1949). There has been no research, however, evaluating the impact of float sets during the fall trapping seasons or any studies in the Great Plains region. The high muskrat population numbers, the increase in pelt price, and the increase in trappers on the landscape has prompted some to ask the question of the vulnerability of non-target species to trapping practices. Therefore, the need to determine the impacts, if any, on non-target injury or capture at muskrat float sets is needed.

Assessing Vulnerability of Water Birds to Float Sets

To determine the vulnerability of non-target water birds to muskrat float sets, we identified eastern North Dakota as an area with high muskrat trapping pressure using float sets (Tucker 2012a) and a critical area for waterfowl during the spring and fall migrations (Baldassarre and Bolen 2006). We selected four study areas, including the Devils Lake Basin (Nelson County), Arrowwood National Wildlife Refuge (NWR; Stutsman County), Chase Lake NWR (Stutsman County), and Tewaukon NWR (Sargent County; Figure 2). All of these locations had a combination of small "pothole" type wetlands along with a number of larger semi-permanent wetlands that represent traditional areas used by muskrat trappers in North Dakota. These areas are also used by high densities of waterfowl.

To further understand vulnerability, it is important to estimate how often animals come in contact with float sets and how they interact with them that leads to capture or reduces vulnerability. Remote cameras can be utilized to monitor a location at all times without researchers being present. Data collected from cameras can be stored digitally and reviewed by the researcher at any time. Therefore, behavioral data collected from cameras can be used determine the effect of different cover types on muskrat and waterfowl behavior when they encounter a float set.

In addition to cameras surveys, the overall wetland use beyond the camera field of view needs to be assessed. Four-square mile waterfowl surveys could be use to accomplish this task. Protocol for the four-square mile counts includes an observer being a safe distance (no disturbance) away from a wetland to use binoculars to get an accurate count of water bird use on the wetland. This can be done over a period of days in order to determine average water bird use of a wetland.

To examine if seasonality influences non-target vulnerability or mortality, trapping efforts need to focus on the timing when muskrat trappers and water birds are simultaneously using wetlands. In North Dakota, muskrat trapping seasons and water bird migrations occur at similar times. Fall trapping season begin around the end of October, which coincides with migration of most waterfowl species. The spring trapping season ends the last week in April, which coincides with the migration of many avian species, depending on weather. The spring season was identified as the most important season to evaluate based on the importance of North Dakota as a critical breeding ground for many avian species and the increase in popularity of floating muskrat sets during the spring breeding season.

Muskrat Float Set Designs

Many float designs and cover types exist (Figure 1). Surveys conducted by the North Dakota Fur Hunters and Trappers Association suggest the most popular float design used by trappers in North Dakota is the rectangle consisting of a rectangular board with short side bumpers, a foam bottom, and a foothold trap at each end of the float (Tischaefer 2011). A survey conducted by the North Dakota Game and Fish Department indicated a variety of popular cover types included metal wire mesh, PVC pipe, drain tile tubes, and plastic mesh (Tucker 2012a). In particular, 2.54 cm by 2.54 cm (1 in. by 1 in.) wire mesh and 15.24 cm by 15.24 cm (6 in. by 6 in.) wire mesh appear to be popular cover types and potential threats to waterfowl by having a similar appearance to nesting loafing structures commonly placed in wetlands. The 2.54 cm by 2.54 cm wire mesh is commonly used to make hen houses for ducks. The 15.24 cm by 15.24 cm wire mesh is a common scrap metal due to its use in fencing, but also provides opportunities for animals to enter the float from all sides even though the mesh is smaller than the state required minimums of 20.32 cm (8 inches).

Study Objectives

In order to evaluate incidental take and vulnerability of water birds and other non-target species to floating muskrat sets, we conducted a study to answer the following questions.

1) Estimate the amount, if any, of incidental take of non-target species from uncovered float sets compared to covered float sets with 2.54 cm by 2.54 cm wire mesh or 15.24 cm by 15.24 cm wire mesh during fall and spring trapping seasons with primary interest on spring trapping season (Chapter 2).
    a. Identify what types of injuries non-target species sustain if capture occurs at a float set. We will examine if there are any patterns to species, age, or sex of individuals most likely to be incidentally captured.
2) Evaluate the encounter rates (coming into camera view around float sets) of waterfowl and other water birds at muskrat float sets (Chapter 2).
3) Evaluate the behaviors (how do they react to the float sets) of waterfowl and other water birds at muskrat float sets (Chapter 2).
4) Evaluate muskrat trapping efficiency (e.g., captures by cover type) and behaviors between covered (both 2.54 cm by 2.54 cm and 15.24 cm by 15.24 cm wire mesh) and uncovered float sets (Chapter 3).

We will use the behavioral observations and capture data to recommend best management practices for float set designs and regulations to minimize incidental captures (Chapter 4).

LITERATURE CITED

Ahlers, A.A., and E. J. Heske, and M. A. Mitchell, and R. L. Schooley. 2010. Home ranges and space use of Muskrats (*Ondatra zibethicus*) in restricted linear habitats. Wildlife Biology. 16: 400-408.

Bailey, R. O. 1976. Mallard mortality in Manitoba's extended spring muskrat trapping season. Wildlife Society Bulletin, Vol. 4, No. 1 pp. 26-28.

Baldassarre, G. A., and E. G. Bolen. 2006. Waterfowl Ecology and Management. 2nd ed. Krieger Publishing, Malabar, FL.

Bishop, R. A., R. D. Andrews, and R. J. Bridges. 1979. Marsh management and its relationship to vegetation, waterfowl, and muskrats. Proceedings of the Iowa Academy of Science 86:50-56.

Boutin, S., and D. E. Birkenholz. 1987. Muskrat and Round-tailed Muskrat. *in* M. Novak, J. A. Baker, M. E. Obbard, andB. Malloch, editors. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, ON, Canada.

Clark, W. R. 1987. Effects of harvest on annual survival of muskrats. Journal of Wildlife Management 51:265-272.

Cotner, L. A., and R. L. Schooley. 2011. Habitat occupancy by riparian muskrats reveals tolerance to urbanization and invasive vegetation. The Journal of Wildlife Management 75:1637-1645.

de Szalay, F. A., and W. Cassidy. 2001. Effects of muskrat (*Ondatra zibethicus*) lodge construction on invertebrate communities in a Great Lakes coastal wetland. American Midland Naturalist 146:300-310.

Dozier, H. L. 1950. Muskrat Trapping on the Montezuma National Wildlife Refuge, New York, 1943-1948. The Journal of Wildlife Management 14: 403.

Erb, J., N. C. Stenseth, and M. S. Boyce. 2000. Geographic variation in population cycles of Canadian muskrats (*Ondatra zibethicus*). Canadian Journal of Zoology 78:1009-1016.

Errington, P.L. 1963. Muskrat populations. Iowa State University Press, Ames.

Gashwiler, J. S. 1949. The effect of spring muskrat trapping on waterfowl in Maine. Journal of Wildlife Management 13:183-188.

Linscombe, G. 1976. An evaluation of the No. 2 Victor and 220 conibear traps in coastal Louisiana. Louisiana Wildlife and Fisheries Commission report. pp 560-568.

Mendall, H. L. 1958. The ring-necked duck in the northeast. Univ. Maine Studies, 2nd Ser. 73, Orono. 317pp.

O'Neil, T. 1949. The muskrat in the Louisiana coastal marshes. Louisiana Department of Wildlife and Fisheries. New Orleans. 152pp.

Parker, G. R. 1983. An evaluation of trap types for harvesting muskrats in New Brunswick. Wildlife Society Bulletin 11: 339-343.

Prairie Pothole Joint Venture report. 2005. Implementation Plan Section 2 – Waterfowl Plan.

Roberts, N. M., and S. M. Crimmins. 2010. Do Trends in Muskrat Harvest Indicate Widespread Population Declines? Northeastern Naturalist 17:229-238.

Seabloom, R. W. 2011. Mammals of North Dakota. North Dakota Institute for Regional Studies, Fargo, ND.

Schwartz, C.W. and F. R. Schwartz. 1959. The wild mammals of Missouri. Univ. Missouri Press and Mo. Conserv. Comm., Columbia. 3-11pp.

Stocek, R.F., and D.J., Cartwright. 1985. Birds as non-target catches in the New Brunswick furbearer harvest. Wildlife Society Bulletin 13: 314-317.

Stout, I. J. 1967. The nature and patterns of non-hunting mortality in fledged North American waterfowl. M.S. Thesis. Virginia Poly-technic Inst., Blacksburg. 329pp.

Tischaefer, R. 2011. North Dakota Fur Hunters and Trappers Association preliminary muskrat trapping survey. Unpublished data.

Tucker, S. 2012a. Study No. E-II: Furbearer harvest regulations study. Project No. W-67-R-52, Report No. C-456, North Dakota Game and Fish Department, Bismarck, North Dakota, USA.

Tucker, S. 2012b. Study No. E-II: Furbearer harvest regulations study. Project No. W-67-R-51, Report No. C-453, North Dakota Game and Fish Department, Bismarck, ND.

Tucker, S. 2014. Study No. E-11: Furbearer Harvest Regulations Study. North Dakota Game and Fish Department.

Wilner, G. R., G. A. Feldhamer, E. E. Zucker, and J. A. Chapman. 1980. *Ondatra zibethicus*. Mammal Species 141:1-8.

Wright, B. S. 1954. High tide and an east wind-the story of the black duck. Stackpole Co., Harrisburg, Pennsylvania and Wildlife Management Institute, Washington, D.C. 162pp.

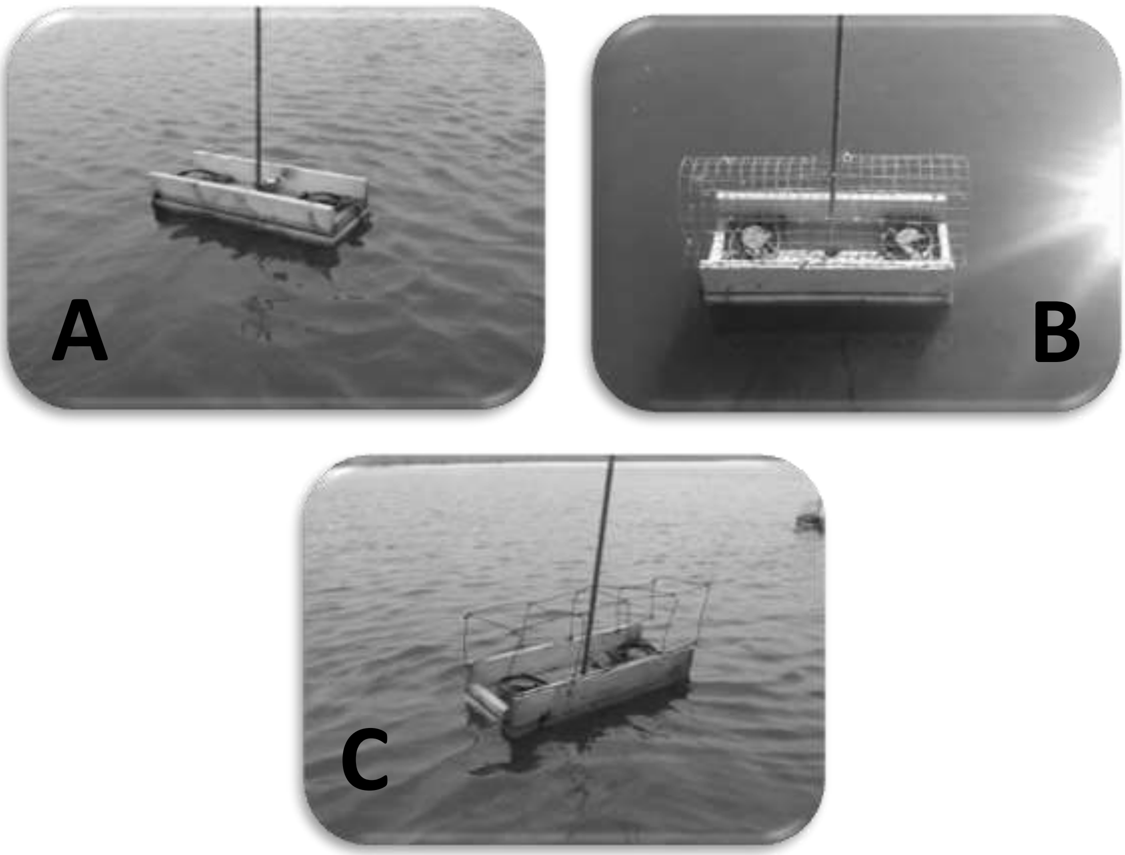

Figure 1. **Examples of the variability in cover types for muskrat float sets used during trapping in eastern North Dakota, 2012-2014. A)** uncovered float set, **B)** float set using 2.54 cm by 2.54 cm (1 in x 1 in) metal wire mesh cover, and **C)** float set using 15.24 cm by 15.24 cm (6 in x 6 in) wire mesh cover type. Photos courtesy of Stephanie Tucker, North Dakota Game and Fish Department.

