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# The Human Dimensions of Waterfowl Hunters at Cheyenne Bottoms Wildlife Area, Barton County, Kansas

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**THE HUMAN DIMENSIONS OF WATERFOWL HUNTERS**

**AT CHEYENNE BOTTOMS WILDLIFE AREA,**

**BARTON COUNTY, KANSAS**

being

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by

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## ABSTRACT

### CHAPTER ONE

An on-site human dimension survey was applied at Cheyenne Bottoms Wildlife Area (CHBW), Kansas, to evaluate waterfowl hunters' support for three alternative management strategies. The strategies included in the survey were: 1) the creation of a refuge-in-time where hunting would be allowed for the entire day, but only on odd-numbered calendar dates, 2) the designation of an existing pool as a primitive pool, i.e., no motorized watercraft allowed, and 3) the creation of a refuge-in-time where hunting would only be allowed in a given pool from ½ hour before sunrise to 1300 hours, but hunting would be allowed every day during that time.

Waterfowl hunters at CHBW were surveyed during three different season frameworks during the 2007-2008 and 2008-2009 waterfowl seasons: September teal season, early duck season, and late duck and goose season. There were no significant differences detected relative to season framework; however, waterfowl hunters at CHBW did support the implementation of a primitive pool. The analyses of these surveys will be used to help direct future management decisions, in an effort to increase waterfowl hunter participation and satisfaction at CHBW.

### CHAPTER TWO

Wildlife managers use harvest registration systems based on self-reporting by hunters, including report cards, to monitor harvests and make management decisions. Not all hunters comply with these systems, even when mandatory. The inconsistency in reporting has been shown to cause errors in harvest estimates, yet evaluation of reporting-

rate variability rarely occurs. The primary goal of this research was to assess the rates of waterfowl hunter compliance with the Daily Hunt Permit (DHP) registration system at CHBW during the 2007-2008 and 2008-2009 waterfowl seasons. A secondary goal was to evaluate the accuracy of the self-reported rates of harvest for the waterfowl species the participating hunters harvested at CHBW. Waterfowl hunter origins at CHBW also were investigated by using the information provided. During my study, waterfowl hunters traveled from 38 Kansas counties and eight states to participate in the 2007 and 2008 waterfowl seasons. Reporting rates for the waterfowl species harvested at CHBW were found to be highly variable, with an average reporting rate for all species during the study period of 63.7%. Compliance with the DHP system at CHBW was found to be significantly different between survey weeks within a season and the 2007 and 2008 waterfowl seasons collectively. The overall compliance rate was 55.4%. These results indicated nearly one-third of the waterfowl harvest at CHBW remains unreported each year, with nearly half of all hunters not being compliant with the DHP system.

**CHAPTER THREE**

Understanding how the perceived and actual threats and risks associated with wildlife diseases affect hunters is becoming increasingly important to wildlife agencies in the United States. To assess the degree to which avian influenza has influenced the attitudes of waterfowl hunters in Kansas, and to evaluate the effects of avian influenza on waterfowl hunter participation in Kansas, a survey that asked Kansas waterfowl hunters to rate their knowledge and concerns relative to avian influenza was developed. The survey was mailed to 1,000 hunters that purchased Harvest Information Program (HIP) stamps in Kansas during the 2005-2006 and 2006-2007 waterfowl seasons, with a return rate of 41.7%. The results of this survey indicated fears of avian influenza are very low in Kansas, and avian influenza is having very little influence on hunter participation.

**CHAPTER FOUR**

During the past century, the food habits and natal origin of migratory waterfowl have been studied extensively. Establishing scientific linkages between the different sites used by migratory bird populations, throughout their flyways, helps to better understand their demographic characteristics and overall health. A relatively new dimension of waterfowl research has emerged during the last few decades: stable isotopes. Isotope patterns can be used to investigate the food habits and natal origin of migratory waterfowl. Significant differences were detected among the $\delta^{13}C$ and $\delta^{15}N$ values of the waterfowl species sampled at CHBW; however, the on-site food habits investigation indicated waterfowl migrating through CHBW were primarily consuming the same groups of food items, with slight differences in the percent occurrence of the five most frequently occurring food items among the species investigated. Comparisons were made between the $\delta^{2}H$ values of hunter-harvested waterfowl feathers and United States Geological Survey (USGS) Kansas waterfowl band recovery data for the 2007 and 2008 waterfowl seasons, in order to make inferences relative to the natal origin of waterfowl harvested at CHBW. The general trend across the waterfowl species investigated indicated the northernmost areas of the waterfowl breeding grounds were more represented by the $\delta^{2}H$ values obtained in my sample, in comparison to USGS waterfowl banding data.