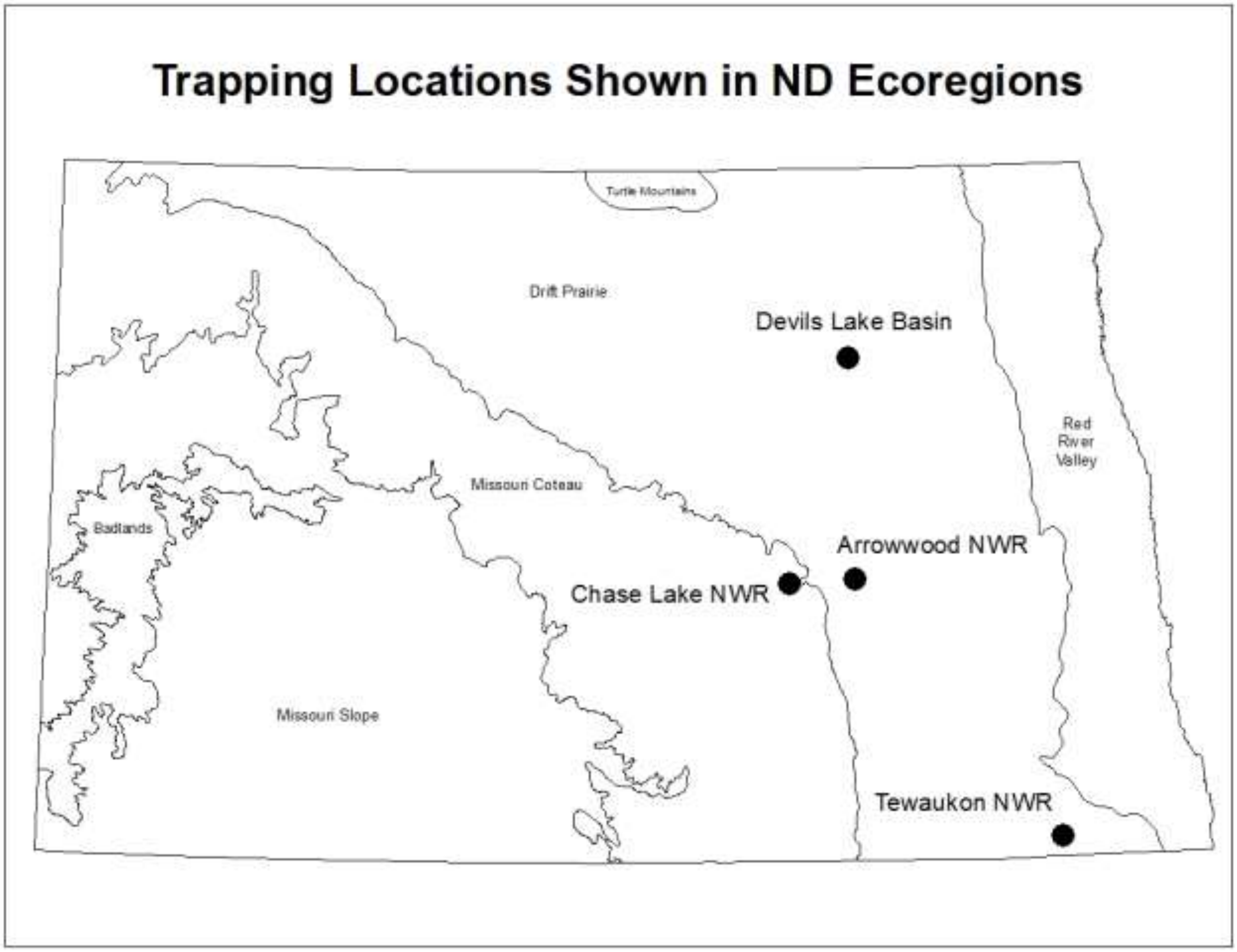

Figure 2. **Major physiographic regions of North Dakota with dots marking the four primary field locations for trapping.** Each location was selected on the basis of muskrat populations frequently targeted for trapping, nonresident trapping pressure, and migrating waterfowl usage.

CHAPTER II

INCIDENTAL TAKE AND VULNERABILITY OF WATER BIRDS TO MUSRKAT FLOAT SETS

ABSTRACT

Muskrats (*Ondatra zibethicus*) are becoming a highly sought after furbearer species in North Dakota due to an increase in pelt prices. In 2011, regulation changes by the North Dakota Game and Fish Department allowed trappers to use float sets to trap muskrats during the spring season. Current regulations require float sets used during the spring trapping season to have a covering made of either wire mesh, wood, or plastic and must not have an opening exceeding 20.32 cm (8 in) to attempt to minimize the incidental take of non-target species. The primary goal of this project was to determine if muskrat float set covers are effective in eliminating incidental take of non-target species. Float sets used included uncovered, 2.54 cm by 2.54 cm (1 in x 1 in) wire mesh, and 15.24 cm by 15.24 cm (6 in x 6 in) wire mesh float sets. Trapping efforts were focused to four locations across eastern North Dakota over a two year period. During the study, seven non-targets species (three black-crowned night heron (*Nycticorax nycticorax*), two blue-winged teal (*Anas discors*), and two painted turtles (*Chrysemys picta*)) were captured over 4,245 trap nights (0.002 captures/trap night). All non-targets were captured on uncovered float sets except for the painted turtles (1 in x 1 in and 6 in x 6 in). In addition to float sets, cameras were placed at each float set to evaluate the number of encounters and behaviors displayed of non-target water birds at float sets. We found that cover type did not influence encounter rates or behavior displayed of water birds at float sets, and that water birds

in general were 7.5 times more likely to encounter a float in the spring as compared to the fall. We found non-duck water birds were 10.1 times more likely to contact float sets as compared to puddle and diving ducks. Regardless of guild, birds were 2.3 times less likely to contact a float set with a 1 in x1 in cover as compared to an uncovered float set. These results show the vulnerability of non-target water birds to uncovered muskrat float sets, especially during the spring trapping season, and illustrate the need for further investigation.

INTRODUCTION

Muskrats (*Ondatra zibethicus*) are one of the most widely distributed and sought after species of furbearer in North America (Boutin and Birkenholz 1987, Roberts and Crimmins 2010). Commonly used methods to trap muskrats include the use of footholds, body gripping traps, colony traps, and float sets. Float sets are a popular open water trapping equipment used during spring and fall trapping seasons. A float set usually consists of a flat wooden base that floats just above the water's surface with either foothold or body gripping traps placed on the top of the platform. The use of this type of trapping equipment has increased in recent years due to the ease of use and efficiency of capture when used in muskrat trapping.

Recently, fur prices have increased to the highest they have been in decades (Tucker 2014). This has led to more trappers being on the landscape to take advantage of the pelt price increase. The increase in pelt prices, in particular muskrats, along with an increase in the use of float sets has led to managing wildlife agencies and researchers to question whether or not float sets are of risk to non-target incidental captures (e.g. waterfowl and water birds). Information available on non-target catches of birds by furbearer trappers has been collected incidental to predator control studies (Robinson 1943, Beasom 1974, Linhart 1981) and leg hold trap evaluations (Palmisano and Dupuie 1975, Linscombe 1976, Berchielli and Tullar 1980, Berchielli and Leubner 1981, Linhart 1981, Novak 1981). Research on the impacts of muskrat trapping, particularly the use float sets, on avian non-target incidental injuries and captures is limited.

Mainly, research has focused on the overall threat of muskrat trapping and of the equipment used (excluding float sets) on avian non-target capture. Footholds and body gripping traps have been shown to pose a threat to avian non-target injury or capture (Liscombe 1976, Parker 1983, Stocek and Cartwright 1985). During the 1972-73 trapping seasons in Louisiana, an evaluation was done on the No. 2 Victor foothold and single spring 220 body gripping to determine the efficiency and incidental impact of the traps. The evaluation resulted in 127 birds, 15% were ducks, being captured in the two types of traps with the majority of captures on the 220 body gripping trap (Liscombe 1976). This evaluation demonstrated the potential vulnerability of avian non-targets to body gripping type traps. In New Brunswick (Canada), however, the majority of avian non-targets were captured n foothold traps (Parker 1983). Similar vulnerability of avian non-targets to foothold and body gripping type traps was shown in a province-wide survey of trappers in New Brunswick (Canada) conducted at the close of the trapping seasons of 1980-1981, 1981-1982, and 1982-1983 to measure the frequency and composition of bird catches and to relate them to trap type and furbearer harvest. Results of the survey showed that 2% of all trappers captured a duck or a merganser (Stocek and Cartwright 1985). While there was evidence showing the vulnerability of avian non-targets to footholds and body gripping traps, the research on the vulnerability to float sets was lacking. The only research to investigate the impact of float sets on avian non-target captures was reported in 1949 from a study in Maine. Gashwiler (1949) estimated a total kill of 1,945 ducks during the 1946 trapping season, and injuries incurred by an additional 2,220 ducks actively involved in breeding activities.

Spring muskrat trapping has been shown to be a threat to avian non-targets (Wright 1945, Mendall 1958, Bailey 1976, Stout 1976). Wright (1945) found that spring muskrat trapping was the greatest single source of accidental mortality to nesting ducks in the northeast United States. Bailey (1976) stated that spring muskrat trapping can reduce the number of productive mallard (*Anas platyrhynchos*) hens in a waterfowl population as a result of incidental capture mortalities. Bailey surveyed muskrat trappers in a 10.4 km study block southeast of Minnedosa, Manitoba (Canada) and found that from the estimated population of 144 breeding pairs of mallards, 16 individuals were trapped by steel jawed traps place on muskrat huts, trails, and floating vegetation, and of those, 15 were females (Bailey 1976). Mendall (1958) considered spring muskrat trapping practices as a prime cause of accidental mortality to breeding ring-necked ducks (*Aythya collars*) in northeastern USA. Stout (1967) analyzed the continental band recoveries from waterfowl caught by devices other than banding traps and attributed 69 percent of spring band recoveries to muskrat trapping related mortalities. A noticeable trend which exists in research is that waterfowl species are among the highest captured. Waterfowl species seem to be especially vulnerable to incidental capture in muskrat float sets during spring trapping seasons. This may be in part due to the breeding behavior of some water species to nest on floating structures in the springtime (Baldassarre and Bolen 2006). Also, some nesting structures (e.g., hen houses) for waterfowl are similar in appearance to muskrat float sets.

Our objectives for this study were to estimate the amount of incidental take or injury, estimate encounter rates of birds at float sets, and evaluate the behavior of non-target water birds at covered and uncovered muskrat float sets in eastern North Dakota. One of our main focal points of this study was to determine water bird non-target vulnerability during the spring trapping season. We evaluated factors that may influence whether a water bird would contact a float set or not using data gathered from trail cameras placed at float sets over a two-year period.

METHODS

Study Areas

To determine incidental take on non-target species using covered and uncovered muskrat float sets, we trapped muskrats at four locations across eastern North Dakota in the fall and spring trapping seasons during Fall 2012-13 and Spring 2013-14 (Figure 3). Trapping locations were primarily on federal wildlife refuge and waterfowl production area (WPA) property. Access to private land was obtained in order to supplement trapping sites when needed. The four trappings locations (Figure 3) were selected based on a nonresident trapping activity survey sent out by the North Dakota Game and Fish Department (Tucker 2012b). These locations were in four counties (Nelson, Stutsman, Sargent, and Richland) and had the highest density of nonresident trappers.

Devils Lake Basin Study Location (Nelson County)

The Devils Lake study location is in northeastern North Dakota, and is approximately a 64.37 km^2 (40 mi^2) unit about 38.5 km^2 (15 mi^2) northeast of the town of Devils Lake, ND. The Devils Lake area has observed an increase in the number of wetlands and wetland size in recent years due to abundant snowfall. In response to abundant wetlands, muskrat populations have thrived in this area and trapping for muskrats has become a common practice along any state highway and other easily accessible wetlands with an abundant muskrat population. We used a variety of wetlands in this study area that included intermittent streams, semi-permanent, and permanent wetlands located on Waterfowl Production Areas (WPA) and private lands.

Arrowwood National Wildlife Refuge (NWR) Study Location (Stutsman County)

Arrowwood NWR was established in 1935 as a refuge for breeding water birds and other wildlife. It is located along the James River in east-central North Dakota and is comprised of 64.49 km^2 (15,936 acres) with a mix of grasslands, wooded coulees, and cultivated fields. Located in the refuge are four main water bodies: Arrowwood, Mud, and Jim Lakes, and Depuy Marsh. These are naturally occurring riverine lakes that have had control structures added at their outlets. Arrowwood is managed primarily to attract waterfowl during migration periods, but also contains excellent nesting habitat for grebes, shore birds, and many other forms of wildlife.

We focused primarily on the drainage canal that runs adjacent to the natural riverine lakes on the refuge property. This type of trapping location was utilized for its ease of access and quick set-up of float sets simulating a common and increasing practice of muskrat trapping in road ditches.

Chase Lake Wetland Management District (WMD) Study Location (Stutsman County)

The Chase Lake WMD covers two counties, Stutsman and Wells Counties in south central North Dakota. The mission of the WMD is to protect wetlands and surrounding grasslands for waterfowl production and other wildlife. Since 1960, the District has acquired 134 Waterfowl Production Areas (WPAs) totaling over 157.01 km^2 (38,800 acres). The Chase Lake WMD covers two physiographic regions, the Missouri Coteau on the west and Drift Prairie on the east.

We focused trapping efforts at Chase Lake WMD at the main Chase Lake Station WPA. This WPA has an abundance of wetlands that vary in size and depth. Muskrat populations are becoming overpopulated in this area, which has led to the muskrats becoming a nuisance on the WPA. Chase Lake WMD has both a large population of muskrats and migrating waterfowl in the fall and spring seasons, making it an ideal location for research on the interactions between birds and muskrats.

Tewaukon NWR Study Location (Sargent County)

Tewaukon NWR was established in 1934 and is comprised of 33.84 km^2 (8,363 acres) in the SE part of North Dakota. Tewaukon NWR is located alongside the Wild Rice River, which flows from west to east and then north out of Lake Tewaukon. Numerous pothole wetlands are located on the refuge which serves as a popular stop for migrating waterfowl. The Wetland Management District (WMD) runs through three counties (Richland, Ransom, and Sargent), and has 106 Waterfowl Production Areas (WPA). The district also has a number of grassland and wetland easements on district private lands.

Muskrat Float Set Design

Although many float designs and cover types exist, the designs selected for this study were based upon a preliminary survey conducted by the North Dakota Fur Hunters and Trappers Association (Tischaefer 2011). Survey results suggested the most popular float design used by trappers in North Dakota is a rectangular board with short side bumpers, a foam bottom, and a foothold trap at each end of the float. An additional survey was conducted by North Dakota Game and Fish Department to determine more specific details about trapping locations, materials used, float specifications, and muskrat trapping techniques (Tucker 2012a). This survey indicated popular cover types included metal wire mesh, PVC pipe, drain tile tubes, plastic mesh (Tucker 2012a). From the most popular float covers, we selected 2.54 cm by 2.54 cm wire mesh (hereafter: 1x1) and 15.24 cm by 15.24 cm wire mesh (hereafter: 6x6) coverings in addition to a float that would have no cover to (hereafter: uncovered). Also, we selected Duke No. $1^{1/2}$ foothold traps to be used on our float sets.

Field Methods

Trapping occurred with three float sets (i.e., one of each cover type) placed on wetlands with muskrat signs (presence of tracks, scat, lodges, and feeding sign) and water bird use. Float sets were staked with rebar and baited with apples. Wetlands selected were similar in size and wetland structure to those most commonly utilized by North Dakota muskrat trappers based upon survey results and personal inquiries. Selected wetlands were classified using the system Stewart and Kantrud (1971) created to classify natural lake and ponds in the glaciated prairie region. Based on the system, an ephemeral wetland is an I, a temporary wetland is a II, a seasonal pond or lake is a III, a semi-permanent pond or lake is a IV, and a permanent pond or lake is a V (Stewart and Kantrud 1971). Intermediate streams (IS) were also used as a classification for road-ditch type wetlands that trappers commonly use.

In order to estimate incidental take or injury, evaluate behaviors, and determine encounter rates of water birds at covered and uncovered muskrat float sets, we deployed approximately 60 trail cameras (Covert Extreme Red 40) at each float set (one camera per float). Each camera was placed approximately 5 meters from the float set and camouflaged in nearby vegetation (e.g. cattails). Cameras were set to record video for one minute when activated by motion (high sensitivity) in the camera viewing area. There was a 30 second delay in between video recordings to attempt to cut down on the number of videos recorded. We collected data on muskrats and waterfowl that approach the float set, the number of muskrats and waterfowl caught in the float sets, and additional behaviors documenting interactions when the float set was encountered. Behaviors were classified as either a swim by, fly by, on float, contact float, or trapped. Specific interest for non-target species were actual encounters versus captures to determine vulnerability to these species.

We used a combination of small “pothole” type wetlands along with a number of larger semi-permanent wetlands in order to replicate the traditional type of wetlands used by muskrat trappers in North Dakota. The spring trapping period was the focal point of this study. Thus, muskrat trapping commenced at ice-out and continued for approximately 2 weeks following ice-out. This time period coincided with the highest quality of pelts of muskrats and the highest concentration of migrating waterfowl. We started trapping during the spring in the southern-most site (Tewaukon NWR) as ice-out occurred, and moved to the more northern sites as they thawed creating open water attractive to migratory birds. We followed the waterfowl migration north and continued trapping for approximately the first two weeks of wetlands thawing, resulting in approximately 6 weeks of intense trapping across the four study locations. We performed daily trap checks to remove any captures and replenished bait as needed. Float sets were active at a wetland for approximately 5-7 days. This timeframe was used to emulate trapping practices commonly used where trappers deploy floats for a week or less at a wetland and then move them once trap success declines.

Fall trapping occurred in a reverse order starting with the northern trapping location (Devils Lake) down to the southeastern location (Tewaukon NWR) and coincided with peak fall migration and current and historic trapping season dates. Based on data from North Dakota Game and Fish Department waterfowl biologists, our sites had historical trends of abundant waterfowl during migration.

Water bird Use Surveys

To assess specific species of water birds that use the same wetlands as muskrats, we conducted surveys during each trapping period on each wetland. This consisted of a brief survey upon arrival at the wetland of counts of water birds divided into number of diving ducks, dabbling ducks, and other water bird species (e.g., grebes, herons, etc.). We performed the survey as we approached each wetland used for a trapping location, and used binoculars to identify water birds using the wetland within 200m from the float set location in a similar fashion to four-square mile surveys conducted for breeding waterfowl.

Incidental-take and Non-target Species Protocols

When a non-target capture occurred, we recorded the species captured and the extent of injuries (mortality, broken leg, etc.). If an animal (muskrat or non-target) was wounded in a way that recovery was not possible, we followed proper permit protocols from the U.S. Fish and Wildlife Service (Permit No: MB80456-1), University of North Dakota IACUC protocols (Office of Laboratory Animal Welfare No. A3917-01, Protocol No. 1208-1), and North Dakota Game and Fish Department (GNF03308880 and GNG03538895) for euthanasia and further necropsy the animal to examine injuries sustained. All incidental mortality was reported to North Dakota Game and Fish Department and the Migratory Bird Permit Office. Information on species, sex, date of mortality, and location was recorded. All migratory birds were disposed of or donated to the University of North Dakota (UND) Vertebrate Museum (Physical Address: Biology Department, 10 Cornell Street, Stop 9019, Grand Forks, ND 58202-9019) for teaching and research specimens. Lethal methods were required for this study to allow evaluation of non-target mortality and allowed us to examine the extent of an injury sustained by a non-target species so we could make further recommendations on methods of preventing such injuries/mortalities with trap modifications.

A few muskrat pelts were saved by UND for educational specimens in the UND Vertebrate Museum. The majority of the muskrat pelts were donated to the North Dakota Trappers Association to help fund their Fur Trapper Education program.

Data Analysis

We calculated summary statistics of overall trapping results and incidental captures, daily wetland water bird use, estimated encounter rates, and examined behaviors of non-target water birds using video footage recorded from trail cameras placed at float sets. We also explored what covariates (Table 1) influenced water bird encounters and behaviors (e.g., contacted a float, got on top of a float). We conducted all regressions using SAS software (SAS Institute, Inc., Version 9.3).

Daily Water Bird Use at Wetlands

We estimated daily water bird use at wetlands during fall and spring trapping seasons. We divided water bird use into three water bird categories of puddle ducks, diving ducks, and other water birds. The global (i.e., included all predictor variables of interest) hierarchical mixed model was used to estimate the impacts of included covariates on daily water bird each wetland used during the two year study.

Water Bird Encounter Rates at Floats

We estimated water bird encounter rates using the global hierarchical generalized linear mixed model in SAS that accounted for dependence of the three floats at a single wetland across a wetland management district. Due to the hierarchical nature of a model, the covariate of wetland site was nested into trapping location (Devils Lake, Chase Lake, Tewaukon, and Arrowwood). We used daily encounter rates as the dependent (response) variable. The fixed variables included cover type, season, wetland class, and the interaction of season and cover type. Random variables included year and wetland site within trapping locations. We examined coefficient estimates to determine what impact individual covariates had on the daily encounter rates of water birds at float sets. We used an alpha value of 0.05 for statistical significance of the predictor variables, but we also evaluated estimates relative to biological significance of the trends.

Water Bird Behaviors at Floats

We examined behaviors of water birds at float sets video collected at each float. We classified behaviors observed at the floats as either swim by, contact float, and on float/trapped and calculated summary statistics. We explored the influence of multiple covariates on behaviors displayed by water birds at float sets through a series of logistic regressions. We examined which covariates had an impact on whether or not a water bird contacted or went on top of a float set. Bird guilds were divided into groups containing puddle ducks, diving ducks, and other water birds. We used behaviors of contact float or on float as the dependent variables. Predictor variables for both regressions included cover type, season, and bird guild (Other water birds compared to ducks). Year was not used due to quasi-complete separation (i.e., some years we did not have any of the behaviors exhibited by certain bird guilds) during analysis. We estimated individual covariate coefficient estimates of the global models constructed. We back-transformed coefficient estimates to their respective odds ratio (OR) for interpretation. Odds ratio confidence intervals including 1.0 are not considered statistically significant, but may be biologically important if estimates are deviating from 1.0.

RESULTS

Incidental Take

We captured seven non-target animals over 4,245 trap nights (i.e., capture rate of 0.002 incidentals/trap night) during fall and spring trapping season at all study locations over the two year study period (Table 2). Of those seven, five of them were avian non-targets. Non-targets captured included three black-crowned night herons (*Nycticorax nycticorax*), two blue-winged teal (*Anas discors*), and two painted turtles (*Chrysemys picta*). All avian non-targets were captured on uncovered float sets. The turtles were captured on a 1x1 and a 6x6 float set. It is noteworthy that three of the incidental captures were during the open muskrat trapping season (October 25th – April 30th). The other four captures came after the closing date of the season. Dates of incidental captures and extent of injuries to non-target captures were classified and reported to managing agencies (Table 3).

Encounters

We evaluated 8,207 avian encounters with float sets over the two year study period from 311,377 one minute video recordings collected by trail cameras placed at each float set (Table 4). Avian non-targets had a daily encounter rate of 1.93 encounters per day (Table 4). Puddle ducks (47.5%) were observed the most frequently around float sets followed by other water birds (33.0%) and diving ducks (9.5%) (Table 4). Encounters of avian non-targets did not differ much compared to the different cover types (Figure 4).

From our global-mixed model for non-target encounters, we found cover type of the float did not really have an influence on whether an avian non-target encountered a float set. Although not significant, on average we observed 0.517 fewer daily bird encounters on a 1x1 float set and 0.615 fewer encounters on a 6x6 float as compared to an uncovered float set (Table 5). We found a trend for higher encounters rates at more permanent wetlands as compared to the smaller semi-permanent type wetlands with 2.517 fewer daily encounters at type IS wetlands than class

V wetlands (Table 5). Season influenced daily encounter rates with 1.973 fewer avian non-targets daily encounters in the fall as compared to spring (Table 5).

Behaviors

The most common type of behavior observed at float sets was a swim by (99.3%). Other behaviors observed included contact float and on float/trapped but were far less common (Table 6). Puddle ducks were 1.74 times more frequently observed than other water birds and 6.10 times more frequently captured on video than diving ducks (Table 4).

We found that regardless of bird guild, avian non-targets were 2.3 times less likely to contact a float set with a 1x1 cover as compared to an uncovered float set, but 6x6 covers had similar probabilities of contact as uncovered (Table 7). Avian non-targets were 7.5 times less likely to contact a float set in the fall as compared to the spring season (Table 7). Other, non-duck water birds showed the greatest vulnerability to float sets. They were 10.1 times more likely to contact a float set as compared to a puddle and diving ducks collectively (Table 7). In fact, no diving duck ever contacted a float during this study.

A second logistic regression was used to analyze what covariates had an impact on whether or not an avian non-target would go on top of a float set or not. We found that regardless of bird guild, avian non-targets were 2.1 times less likely to climb on top of a float set with a 1x1 cover as compared to an uncovered float set, but there was a similar probability of non-targets on top of the 6x6 and uncovered floats (Table 8). Further, avian non-targets were 6.8 times less likely to climb on top of a float set in the fall as compared to the spring season. Similar to the analysis of birds contacting float sets, water birds were 10.2 times more likely to climb on top of a float set as compared to puddle and diving ducks collectively (Table 8), suggesting when other water birds contacted the float they were usually on top of it.

Of the birds incidental taken on floats, black crowned night herons and blue-winged teal were the most common avian non-targets to climb onto float sets. Night herons encountered float sets 13 times, with 8 of those resulting in a night heron climbing onto a float set (61.5% of total behaviors observed). Blue-winged teal climbed onto float sets during .4% of the occurrences observed at float sets (Table 9).

DISCUSSION

Our results suggest that avian non-targets water birds are vulnerable to incidental capture or injury from the use of uncovered muskrat float sets. These results are consistent with past research that have found that muskrat trapping and the equipment used (e.g., footholds, body grippers, etc.) has a negative impact on non-target animals through incidental take or injury (Wright 1945, Gashwiler 1949, Mendall 1958, Bailey 1976, Linscombe 1976, Stout 1976, Parker 1983, Stocek and Cartwright 1985). Most studies focus on the vulnerability of waterfowl to muskrat trapping practices and do not include other common water birds. To our knowledge only a few studies have looked at water bird vulnerability during the spring seasons, and no studies have focused on the fall season. A focal point of this study was to determine water bird vulnerability in the spring due to the importance of the breeding season to species such as puddle ducks, diving ducks, and other water birds, suggesting that covers eliminate non-target bird captures during both seasons and may be more important during the spring.

We found that water birds are more vulnerable in the spring season as compared to the fall season; they were more likely to contact and even sit on top of a float during the spring. Bailey (1976) also showed that mallards are vulnerable to muskrat trapping practices during the spring season in Manitoba, Canada. The only research to focus on the vulnerability of waterfowl to muskrat float sets found similar results to our study. Gashwiler (1949) estimated a total of

1,945 total ducks captured during the 1946 spring muskrat trapping season in Maine. He reported for every 14.7 muskrats captured, one duck was captured. Our results showed vulnerability to float sets, but not to this magnitude. We observed that for every 98 muskrats captured, we would catch one water bird. The difference in magnitude of water bird captures could be due to the difference in habitat and species of waterfowl present in North Dakota and Maine. Gashwiler (1949) showed that 43 percent of waterfowl captured were American black ducks, which are not common in North Dakota.

The most vulnerable bird guild was the other water bird guild (e.g, coots, grebes, herons, etc.); they were more than 10 times more likely to contact a float as compared to duck species. This may be in part due to the breeding behavior of some water species to nest on floating vegetation or structures in the springtime (Baldassarre and Bolen 2006). Also, some nesting structures (e.g., hen houses) for waterfowl are similar in appearance to muskrat float sets which are readily available in many wetlands in eastern North Dakota and with increasing water levels several of these nesting structures are close to the surface of the water. Gashwiler (1949) found similar results to our research, showing that water birds (especially waterfowl) are vulnerable to float sets during spring trapping seasons; however, our results indicated a much lower potential impact on avian populations from float sets alone.

The captures of the three black-crowned night herons compared to the two blue-winged teal should warrant attention to managing agencies. Current population estimates of black-crowned night herons are approximately 50,000 in North America, compared to the population of blue-winged teal being estimated upwards of 8 million birds (North Dakota Game and Fish waterfowl staff, personal communication). With so many fewer black crowned night herons on the landscape as compared to blue-winged teal, the fact that we caught so many in our uncovered float sets is alarming.

We found that cover type did not have much of an influence on whether or not a water bird encountered a float, but played a larger role in if a float set was contacted or if the bird was trapped. Although not a large number of captures during the study (5 birds, 2 turtles), all of our non-target water bird captures were on uncovered float sets. Therefore, capture records show that the covers prevented incidental water bird capture during this study.

We did not test different float designs so future work is warranted on this topic; however, we were able to compare two types of wire covers. We found behaviors were different at floats with smaller mesh sizes and could deter birds from contacting a float set. Birds encountering float sets with 6x6 covers contacted and were on top of these floats as often as uncovered floats.

Applications of our research are not limited to eastern North Dakota, but to a wide variety of surrounding states that have also observed an increase in the use of muskrat float sets. Personal communication with trappers and other wildlife agencies on the topic of incidental water bird capture using muskrat float sets has raised some concerns. Although we did not capture many non-targets on our float design, anecdotal evidence suggests other designs may result in higher mortality rates of birds. The current cover requirement in North Dakota Game and Fish regulations appears to result in floats that have sides and sit higher in the water than other designs used in areas not having cover requirements. These float set designs that sit lower in the water and are uncovered have been reported to catch several non-target water birds (SD Game Fish & Parks, personal communication, September 2013). We believe this is due to the fact that these floats would be more appealing and easier to climb onto by birds and other non-targets than our float design. Our float design was difficult for water birds to get onto and also stay on. The videos collected during the study showed that when a water bird attempted to get onto a float set, they needed to flap their wings just go get far enough out of the water and get onto the float set. When the water bird would get onto the float set, the floats were unstable and would "wobble" in the water which most of the time forced the water bird to exit the float set. In contrast, a float set design without sides to attach a cover would sit lower in the water and be more stable for a water bird to go onto. We believe that our design is effective at eliminating non-target water bird capture by being higher in the water and creating an unstable structure for water birds to perch on. Further research is needed on the effect float set height in the water has on non-target water bird injury or take.