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I sincerely thank the waterfowl hunting community at Cheyenne Bottoms, as they were an integral part of this research. Thank you for completing the surveys and for allowing us to collect samples from the waterfowl you harvested. I look forward to crossing paths with you in the marsh!

## PREFACE

This thesis has been written in four chapters, and each chapter is formatted to fulfill the requirements of the author guidelines for The Journal of Wildlife Management.

Key words: avian influenza; Cheyenne Bottoms; human dimensions; waterfowl; stable isotope.

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# GENERAL INTRODUCTION

This thesis is comprised of four chapters, the first three of which are investigations in the human dimensions of wildlife management. Chapters One and Two both incorporate on-site studies conducted at Cheyenne Bottoms Wildlife Area (CHBW), Barton County, Kansas. Chapter Three consists of data from a mail survey. Chapter Four involved the use of stable isotopes to investigate both waterfowl diet and the natal origin of waterfowl harvested at CHBW.

The research presented in Chapter One is an effort to better understand the attitudes, desires, and expectations of the waterfowl hunting constituents at CHBW. An on-site human dimension survey was applied to evaluate waterfowl hunters' support for three Alternative Management Strategies: 1) the creation of a refuge-in-time where hunting would be allowed for the entire day, but only on odd-numbered calendar dates, 2) the designation of an existing pool as a primitive pool, i.e., no motorized watercraft allowed, and 3) the creation of a refuge-in-time where hunting would only be allowed in a given pool from ½ hour before sunrise to 1300 hours, but hunting would be allowed every day during that time. Waterfowl hunters at CHBW were surveyed during three different season frameworks during the 2007-2008 and 2008-2009 waterfowl seasons: September teal season, early duck season, and the late duck and goose season.

The primary goal of Chapter Two was to assess the rates of waterfowl hunter compliance with the Daily Hunt Permit (DHP) registration system at CHBW, Barton County, Kansas, during the 2007-2008 and 2008-2009 waterfowl seasons.

A secondary goal was to evaluate the accuracy of the self-reported rates of harvest for waterfowl species harvested at CHBW. Hunter origins at CHBW also were investigated by using the information on the DHPs.

The goal of Chapter Three was to understand how the perceived and actual threats and risks associated with avian influenza affect waterfowl hunters in Kansas. A survey that asked Kansas waterfowl hunters to rate their knowledge and concerns relative to avian influenza was developed. This survey assessed the degree to which avian influenza has influenced the attitudes of waterfowl hunters in Kansas, and evaluated the effects of avian influenza on waterfowl hunter participation in Kansas.

The first objective of Chapter Four was to investigate waterfowl food habits at CHBW through traditional gizzard content analyses, and to compare the general trends of those analyses to the carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotope values of CHBW hunter-harvested waterfowl feathers. The second objective was to evaluate the hydrogen isotope ($\delta^{2}H$) values of hunter-harvested waterfowl feathers at CHBW, and to compare the $\delta^{2}H$ values to Kansas' waterfowl band recovery data for the 2007 and 2008 waterfowl seasons, in order to make inferences relative to the natal origin of waterfowl harvested at CHBW by hunters.

# CHAPTER ONE

# WATERFOWL HUNTERS' SUPPORT FOR ALTERNATIVE MANAGEMENT STRATEGIES AT CHEYENNE BOTTOMS WILDLIFE AREA

## ABSTRACT

An on-site human dimension survey was applied at Cheyenne Bottoms Wildlife Area (CHBW), Kansas, to evaluate waterfowl hunters' support for three alternative management strategies. The strategies included in the survey were: 1) the creation of a refuge-in-time where hunting would be allowed for the entire day, but only on odd-numbered calendar dates, 2) the designation of an existing pool as a primitive pool, i.e., no motorized watercraft allowed, and 3) the creation of a refuge-in-time where hunting would only be allowed in a given pool from ½ hour before sunrise to 1300 hours, but hunting would be allowed every day during that time.

Waterfowl hunters at CHBW were surveyed during three different season frameworks during the 2007-2008 and 2008-2009 waterfowl seasons: September teal season, early duck season, and late duck and goose season. There were no significant differences detected relative to season framework; however, waterfowl hunters at CHBW did support the implementation of a primitive pool. The analyses of these surveys will be used to help direct future management decisions, in an effort to increase waterfowl hunter participation and satisfaction at CHBW.