Management implications

The increased use of muskrat float sets along with an increase in pelt price in recent years has led managing wildlife agencies to develop concern as to whether this type of trapping practice has a negative impact on non-target water birds through incidental take or injury. Here, we have found that water birds are vulnerable to muskrat float sets, especially during the spring trapping seasons. While our results demonstrated low numbers of incidental take on the float set designs we used, covers did eliminate any non-target bird captures and smaller mesh sizes reduced contact by these birds compared to uncovered float sets.

Trapping of furbearer species, such as muskrats, is also very popular throughout the state. Recently, fur prices have increased to the highest they have been in decades (Tucker 2014). If prices continue to be high, we expect to see more trappers on the landscape which would increase non-target water bird vulnerability with more traps being used. Based on our research, current regulations on muskrat float sets in North Dakota are efficient in limiting incidental non-target water bird take or injury through the requirement of float set covering during the spring trapping season. Water birds were the most vulnerable during this season and continued protection is necessary. Continued research on this subject will ultimately help to understand these processes as well as mitigate impacts on local ecosystems.

LITERATURE CITED

Bailey, R. O. 1976. Mallard mortality in Manitoba's extended spring muskrat trapping season. Wildlife Society Bulletin 4:26-28.

Baldassarre, G. A., and E. G. Bolen. 2006. Waterfowl Ecology and Management. 2nd ed. Krieger Publishing, Malabar, FL.

Beasom, S. L. 1974. Selectivity of predator control techniques in south Texas. Journal of Wildlife Management. 38: 837-844.

Berchielli, L. T., and B. F. Tullar, Jr. 1980. Comparison of a leg snare with a standard leg-gripping trap. New York Fish and Game Journal 27:63-71

Berchielli, L. T., and A. B. Leubner. 1981. A technique for capturing red and gray foxes. Pages 1555-1559 in J. A. Chapman and D. Pursley, eds. Proc. World- wide Furbearer Conf., Frostburg, Md. 2056pp.

Boutin, S., and D. E. Birkenholz. 1987. Muskrat and Round-tailed Muskrat. Pp xxx - xxx *in* M. Novak, J. A. Baker, M. E. Obbard, and B. Malloch, editors. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, ON, Canada.

Gashwiler, J. S. 1949. The effect of spring muskrat trapping on waterfowl in Maine. Journal of Wildlife Management 13:183-188.

Linhart, S. B. 1981. Field evaluation of techniques for reducing coyote predation on livestock. Pages 1826-1838 in J. A. Chapman and D. Pursley, eds. Proc. Worldwide Furbearer Conf., Frostburg, Md. 2056pp.

Linscombe, G. 1976. An evaluation of the No. 2 Victor and 220 conibear traps in coastal Louisiana. Louisiana Wildlife and Fisheries Commission report. pp 560-568.

Mendall, H. L. 1958. The ring-necked duck in the northeast. University of Maine Studies, 2nd Ser. 73, Ornithology. 317pp.

Novak, M. 1981. The foot-snare and the leg-hold traps: a comparison. Pages 1671-1685 in J. A. Chapman and D. Pursley, eds. Proc. Worldwide Furbearer Conf., Frostburg, Md.2056pp .

Palmisano, A. W., and H. H. Dupuie. 1975. An evaluation of steel traps for taking fur animals in coastal Louisiana. Southeastern Assoc. Game and Fish Comm. Conf. 29:342-347.

Parker, G. R. 1983. An evaluation of trap types for harvesting muskrats in New Brunswick. Wildlife Society Bulletin 11:339-343.

Roberts, N. M., and S. M. Crimmins. 2010. Do Trends in Muskrat Harvest Indicate Widespread Population Declines? Northeastern Naturalist 17:229-238.

Robinson, W. B. 1943. The "Humane Coyote-Getter" vs. the steel trap in control of predatory animals. Journal of Wildlife Management 7:179-189.

Stewart, R. E., and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Resource Publication 92, Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C. 57pp.

Stocek, R.F., and D.J., Cartwright. 1985. Birds as non-target catches in the New Brunswick furbearer harvest. Wildlife Society Bulletin 13:314-317.

Stout, I. J. 1967. The nature and patterns of non-hunting mortality in fledged North American waterfowl. M.S. Thesis. Virginia Poly-technic Inst., Blacksburg. 329pp.

Tischaefer, R. 2011. North Dakota Fur Hunters and Trappers Association preliminary muskrat trapping survey. Raw data.

Tucker, S. 2012a. Study No. E-II: Furbearer harvest regulations study. Project No. W-67-R-52, Report No. C-456, North Dakota Game and Fish Department, Bismarck, North Dakota, USA.

Tucker, S. 2012b. Study No. E-II: Furbearer harvest regulations study. Project No. W-67-R-51, Report No. C-453, North Dakota Game and Fish Department, Bismarck, ND.

Tucker, S. 2014. Study No. E-11: Furbearer Harvest Regulations Study. North Dakota Game and Fish Department.

Wright, B. S. 1954. High tide and an east wind-the story of the black duck. Stackpole Co., Harrisburg, Pennsylvania and Wildlife Management Institute, Washington, D.C. 162pp.

Table 1. Explanatory covariates used for analyzing muskrat trapping and incidental take of non-target water birds in eastern North Dakota, 2012–2014.

Covariate	Data Type	Description
Site	Categorical	Individual Wetlands: MR001-MR113
Location	Categorical	Wetland district: Chase Lake, Devils Lake, Arrowwood, and Tewaukon
Year	Categorical	Study year: 2012, 2013, or 2014
Season	Categorical	Trapping season: Fall or Spring
Cover Type	Categorical	Uncovered, 1 in by 1 in, and 6 in by 6 in
Wetland Class	Categorical	Wetland type: IS, III, IV, V
Bird Guild	Categorical	Puddle duck, Diving duck, and Other water birds

Table 2. Summary of muskrat trapping and incidental capture rates in eastern North Dakota, 2012-2014.

Trapping season	Trap nights	No. incidentals	No. muskrats	No. muskrats/ trap night	No. incidentals/ trap night
Fall 2012	273	0	22	0.081	0.000
Spring 2013	1,314	1	72	0.055	0.0007
Fall 2013	918	0	165	0.179	0.000
Spring 2014	1,740	6	231	0.133	0.003
Total	4,245	7	490	0.115	0.002

Table 3. Summary of incidental captures during muskrat float research in eastern North Dakota, 2012-2014.

Species	Date	Cover Type	Wetland Class	Mortality	Location
Black-crowned Night Heron	4/27/2013	None	4	Yes	Tewaukon
Black-crowned Night Heron	5/14/2014	None	4	Yes	Chase Lake
Blue-winged Teal	5/10/2014	None	3	Yes	Chase Lake
Black-crowned Night Heron	5/22/2014	None	4	Yes	Devils Lake
Blue-winged Teal	5/21/2014	None	4	Yes	Devils Lake
Painted Turtle	4/22/2014	1x1	3	No (released)	Tewaukon
Painted Turtle	4/21/2014	6x6	3	No (released)	Tewaukon

Table 4. Summary of the number of observed encounters and encounter rates of water birds from trail camera videos collected during fall and spring trapping season in eastern North Dakota, 2012-2014.

Species	Swim by	Contact float	On float/trapped	Total	No. Encounter/day
Puddle duck	4,709	1	13	4,723	1.11
Diving duck	774	0	0	774	0.18
Other water birds	2,665	4	41	2,710	0.64
Total	8,148	5	54	8,207	1.93

Table 5. Fixed effect coefficient estimates of covariates exploring water bird encounter rates for three types of covers on floating muskrat sets in fall and spring and at different wetland classes. See Table 1 for covariate descriptions.

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	4.3654	1.2006	2	3.64	0.0680
Cover_Type[1] 1x1	-0.6783	0.4644	458	-1.46	0.1448
Cover_Type[1] 6x6	-0.6126	0.4632	458	-1.32	0.1867
WC – IS[1]	-2.1576	1.2283	458	-1.76	0.0796
WC - 3[1]	-1.0491	1.1932	458	-0.88	0.3797
WC - 4[1]	-0.5146	1.1925	458	-0.43	0.6663
Cover_Type* Season 1x1*Fall	0.0431	0.7340	458	0.55	0.5850
Cover_Type* Season 6x6*Fall	-0.0050	0.7332	458	-0.01	0.9946
Season[1]	-1.9729	0.5386	458	-3.66	0 .0003

[1]Baselines used for analysis included none for cover type, type 5 wetland for wetland class, uncovered*spring for interactions of covariates, and spring for season.

Table 6. Summary of behaviors of water birds observed during the two year study at the three different cover types of muskrat float sets used during two year study in eastern North Dakota, 2012-2014. Data was obtained from videos collected by trail cameras placed at float sets.

Behavior	None	1x1	6x6	Totals
Swim by	3,223	2,407	2,518	8,148
Contact Float	2	0	3	5
On Float/trapped	26	8	20	54
Totals	**3,251**	**2,415**	**2,541**	**8,207**

Table 7. Covariate coefficient estimates for whether or not a water bird contacted a float set when it encountered it. Associated odds ratios (OR) are also calculated for result interpretation. See Table 1 for covariate descriptions.

Parameter	Estimate	Standard Error	Odds Ratio	OR LCI	OR UCI
Intercept	-5.5078	0.3554			
1x1	-0.8399	0.4123	0.432	0.192	0.969
6x6	0.1822	0.2973	1.200	0.670	2.149
Season[1]	-2.0148	1.0123	0.133	0.018	0.970
Bird Guild[2]	2.3141	0.3515	10.116	5.079	20.147

[1]Spring was used as the baseline for season analysis.

[2]Other water birds were compared to ducks (baseline) in analysis of bird guild.

Table 8. Covariate coefficient estimates for whether or not a water bird got onto a float set when it encountered it Associated odds ratios (OR) are also calculated for result interpretation. See Table 1 for covariate descriptions.

Parameter	Estimate	Standard Error	Odds Ratio	OR LCI	OR UCI
Intercept	-5.6059	0.3735			
1x1	-0.7492	0.4168	0.473	0.209	1.070
6x6	0.1281	0.3142	1.137	0.614	2.104
Season[1]	-1.9179	1.0133	0.147	0.020	1.071
Bird Guild[2]	2.3213	0.3699	10.188	4.935	21.036

[1]Spring was used as the baseline for season analysis.
[2]Other water birds were compared to ducks (baseline) in analysis of bird guild.

Table 9. Summary of avian non-target behaviors and ratios of being on a float set or trapped at a float set.

Species	On float/trapped	Total behaviors	Ratio of On float/trapped of total behaviors	On float/trapped per trap night
BWTE	13	3,578	0.004	0.003
BCNH	8	13	0.615	0.002
Puddle ducks	13	4,723	0.003	0.003
Diving ducks	0	774	0.000	0.000
Other water birds	41	2,710	0.015	0.010

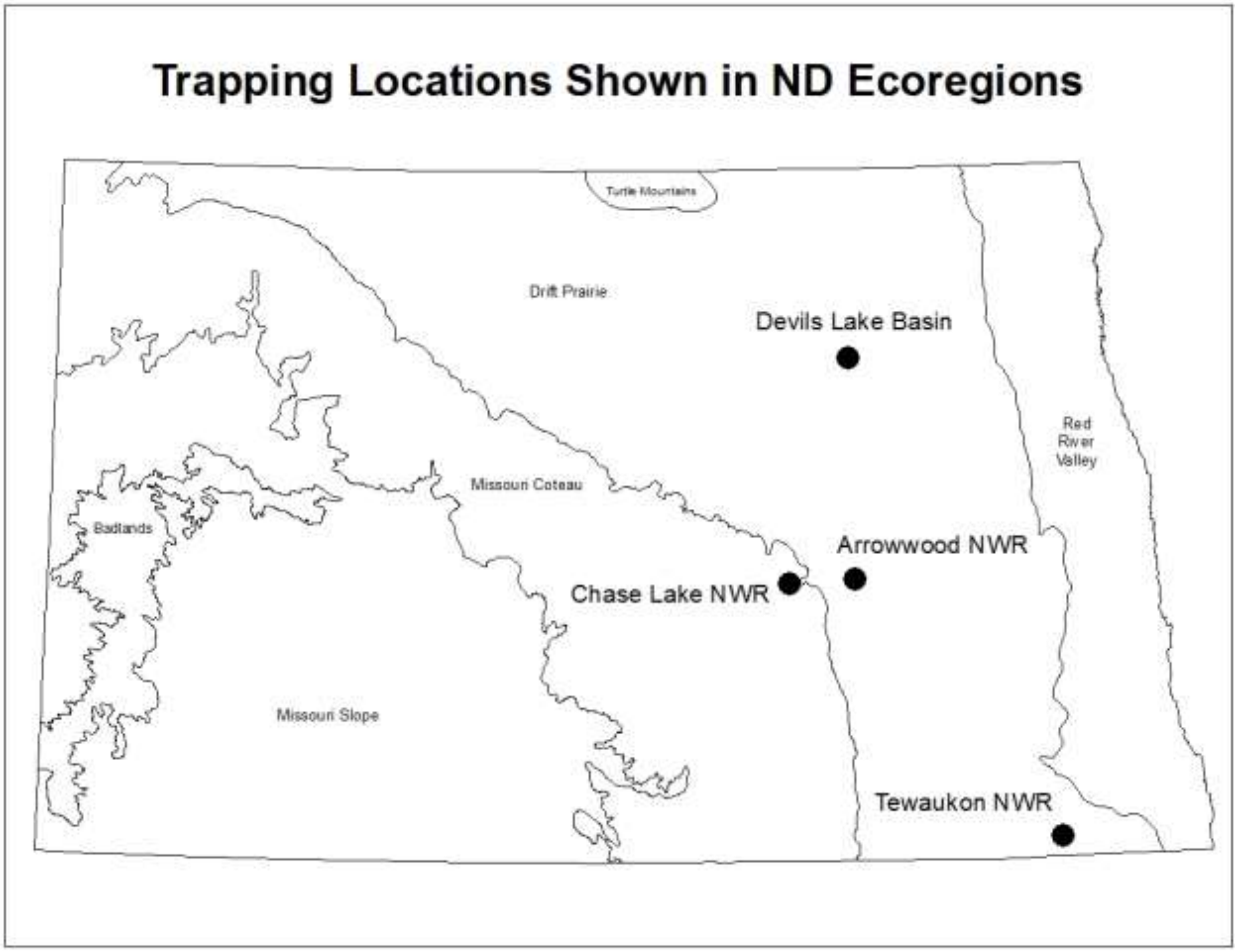

Figure 3. Major physiographic regions of North Dakota with dots marking the four primary field locations for trapping. Each location was selected on the basis of muskrat populations frequently targeted for trapping, nonresident trapping pressure, and migrating waterfowl usage.

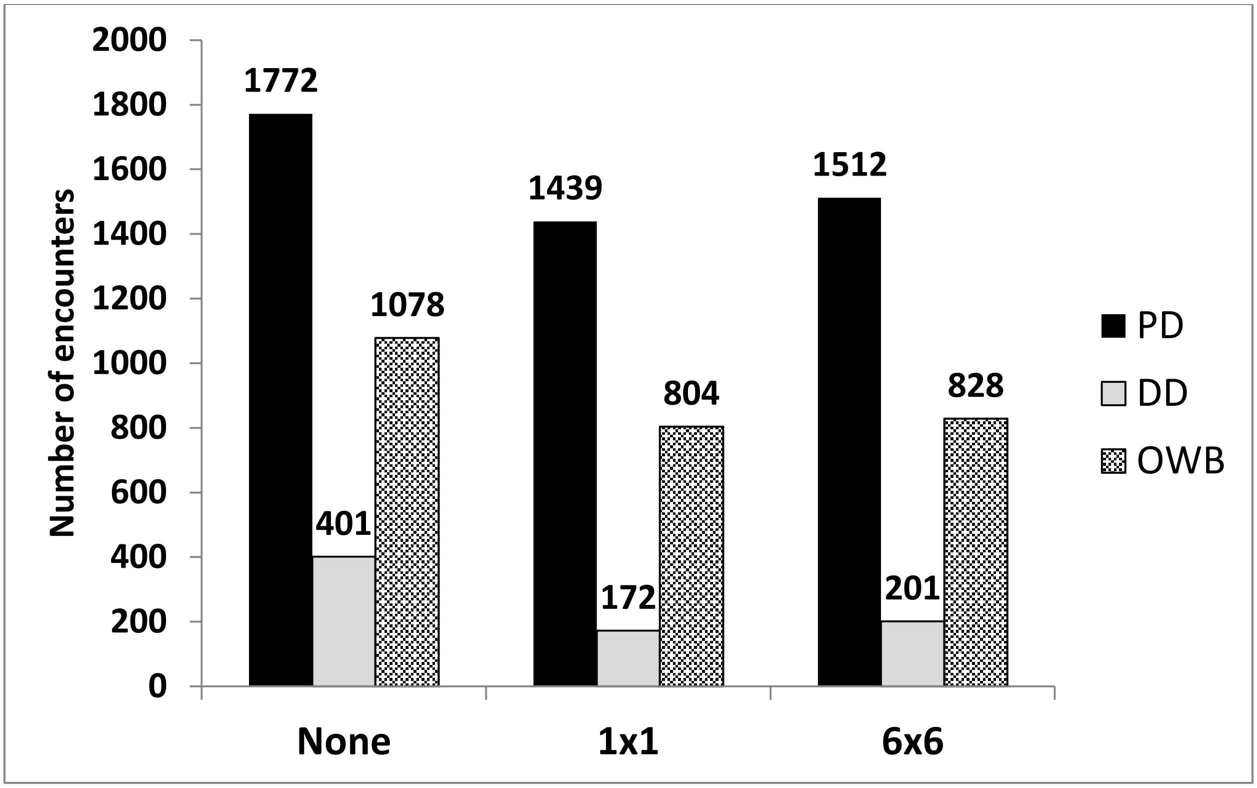

Figure 4. Graph of water bird encounters at float sets separated by cover type and bird guild during two year study in eastern North Dakota, 2012-2014. Cover types included uncovered, 1 in x 1 in (2.54 cm by 2.54 cm) wire mesh and 6 in x 6 in (15.24 cm by 15.24 cm) wire mesh. Bird guilds were denoted as: PD = puddle duck, DD = diving duck and OWB = other water bird.

CHAPTER III

MUSKRAT BEHAVIORS AND TRAPPING EFFICIENCY AT MUSKRAT FLOAT SETS

ABSTRACT

Muskrats (*Ondatra zibethicus*) are becoming a highly sought after furbearer species in North Dakota due to an increase in pelt prices. In 2011, regulation changes by the North Dakota Game and Fish Department allowed trappers to use float sets to trap muskrats during the spring season. Current regulations require float sets used during the spring trapping season to have a covering made of either wire mesh, wood, or plastic and must not have an opening exceeding 20.32 cm (8 in) to attempt to minimize the incidental take of non-target species. The primary objective of this project was to determine if muskrat float set covers are effective in eliminating incidental take of non-target species. Float set covers included uncovered, 2.54 cm by 2.54 cm (1 in x 1 in) wire mesh, and 15.24 cm by 15.24 cm (6 in x 6 in) wire mesh float sets. Trapping efforts were focused to four locations across eastern North Dakota over a two year period. We captured 490 muskrats over 4,245 trap nights (0.115 muskrat per trap night) during fall and spring trapping season at all study locations over the two year study period. Captures by cover type included 209 on 6 in x 6 in, 157 on uncovered, and 124 on 1 in x 1 in float sets. We evaluated 1,149 muskrat encounters with float sets over the two year study period from 311,377 one minute video recordings collected by trail cameras placed at each float set. Muskrats had a daily encounter rate of 0.27 encounters per day. Muskrats mostly common would swim by float sets (45.3%). Other behaviors observed included contacting float by swimming into sides of float

set (14.6%) and climbing onto float/trapped (40.1%). We observed 391 muskrat behaviors at uncovered, 399 at 1 in x 1 in, and 359 at 6 in x 6 in float sets. We found that there was no influence from a 1 in x1 in or 6 in x 6 in cover type on whether a muskrat contacted or went on top/was trapped at a float set. Also, we found that the use of covers did not negatively impact trapping efficiency. In fact, larger mesh sizes (6 in x 6 in) showed a slight increase in trapping efficiency. Further research is needed on different designs of float sets to better understand the impact on muskrat trapping efficiency.

INTRODUCTION

Muskrats (*Ondatra zibethicus*) are one of the most widely distributed and sought after species of furbearer in North America (Boutin and Birkenholz 1987, Roberts and Crimmins 2010). However, modern farming practices in the Midwestern United States have altered muskrat habitat by draining wetlands and channelizing small streams to transport excess water away from drain-tiled agriculture fields. Loss of critical wetland habitat has shifted the distribution of muskrats and condensed populations into larger groups (Ahlers et al. 2010).

There are many ideas as to the best practices for the trapping of muskrats, and these vary from different seasons (Aldous 1947) to different types of equipment used. Trappers are an inventive and original group. Equipment used for trapping is constantly evolving to meet the demands of the fur market. A trapper’s main goal is to harvest the maximum number of target animals in the most efficient way. To our knowledge, no research has been done to evaluate the trapping efficiency at muskrat float sets and regulations related to cover types for this trapping method. Most studies have concentrated on the biology, ecology, and population dynamics of the species or the impact of environment and climate upon fecundity, survival, and mortality (Parker 1983). While other research has focused on the impacts trapping has on non-targets (Chapter 2, Gashwiler 1949, Wright 1945, Bailey 1976, Liscombe 1976, Parker 1983, Stocek and Cartwright 1985). This lack of research into trapping efficiency shows the need for further investigation into the topic.

Recently, fur prices, specifically relative to muskrats, have increased to the highest they have been in decades (Tucker 2014). This has led to more trappers being on the landscape to take advantage of the pelt price increase. The increase in muskrat pelt prices along with the increase in trapping pressure has led to trappers, managing wildlife agencies, and researchers to consider regulations and population impacts of float sets for muskrats (Figure 6) . A float set usually consists of a flat wooden base that floats just above the water's surface with either foothold or body gripping traps placed on the top. Foothold traps are triggered when the muskrat steps on a pressure sensitive pan that triggers the jaws of the trap, capturing the muskrat, and resulting in immediate death or drowning after retreating to the water. Trappers are especially interested in if required coverings on a float set that are required to minimize non-target captures increase or decrease muskrat trapping efficiency.

The North Dakota Game and Fish Department manages muskrats with annual hunting and trapping seasons from late October until late April each year. Approximately 30,000 muskrats are harvested annually in North Dakota (Seabloom 2011). However, the number of muskrats harvested fluctuates based on population abundance, pelt values, and weather conditions. For example, during the 2010-2011 North Dakota muskrat season, there were over 50,000 muskrats trapped or shot (Tucker 2012b). In North Dakota, the most commonly used methods of trapping include footholds, body gripping traps, colony traps, or float sets. On average a trapper will capture at least one muskrat per day of trapping in North Dakota, although there is considerable variability (Tucker 2012b). Trapping during the spring has become popular due to the efficiency of open water traps, including float sets, and the quality of the pelts at this time of the year.

In 2011, regulation changes by the North Dakota Game and Fish Department allowed trappers to use float sets to trap muskrats during the spring season. Float sets were required to have a covering made of wire mesh, wood, or plastic and must not have an opening that exceeds 20.32 cm (8 in) in height, width, or diameter to attempt to minimize the capture of non-target species. Covers may force muskrats to enter the float set from the ends where traps are placed potentially increasing muskrat capture rates, while some trappers suggest the covers will have a negative impact on muskrat captures.

The objectives for this study were to evaluate muskrat trapping efficiency between covered and uncovered float sets and to evaluate muskrat behaviors when they encountered float sets based on trail cameras placed at float sets. The use of cameras has become a popular and widely used method for collecting such data on a variety of different taxa (O'Connell et al. 2006, Lyra-Jorge et al. 2008, Rowcliffe and Carbone 2008). This technique allows a site to be surveyed for extended lengths of time without the need for researcher presence. In addition, technology has made the use of cameras affordable and logistically favorable with increased memory storage and battery life (Locke et al. 2012). We used this data to analyze what factors impact whether a muskrat encounters, contacts, or goes onto a float set as part of a larger study evaluating non-target captures on covered and uncovered float sets at four trapping locations over a two year period during fall and spring muskrat trapping seasons in North Dakota.

METHODS

Study Areas

To determine muskrat trapping efficiency using covered and uncovered muskrat float sets, we trapped muskrats at four trapping locations across eastern North Dakota in the fall and spring trapping seasons during Fall 2012-13 and Spring 2013-14 (Figure 5). Trapping locations were primarily on federal wildlife refuge and waterfowl production area (WPA) property. Access to private land was obtained in order to supplement trapping sites when needed. The four trappings locations (Figure 5) were selected based on a nonresident trapping activity survey sent out by the North Dakota Game and Fish Department (Tucker 2012b). These locations were in four counties (Nelson, Stutsman, Sargent, and Richland) and had the highest density of nonresident trappers.

Devils Lake Basin Study Location (Nelson County)

The Devils Lake study location is in northeastern North Dakota, and is approximately a 64.37 km^2 (40 mi^2) unit about 38.5 km (15 mi) northeast of the town of Devils Lake, ND. The Devils Lake area has observed an increase in the number of wetlands and wetland size in recent years due to abundant snowfall. In response to abundant wetlands, muskrat populations have thrived in this area and trapping for muskrats has become a common practice along any state highway and other easily accessible wetlands with an abundant muskrat population. We used a variety of wetlands in this study area that included intermittent streams, semi-permanent, and permanent wetlands located on Waterfowl Production Areas (WPA) and private lands.

Arrowwood National Wildlife Refuge (NWR) Study Location (Stutsman County)

Arrowwood NWR was established in 1935 as a refuge for breeding water birds and other wildlife. It is located along the James River in east-central North Dakota and is comprised of 64.49 km^2 (15,936 acres) with a mix of grasslands, wooded coulees, and cultivated fields. Located in the refuge are four main water bodies: Arrowwood, Mud, and Jim Lakes, and Depuy

Marsh. These are naturally occurring riverine lakes that have had control structures added at their outlets. Arrowwood is managed primarily to attract waterfowl during migration periods, but also contains excellent nesting habitat for grebes, shore birds, and many other forms of wildlife.

We focused primarily on the drainage canal and intermittent stream that runs adjacent to the natural riverine lakes on the refuge property. This type of trapping location was utilized for its ease of access and quick set-up of float sets simulating a common and increasing practice of muskrat trapping in road ditches.

Chase Lake Wetland Management District (WMD) Study Location (Stutsman County)

The Chase Lake WMD covers two counties, Stutsman and Wells Counties in south central North Dakota. The mission of the WMD is to protect wetlands and surrounding grasslands for waterfowl production and other wildlife. Since 1960, the district has acquired 134 Waterfowl Production Areas (WPAs) totaling over 157.01 km^2 (38,800 acres). The Chase Lake WMD covers two physiographic regions, the Missouri Coteau on the west and Drift Prairie on the east.

We focused trapping efforts at Chase Lake WMD at the main Chase Lake Station WPA. This WPA has an abundance of wetlands that vary in size and depth. Muskrat populations are becoming overpopulated in this area, which has led to the muskrats becoming a nuisance on the WPA. Chase Lake WMD has both a large population of muskrats and migrating waterfowl and water birds in the fall and spring seasons, making it an ideal location for research on the interactions between muskrats and water birds.

Tewaukon NWR Study Location (Sargent County)

Tewaukon NWR was established in 1934 and is comprised of 33.84 km^2 (8,363 acres) in the SE part of North Dakota. Tewaukon NWR is located alongside the Wild Rice River, which flows from west to east and then north out of Lake Tewaukon. Numerous pothole wetlands are located on the refuge which serves as a popular stop for migrating waterfowl.

The Wetland Management District (WMD) runs through three counties (Richland, Ransom, and Sargent), and has 106 Waterfowl Production Areas (WPA). The district also has a number of grassland and wetland easements on district private lands.

Muskrat Float Set Design

Although many float designs and cover types exist, the design selected for this study was based upon a preliminary survey conducted by the North Dakota Fur Hunters and Trappers Association (Tischaefer 2011). Survey results suggested the most popular float design used by trappers in North Dakota is a rectangular board with short side bumpers, a foam bottom, and a foothold trap at each end of the float (Figure 5). An additional survey was conducted by North Dakota Game and Fish Department to determine more specific details about trapping locations, materials used, float specifications, and muskrat trapping techniques (Tucker 2012a). This survey indicated popular cover types included metal wire mesh, PVC pipe, drain tile tubes, plastic mesh (Tucker 2012a). From the most popular float covers, we selected 2.54 cm by 2.54 cm wire mesh (hereafter: 1x1) and 15.24 cm by 15.24 cm wire mesh (hereafter: 6x6) coverings in addition to a float that would have no cover to (hereafter: uncovered). Also, we selected Duke No. $1^{1/2}$ foothold traps to be used on our float sets.

Field Methods

Trapping occurred with three float sets (i.e., one of each cover type) placed on wetlands with muskrat signs (presence of tracks, scat, lodges, and feeding sign) and water bird use. Float sets were staked with rebar and baited with apples. Wetlands selected were similar in size and wetland structure to those most commonly utilized by North Dakota muskrat trappers based upon survey results and personal inquiries. Selected wetlands were classified using the system Stewart and Kantrud (1971) created to classify natural lake and ponds in the glaciated prairie region. Based on the system, an ephemeral wetland is an I, a temporary wetland is a II, a seasonal pond or lake is a III, a semi-permanent pond or lake is a IV, and a permanent pond or lake is a V (Stewart and Kantrud 1971). Intermediate streams (IS) were also used as a classification for road-ditch type wetlands that trappers commonly use. We used a combination of small "pothole" type wetlands along with a number of larger semi-permanent wetlands in order to replicate the traditional type of wetlands used by muskrat trappers in North Dakota. In each trapping location, we selected 15 to 20 wetland sites that had sign of muskrat use and deployed each of the three cover types at each wetland.

In order to evaluate behaviors and determine encounter rates of muskrats at covered and uncovered float sets, we deployed trail cameras (Covert Extreme Red 40) at each float set (up to 60 float sets with cameras at a time). Each camera was placed approximately 5 meters from the float set and camouflaged in nearby vegetation (e.g. cattails). Cameras were set to record video for one minute when activated by motion (high sensitivity) in the camera viewing area. There was a 30 second delay in between video recordings to attempt to reduce the number of repeated observations of the same individual. We recorded data on muskrats and water birds that approached the float set, the number of muskrats and water birds caught in the float sets, and additional behaviors documenting interactions with the float set. Behaviors were classified as either a swim by, fly by, contact float (but did on climb on it), on float, or trapped.

The spring trapping period was the focal point of this study due to questions regarding muskrat float set regulations. Thus, muskrat trapping commenced at ice-out. This time period coincided with the highest quality of pelts of muskrats and the highest concentration of migrating waterfowl. We started trapping during the spring in the southern-most site (Tewaukon NWR) as ice-out occurred, and moved to the more northern sites as they thawed creating open water attractive to migratory birds and conducive to using float sets to trap muskrats. We followed the waterfowl migration north and continued trapping for approximately the first two weeks of wetlands thawing, resulting in approximately 6 weeks of intense trapping across the four study locations. We performed daily trap checks to remove any captures and replenished bait as needed. Float sets were active at a wetland for approximately 5-7 days. This timeframe was used to emulate trapping practices commonly used where trappers deploy floats for a week or less at a wetland and then relocate them as trap success declines.

Fall trapping occurred in a reverse order starting with the northern trapping location (Devils Lake) down to the southeastern location (Tewaukon NWR). Trapping coincided with current and historic trapping season dates. All trapping procedures followed University of North Dakota IACUC protocols (Office of Laboratory Animal Welfare No. A3917-01, Protocol No. 1208-1), and North Dakota Game and Fish Department Scientific Collecting Permits (GNF03308880 and GNG03538895). Muskrat pelts were donated to the North Dakota Trappers Association to help fund their Fur Trapper Education program. An estimated total of $2,098.28 was raised off the sale of muskrat pelts collected during this study.

Data Analysis

We calculated summary statistics of captures, estimated encounter rates at float sets, and examined behaviors of muskrats using video footage recorded from trail cameras placed at float sets. We also explored what factors (Table 10) influenced muskrat captures, as well as if a muskrat behaviors at a float set.

Trapping Efficiency

We estimated muskrat trapping efficiency using a global (i.e., all covariates of interest were included in model) hierarchical generalized linear mixed model in SAS (SAS Institute, Inc). We used a hierarchical structure to the model to account for the dependence of multiple floats in a single wetland within a wetland management district (Devils Lake, Chase Lake, Arrowwood, or Tewaukon). We explored the influence of multiple covariates (Table 10) on the trapping efficiency of covered and uncovered float sets. We used daily capture rates as the dependent (response) variable. The fixed variables included cover type, season, wetland class, and the interaction of season and cover type. Random variables included year and wetland site within trapping locations. We examined the beta coefficient estimates to determine what impact individual covariates had on the daily capture rates of muskrats at float sets.

Behaviors at Float Sets

From the video clips, we explored covariates of cover type, wetland class, season, year, and interactions among the covariates (Table 10) influence on behaviors displayed of muskrats with float sets through a series of logistic regressions in SAS. Response variables included a binary response of whether or not 1) a muskrat contacted a float set, or 2) a muskrat climbed on top of a float set. We estimated individual covariate beta estimates and back-transformed these covariate estimates to their respective odds ratio (OR) for interpretation. Odds ratio confidence intervals including 1.0 are not considered statistically significant, but may be biologically important if estimates are deviating from 1.0.

RESULTS

Encounters

We evaluated 1,149 muskrat encounters with float sets over the two year study period from 311,377 one minute video recordings collected by trail cameras placed at each float set.

Muskrats had a daily encounter rate of 0.27 encounters per trap night. Muskrats had more encounters with float sets in the fall (0.60 encounters/trap night) as compared to the spring (0.14 encounters/trap night).

Trapping Efficiency

We captured 490 muskrats over 4,245 trap nights (0.115 muskrat per trap night) during fall and spring trapping season at all study locations over the two year study period (Table 11). When examining factors influencing muskrat trapping efficiency, we found that the use of covered float sets did not negatively impact the trapping efficiency. In fact, larger mesh size (6x6) showed an increase (0.06 more muskrats/trap night) in trapping efficiency compared to an uncovered float set. Wetland class did not have an impact on trapping efficiency; this is not surprising since we selected wetlands based on the presence of muskrats or sign. We found that trapping efficiency was increased (0.10 more muskrats/trap night) during the fall trapping season as compared to the spring (Table 12). Further, we found that the interaction of the covariates cover type (6x6) and season (fall) showed a slight increase in trapping efficiency (Table 12).

Behavior – Contact Float set or Not

The most common type of behavior observed at float sets was a swim by (45.3%). Other behaviors observed included contacting the float (14.6%) and being on float or trapped (40.1%). We observed little variation among number of behaviors and cover types with 391 behaviors at uncovered, 399 at 1x1, and 359 at 6x6 float sets (Table 13, Figure 8).

When examining factors influencing muskrat behaviors, we found no influence of cover type on whether a muskrat contacted the float or not with odds ratio estimates essentially equal to one (Table 14). However, we found that muskrats were 4.3 times more likely to contact a float set in a type III wetland as compared to a type V (Table 14). We found no clear patterns on the influence of season or year on muskrat behaviors (Table 14).

Behavior – On float set/Trapped or not

We found no influence of covered floats (regardless of mesh size) relative to uncovered float sets on whether a muskrat went on top of the float (had potential of capture) or was trapped with odds ratio estimates essentially equal to one (Table 15). Also, we found that there were no clear patterns on the influence of wetland class, season, or year on muskrat behaviors (Table 15).

DISCUSSION

Our results suggest that muskrat trapping efficiency is not really decreased by the use of 1x1 and 6x6 wire mesh coverings on float sets. We captured the most muskrats on a 6x6 wire mesh covered float set (42.7%). While the fewest muskrat captures were on the 1x1 covered float set, there was not much difference between the 1x1 and uncovered capture efficiency. These results show that covers on float sets do not negatively impact muskrat captures as compared to uncovered float sets. These results suggest a covered float set does not detour a muskrat from encountering it. This is also consistent with the little variation we found in muskrat captures between covered and uncovered float sets. Further research on the interaction of muskrats with float sets is needed to determine the impacts and understand the processes involved.

We did experience a relatively low muskrat capture per trap night ratio (0.115). We believe this is in part due to the muskrat population in eastern North Dakota being at the bottom curve of a population cycle. These observations agree with North Dakota's annual rural mail carrier survey of furbearer species (Tucker 2014). Muskrat populations typically cycle over a 4 year period in North America (Erb et al. 2000).

We found that muskrat behaviors at float sets were not impacted by many of our covariates. There was no impact from cover type, season, or year on whether a muskrat would contact a float set or not. However, we did find that muskrats had a slightly higher probability of contacting a float set in a type III wetland as compared to other classes of wetlands. We believe this is due to the type III wetlands representing the preferred habitat of muskrats. A type III wetland is classified as a seasonal pond or lake that is typically dominated by emergent wetland grasses, sedges and rushes (Stewart and Kantrud 1971). Muskrats are primarily herbivorous and consume shoots, roots, bulbs, and leaves of aquatic plants such as those commonly found in type III wetlands. Also, muskrat densities on marsh areas are related to the type of emergent vegetation present (Boutin and Birkenholz 1987).

From a trapper's viewpoint, catch efficiency is usually regarded as the most important trap characteristic (Warburton 1982). We examined if specific covariate influenced whether a muskrat went onto a float set increasing the chances of capture or was trapped at covered and uncovered float sets. Our results showed that cover type, season, year, and wetland class had no influence on whether a muskrat went onto or was trapped at one of our float sets. While our analysis showed no significant impact of cover types on muskrat capture, suggesting the use of covers to minimize non-target captures is a management action that does not negatively impact muskrat trapper success.

To our knowledge, no prior work has been done investigating the trapping efficiency of muskrat float sets. Trapping technology has often been judged from very limited data (Proulx and Barrett 1989) and field evaluations of new traps often produce inconclusive results on efficiency of traps (Warburton 1982). We found that the use of covered float sets does not negatively impact muskrat trapping efficiency. In fact, we found an increase in efficiency while using larger mesh sizes (6x6) as the covering on a float set. We realize that our float set designs are one of many different types of float sets available to trappers. Therefore, it is possible that trapping efficiency and muskrat behaviors could be impacted by the use of covers on different float set designs. Further research should focus on different float set, floats height in the water and covering designs to evaluate trapping efficiency among a wider variety of float set covering combinations available to trappers today.

Management implications

The increased use of muskrat float sets along with an increase in pelt price in recent years has led wildlife agencies to develop regulations to manage this new technique and minimize the impacts on non-targets (See Chapter 2). Regulations in North Dakota require float sets used during the spring trapping season to have a covering on them in attempt to minimize the non-target impacts. Here, we have found that muskrat trapping efficiency is not really decreased through the use of 1x1 and 6x6 covered float sets. While our results showed that the covers on the float sets did not have an influence on whether a muskrat encountered, contacted, went onto, or was trapped at a float set, we captured the most muskrats at a 6x6 wire mesh covered float set.

We believe the use of smaller mesh sizes on covers would decrease the amount of muskrats climbing through the sides of float sets and avoiding the traps while simultaneously being less attractive to non-target animals (See Chapter 2). Further, larger mesh sizes could pose a problem to muskrats when captured, in that the muskrat can get tangled in the mesh over the side of the float and not be able to be quickly dispatched by the intended drowning nature of the set. Smaller mesh sizes would eliminate this problem, and would make the float set more humane to muskrats. Another suggestion would be to create a barrier between traps used on float sets. This would be to eliminate “double catches” of muskrats. A “double catch” involves a muskrat being caught in two traps and being unable to reach the water for dispatch by drowning.

Our results suggest that current cover regulations on muskrat float sets in North Dakota create an efficient way to capture muskrats and likely minimize incidental take of water birds (Chapter 2). Continued research on this float designs will ultimately help to understand muskrat behaviors to different trapping techniques that mitigate impacts on non-target species.

LITERATURE CITED

Ahlers, A.A., and E. J. Heske, and M. A. Mitchell, and R. L. Schooley. 2010. Home ranges and space use of Muskrats (*Ondatra zibethicus*) in restricted linear habitats. Wildlife Biology 16: 400-408.

Aldous, S. E. 1947. Muskrat Trapping on Sand Lake National Wildlife Refuge, South Dakota. The Journal of Wildlife Management 11:77-90.

Bailey, R. O. 1976. Mallard mortality in Manitoba's extended spring muskrat trapping season. Wildlife Society Bulletin 4: 26-28.

Boutin, S., and D. E. Birkenholz. 1987. Muskrat and Round-tailed Muskrat. Pages xxx-xxx *in* M. Novak, J. A. Baker, M. E. Obbard, andB. Malloch, editors. Wild Furbearer Management and Conservation in North America. Ontario Ministry of Natural Resources, Toronto, ON, Canada.

Erb, J., N. C. Stenseth, and M. S. Boyce. 2000. Geographic variation in population cycles of Canadian muskrats (*Ondatra zibethicus*). Canadian Journal of Zoology 78:1009-1016.

Gashwiler, J. S. 1949. The effect of spring muskrat trapping on waterfowl in Maine. Journal of Wildlife Management 13:183-188.

Linscombe, G. 1976. An evaluation of the No. 2 Victor and 220 conibear traps in coastal Louisiana. Louisiana Wildlife and Fisheries Commission report. pp 560-568.

Locke, S. L., I. D. Parker, and R. R. Lopez. 2012. Use of Remote Camera in Wildlife Ecology. Pages 311-318 *in* N. J. Silvy, editor. The Wildlife Techniques Manual. Johns Hopkins University Press, Baltimore, MD.

Lyra-Jorge, M. C., G. Ciocheti, V. R. Pivello, and S. T. Meirelles. 2008. Comparing methods for sampling large-and medium-sized mammals: camera traps and track plots. European Journal of Wildlife Research 54:739-744.

O'Connell, A. F., Jr., N. W. Talancy, L. L. Bailey, J. R. Sauer, R. Cook, and A. T. Gilbert. 2006. Estimating site occupancy and detection probability parameters for meso- and large mammals in a coastal ecosystem. Journal of Wildlife Management 70:1625-1633.

Parker, G. R. 1983. An evaluation of trap types for harvesting muskrats in New Brunswick. Wildlife Society Bulletin 11:339-343.

Proulz, G., and M. W. Barrett. 1989. Animal welfare concerns and wildlife trapping: ethics, standards and commitments. Transactions of the Western Section of the Wildlife Society 25:1-6.

Roberts, N. M., and S. M. Crimmins. 2010. Do Trends in Muskrat Harvest Indicate Widespread Population Declines? Northeastern Naturalist 17:229-238.

Rowcliffe, J. M., and C. Carbone. 2008. Surveys using camera traps: are we looking to a brighter future? Animal Conservation 11:185-186.

Seabloom, R. W. 2011. Mammals of North Dakota. North Dakota Institute for Regional Studies, Fargo, ND.

Stewart, R. E., and H. A. Kantrud. 1971. Classification of natural ponds and lakes in the glaciated prairie region. Resource Publication 92, Bureau of Sport Fisheries and Wildlife, U.S. Fish and Wildlife Service, Washington, D.C. 57pp.

Stocek, R.F., and D.J., Cartwright. 1985. Birds as non-target catches in the New Brunswick furbearer harvest. Wildlife Society Bulletin 13:314-317.

Tischaefer, R. 2011. North Dakota Fur Hunters and Trappers Association preliminary muskrat trapping survey. Unpublished data.

Tucker, S. 2012a. Study No. E-II: Furbearer harvest regulations study. Project No. W-67-R-52, Report No. C-456, North Dakota Game and Fish Department, Bismarck, North Dakota, USA.

Tucker, S. 2012b. Study No. E-II: Furbearer harvest regulations study. Project No. W-67-R-51, Report No. C-453, North Dakota Game and Fish Department, Bismarck, ND.

Tucker, S. 2014. Study No. E-11: Furbearer Harvest Regulations Study. North Dakota Game and Fish Department.

Warburton, B. 1982. Evaluation of seven trap models as humane and catch-efficient possum trap. New Zealand Journal of Zoology 9:409-418.

Wright, B. S. 1954. High tide and an east wind-the story of the black duck. Stackpole Co., Harrisburg, Pennsylvania and Wildlife Management Institute, Washington, D.C. 162pp.

Table 10. Explanatory covariates used for analyzing muskrat trapping efficiency and behaviors in eastern North Dakota, 2012–2014.

Covariate	Data Type	Description
Site	Categorical	Individual Wetlands: MR001-MR113
Location	Categorical	Wetland district: Chase Lake, Devils Lake, Arrowwood, and Tewaukon
Year	Categorical	Study year: 2012, 2013, or 2014
Season	Categorical	Trapping season: Fall or Spring
Cover Type	Categorical	Uncovered, 1 in x 1 in, and 6 in x6 in
Wetland Class	Categorical	Wetland type: IS, III, IV, V

Table 11. Summary statistics of trap nights, total muskrats captured and captures per trap night in eastern North Dakota, 2012-2014.

Trapping season	Trap nights	No. muskrats	No. muskrats/ trap night
Fall 2012	273	22	0.081
Spring 2013	1,314	73	0.056
Fall 2013	918	164	0.179
Spring 2014	1,740	231	0.133
Total	4,245	490	0.115

Table 12. Covariate coefficient estimates for three cover types, wetland class, and season on muskrat trapping efficiency using float sets.

Effect	Estimate	Standard Error	DF	t Value	Pr > |t|
Intercept	0.02553	0.05948	2	0.43	0.7095
Cover_Type[1] 1x1	-0.02710	0.01851	565	-1.46	0.1437
Cover_Type[1] 6x6	0.06059	0.01847	565	3.28	0.0011
WC – IS[1]	0.03651	0.04667	565	0.78	0.4344
WC - 3[1]	0.02375	0.04094	565	0.58	0.5620
WC - 4[1]	0.02652	0.03987	565	0.67	0.5062
Cover_Type*Season 1x1*Fall	0.00642	0.03219	565	0.20	0.8418
Cover_Type*Season 6x6*Fall	-0.06711	0.03217	565	-2.09	0.0374
Season[1]	0.10320	0.02746	565	3.76	0.0002

[1]Baselines used for analysis included none for cover type, type 5 wetland for wetland class, uncovered*spring for interactions of covariates, and spring for season.

Table 13. Muskrat behaviors displayed at float sets separated by cover type and classified behavior from trail camera videos collected over 4,425 trap nights during fall and spring trapping seasons in eastern North Dakota 2012-2014.

Behavior	Uncovered	1x1	6x6	Total
Swim by	180	192	148	520
Contact Float	52	60	56	168
On float/trapped	159	147	155	461
Total	391	399	359	1149

Table 14. Covariate coefficient estimates on whether or not a muskrat contacts a float set. Associated odds ratios (OR) are also calculated for result interpretation. See Table 10 for covariate descriptions.

Parameter	Estimate	Standard Error	Odds Ratio	OR LCI	OR UCI
Intercept	-0.4691	0.2240			
1x1[1]	-0.0732	0.1527	0.929	0.689	1.254
6x6[1]	0.2322	0.1560	1.261	0.929	1.713
Season[2]	0.3323	0.2110	1.394	0.922	2.108
Wetland – IS[3]	-0.2661	0.2179	1.534	0.380	6.184
Wetland – 3[3]	0.7761	0.1887	4.349	1.121	16.868
Wetland – 4[3]	0.1838	0.1955	2.405	0.615	9.401
Year (2012)	-0.3448	0.1311	0.629	0.371	1.068
Year (2013)	0.2264	0.0891	1.114	0.735	1.690

[1]Baseline or reference category was an uncovered float.
[2]Baseline for analysis was the spring season.
[3]Baseline for analysis was wetland class 5.

Table 15. Covariate coefficient estimates on whether or not a muskrat got onto a float set. Associated odds ratios (OR) are also calculated for result interpretation. See Table 10 for covariate descriptions.

Parameter	Estimate	Standard Error	Odds Ratio	OR LCI	OR UCI
Intercept	-0.6209	0.2237			
1x1[1]	-0.2957	0.1548	0.744	0.549	1.008
6x6[1]	0.0464	0.1554	1.047	0.773	1.421
Season[2]	0.0825	0.2082	1.086	0.722	1.633
Wetland – IS[3]	-0.1666	0.2201	1.090	0.269	4.414
Wetland – 3[3]	0.5563	0.1886	2.246	0.578	8.725
Wetland – 4[3]	-0.1369	0.1984	1.123	0.286	4.412
Year (2012)	0.0566	0.1309	1.246	0.733	2.116
Year (2013)	0.1067	1.4144	1.310	0.861	1.993

[1]Baseline or reference category was an uncovered float.
[2]Baseline for analysis was the spring season.
[3]Baseline for analysis was wetland class 5.

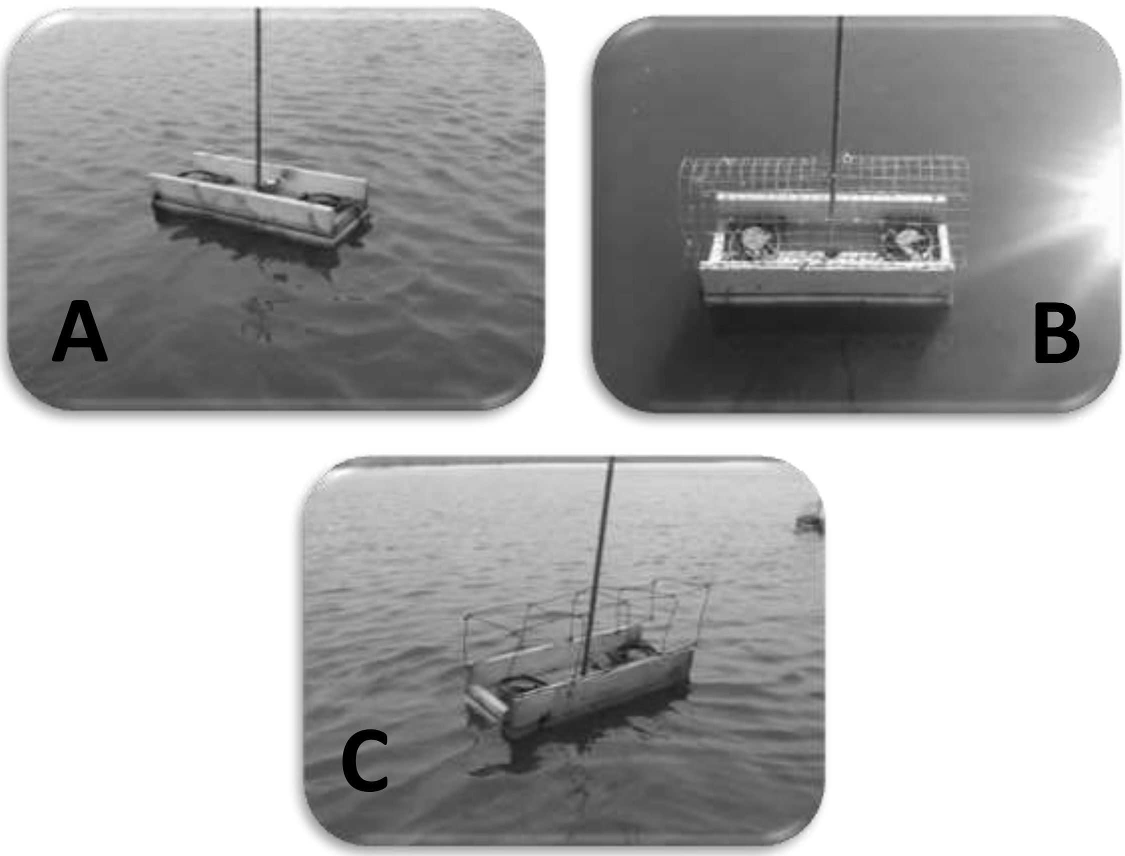

Figure 5. Examples of the variability in cover types for muskrat float sets used during trapping in eastern North Dakota, 2012-2014. A) uncovered float set, **B)** float set using 2.54 cm by 2.54 cm (1 in x 1 in) metal wire mesh cover, and **C)** float set using 15.24 cm by 15.24 cm (6 in x 6 in) wire mesh cover type. Photos courtesy of Stephanie Tucker, North Dakota Game and Fish Department.

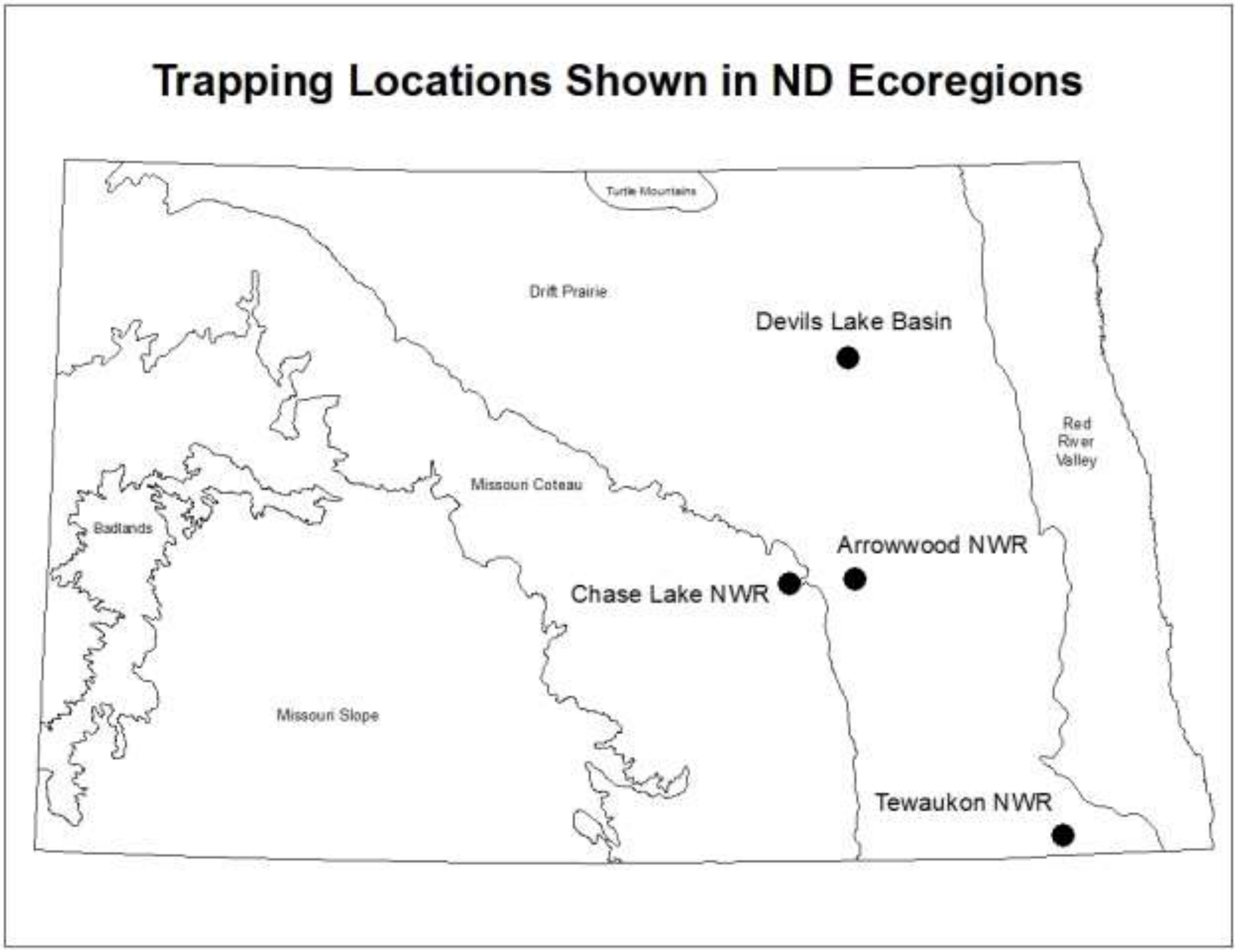

Figure 6. Major physiographic regions of North Dakota with dots marking the four primary field locations for trapping in eastern North Dakota, 2012-2014. Each location was selected on the basis of muskrat populations frequently targeted for trapping, nonresident trapping pressure, and migrating waterfowl usage.

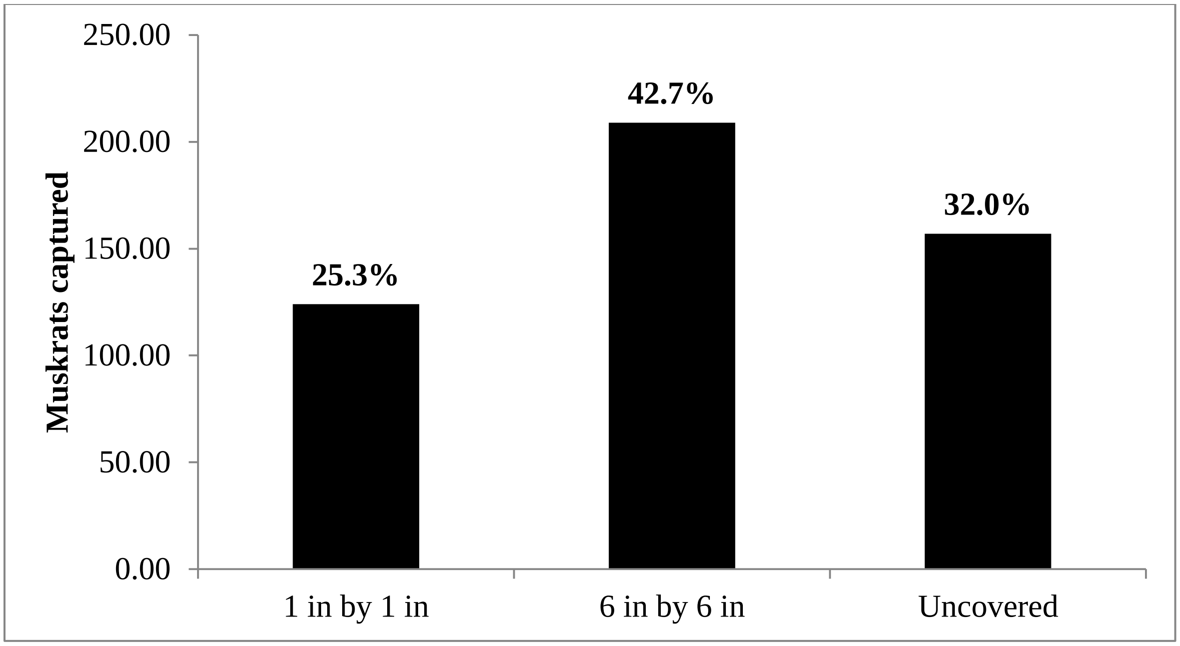

Figure 7. Comparison of muskrat captures by float set cover type (1 in x 1 in wire mesh, 6 in x 6 in wire mesh, uncovered) in eastern North Dakota, 2012 - 2014. Numbers above bars represent percent of total captures.

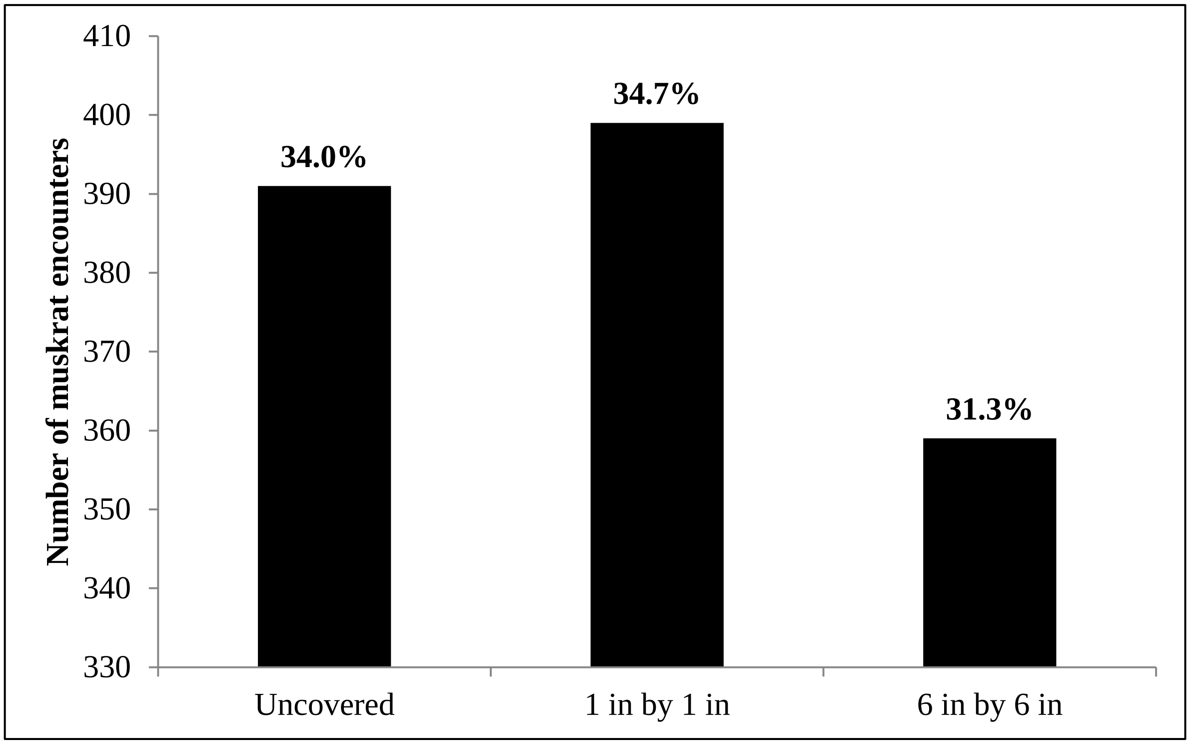

Figure 8. Comparison of muskrat encounters by float set cover type (1 in x 1 in wire mesh, 6 in x 6in wire mesh, uncovered) documented using trail cameras in eastern North Dakota, 2012-2014. Numbers above bars represent percent of total captures.

CHAPTER IV

CONCLUSIONS AND BEST MANAGEMENT PRACTICES

We sought to evaluate the impacts of covered and uncovered muskrat float sets on incidental take or injury of non-target water birds. During the 2012-2014 fall and spring trapping seasons, we trapped at four locations across eastern North Dakota using one float set design with different types of covers (1 in x 1 in, 6 in x 6 in, uncovered) to determine impacts on incidental take and/or injury. We also evaluated muskrat trapping efficiency simultaneously to determine what impact the float set covers had on their behaviors.

In summary, we found water birds were vulnerable to incidental take or injury at covered and uncovered muskrat float sets during our 2-year study (Chapter 2). Water birds were especially vulnerable in the spring seasons as compared to the fall, indicating the current regulation of a covering requirement during the spring trapping season is appropriate. During our study all non-target water birds were captured on uncovered float sets during the spring seasons, and therefore covers appear to reduce non-target take of federally managed water birds. The most vulnerable types of water birds were herons, grebes, coots, and pelicans. These birds were more likely to contact a float set than other birds. However, waterfowl were also found to be vulnerable to float sets because they were the most common type of water bird to encounter a float set, although only a few were captured. Gashwiler (1949) also found that waterfowl were vulnerable to float sets during spring trapping seasons in Maine, but his style of float set and wetland conditions were quite different than those of North Dakota and this study.

The captures of three black-crowned night herons compared to two blue-winged teal should warrant attention to managing agencies and trappers in the region. Current population estimates of black-crowned night herons are approximately 50,000 in North America, compared to the population of blue-winged teal being estimated upwards of 8 million birds (North Dakota Game and Fish waterfowl staff, personal communication). With so many fewer black-crowned night herons on the landscape compared to blue-winged teal, the fact that we caught several in our uncovered float sets is worth noting. Based on our camera results we had 54 water birds that had the potential of being captured resulting from the behavior of being on top of float sets. Of those birds, 8 black-crowned night herons were on top of the floats out of the 13 encounters we observed on camera. Thus, 61.5% of encounters resulted in herons on top of floats, and three (23.1% of encounters) resulted in mortality. In comparison, blue-winged teal (the other non-target avian species captured) encountered floats 3,578 times but only were found on top of the floats on 13 occasions (0.3% of encounters), two of which resulted in mortality.

The seasonal timing of muskrat trapping seasons and migrating water birds was an area we focused on during our 2-year study. The closing date for the muskrat trapping season in North Dakota is currently April 30th. We realize that timing of spring thaw on wetlands is variable, which impacts the use of muskrat float sets by trappers. However, normally some wetlands are available for muskrat trapping and for returning migrating water birds. Timing of our non-target captures indicates that the current season closing date is effective for reducing the likelihood of a muskrat trapper capturing a non-target water bird using float sets. Of seven incidental captures, three of those came before the closing date; one black-crowned night heron (April 27th) and two painted turtles (April 21st and 22nd). All other captures were at least ten days after the current closing date. Thus, current season dates appear to provide some protection to birds from incidental captures on float sets during the spring trapping seasons.

Not surprisingly, cover type of a float set did not influence water bird encounter rates. In other words, whether or not a bird came within the camera's field of view was not influenced by the cover of the float (Chapter 2). However, we found that when birds did encounter float sets, they were less likely to contact the float if it had a smaller (1 in x 1 in) wire mesh size than a larger mesh (6 in x 6 in) or was an uncovered float set, suggesting types of covers may further reduce chances of incidental take of water birds at floating sets.

Although we captured five non-target water birds on uncovered float sets, captures were not common with our float set design (0.002 incidentals/trap night). We realize that our float set design was not all encompassing of the designs available to trappers today, but believe that our design represented an effective float for catching muskrats and eliminating non-target water bird capture when covered. Due to the objective of the study being evaluation of cover regulations, we did not explore incidental take for all types of float set designs, but rather used the most popular design and examined the role of different covers on incidental take. However, our observations and personal communication with other managing wildlife agencies (e.g., South Dakota Game Fish & Parks) suggest there may be other float set designs that result in higher levels of incidental take. Anecdotal evidence suggests that water bird captures are common on float set designs that sit lower in the water as compared to higher. Our design was raised out of the water approximately 1 inch (2.54 cm), which we believe contributed to our low water bird capture rate. The height out of the water is in part due to the size of the float base necessary for attachment of a cover and thus, additional support to enhance floatation. Removal of the cover requirement will likely result in a wider variety of float sets used to capture muskrats and may translate to higher rates of incidental capture than we documented in this study, like that being observed in surrounding states that do not require covers (South Dakota Game, Fish, & Parks, personal communication).

Behavioral observations of water birds that climbed onto a float set provided evidence that our float set design was detouring birds from being on our float sets. Our trail camera videos showed that a water bird, such as a blue-winged teal, would struggle when attempting to get onto our float set design. The teal would physically have to flap its wings and “jump” out of the water to get onto our float set. Once on the float set, birds would almost always return to the water immediately due to the unstable nature of our float design in the water. If a water bird would be on the float set, the float would “wobble” with the added weight of the bird on it. Other float set designs that do not require sides for mounting a cover and are more stable, may be more attractive to water birds as a loafing site, based on anecdotal evidence of non-target captures we have heard about from other state agencies (South Dakota Game, Fish, & Parks, personal communication).

From a trapper’s viewpoint, catch efficiency is usually regarded as the most important trap characteristic (Warburton 1982). Because of this, we sought out to compare the muskrat behaviors at covered and uncovered float sets (Chapter 3). We found that cover type did not negatively decrease muskrat capture efficiency. In fact, efficiency was increased on a 6 in x 6 in wire mesh covered float set. Additionally, we determined there was a lot of variability on the influence of factors such as cover type, season, year, and wetland class on whether or not a muskrat contacted or was trapped at a float set. This information is useful for future management decisions pertaining to the regulation of the use of float sets in North Dakota and surrounding states, as it suggests muskrats did behave differently when encountering covered and uncovered floats.

Considering we did not capture any non-target birds on covered floats and we documented little difference in muskrat behaviors to cover types, we believe requiring floats to be covered in the spring is a prudent regulation. We realize that these five birds do not make an impact on the population of water birds. However, trappers and managing agencies may want to be perceived as sympathetic to any accidental mortality to wildlife and to eliminate law enforcement challenges associated with the incidental take of migratory birds. Additionally, we believe that trappers would want to display a positive public perception of themselves and their practices by showing that they take precautions to ensure animals are not only being taken humanely, but they are attempting to eliminate incidental take or injury while they are trapping.

During the two year study, we observed some best management practices (BMP) that would make the use of covers on muskrat float sets more efficient for muskrat capture and safer for non-target animals. We believe the use of smaller mesh sizes for covers would decrease the number of muskrats climbing through the sides of float sets and avoiding the traps while simultaneously being less attractive to birds (see Chapter 2). Further, larger mesh sizes pose a problem to muskrat when captured, in that the muskrat can get tangled in the mesh over the side of the float and not be able to be quickly dispatched by the intended drowning nature of the set. Therefore, smaller mesh sizes would eliminate this problem, and make the float set more humane to muskrats. Another BMP would be to create a barrier between traps used on float sets. This would be to eliminate “double catches” of muskrats. A “double catch” involves a muskrat being caught in two traps and being unable to reach the water for dispatch by drowning.

BMPs are not only limited to muskrats, but to the safety of water birds as well. We believe float set designs similar to ours are effective at reducing non-target capture of water birds. Our float design sits higher out of the water and has an edge or “lip” at each entrance to deter birds from entering. In addition, our float sets are less stable for water birds to perch or loaf on resulting in decreased vulnerability to capture.

It must be noted that our float set designs are merely a fraction of the available designs being used today. However, we believe that our design successfully displayed an effective float set for trapping muskrats, reducing non-target water bird capture, and evaluating cover regulations. Future research is needed on the impacts of different muskrat float set designs on trapping efficiency and non-target capture or injury. As public scrutiny on trapping practices continue, regulations must strongly consider how even a small number of incidental mortalities and the extent to which agencies are trying to mitigate such occurrences may be perceived by the public. Additional research on aspects of muskrat ecology and non-target interactions in the ecosystem are needed in preparation for future management decisions to minimize negative impacts of muskrat float set use and ensure continued opportunities for trappers using a wide variety of trapping techniques. Collaboration between wildlife experts, regulatory agencies, and the trapping community will be necessary to guarantee the continuation of trapping traditions for future generations.

LITERATURE CITED

Gashwiler, J. S. 1949. The effect of spring muskrat trapping on waterfowl in Maine. Journal of Wildlife Management 13:183-188.

Warburton, B. 1982. Evaluation of seven trap models as humane and catch-efficient possum trap. New Zealand Journal of Zoology 9:409-418.