# INTRODUCTION

Studies suggest some hunters base their level of satisfaction on factors related to successful harvest, such as seeing harvestable wildlife or having shot opportunities (Stankey et al. 1973, Decker et al. 1980, Gigliotti 2000, Brunke and Hunt 2007), yet hunter satisfaction is determined by more than merely harvesting animals (Hendee 1974). There also are sociological components compelling hunters to go afield in pursuit of wild game, as other studies indicate factors unrelated to harvest, such as the opportunity to be outdoors or being close to nature, are often the metrics for hunter satisfaction (Hammitt et al. 1990, Hayslette et al. 2001).

In addition to maintaining healthy wildlife populations, one of the main goals of wildlife managers is to provide satisfactory recreational experiences (Johnson 1993). As a result, hunters play a critical role in the management of wildlife (Brown et al. 2000), as wildlife managers often consider hunters' attitudes in the management of wildlife resources (Filion 1981). As stated by Tarrant et al. (1997), the understanding and consideration of public attitudes, in conjunction with biological data, is critical for effective wildlife management. Research has shown the expectations of hunters play a role in hunter satisfaction. Although Vaske et al. (1982 and 1986) suggest expectations related to harvest are important, other studies suggest hunters have the expectation that conservation and management practices be responsive to their demands, as hunters feel they are an important constituent (Adams et al. 1997).

Interest in the human dimensions of wildlife management has increased in recent years (Manfredo et al. 1996, Decker and Chase 1997). The factors listed above relative to hunter satisfaction, and an increased interest in the human dimension, suggest the human dimension is a very important facet of wildlife management. Still, a literature review by Powell et al. (2010) indicates human dimensions studies have been underrepresented in recent years, especially at the local level.

Aside from annual public meetings, there are relatively few opportunities for waterfowl hunters to provide feedback directly to wildlife agencies (Thomas F. Bidrowski, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.), yet Schroeder et al. (2006) state wildlife managers must be aware of hunters' desires in order to provide quality hunting experiences. In an effort to understand the attitudes, desires, and expectations of waterfowl hunting constituents at Cheyenne Bottoms Wildlife Area (CHBW), and to potentially increase levels of hunter satisfaction through future management decisions, an on-site human dimension survey was developed and applied to evaluate waterfowl hunters' support for three alternative management strategies at CHBW (Appendix A). This type of hunter survey can provide area managers with direct feedback from waterfowl hunters who frequently use a specific wildlife area.

## METHODS

### Description of Study Site

Cheyenne Bottoms, covering approximately 166 square kilometers, is a naturally formed land sink in Barton County, just northeast of Great Bend, Kansas (Schwilling 1985) (Appendix C). As described by Zimmerman (1990), the Cheyenne Bottoms basin is bound on the north, south, and west by terraced bluffs laid down 100 million years ago during the Cretaceous period. Along the east and southeastern sides of the basin, ridges comprised of dune sand and silt were deposited by wind and water during the Pleistocene (Zimmerman 1990). Several geological events in the middle Miocene eventually led to an enclosure of the basin and the development of Cheyenne Bottoms approximately 100,000 years ago (Zimmerman 1990). The only two natural inflows are Blood and Deception creeks (Schwilling 1985), both of which have relatively small drainages and interrupted flows, historically causing Cheyenne Bottoms to be extremely dependent on rainfall events to provide inflow for the marsh. Inputs from these two creeks provide less than twenty percent, on average, of the total water supply that comes from direct precipitation (Zimmerman 1990).

Cheyenne Bottoms fosters impressive biodiversity, and is considered to be one of the most important ecosystems in Kansas (Zimmerman 1990). As described by Oliver and Von Loh (2001), there are many ecological communities in both the upland and wetland areas of the Cheyenne Bottoms basin. The upland areas are comprised of saltgrass (*Distichlis* spp.) grasslands, historic agricultural lands, big bluestem (*Andropogon gerardii*) grasslands, cottonwood (*Populus deltoides*) and willow (*Salix* spp.) riparian woodlands, and Indian-hemp (*Cannabis* spp.) shrublands. In the wetland areas there are cattail (*Typha* spp.) marshes, submergent and floating aquatic communities, mud flats, undifferentiated emergent wetlands, spikerush (*Eleocharis* spp.) wetlands, and prairie cordgrass (*Spartina* spp.) wetlands. Each of these communities is inhabited by many additional plant and animal species.

The passing of The Federal Aid in Wildlife Restoration Act in 1937 provided funding for land acquisition by the state of Kansas (Karl Grover, Kansas Department of

Wildlife, Parks, and Tourism, pers. comm.). In 1942 the first land was purchased by The Kansas Department of Wildlife, Parks, and Tourism (KDWPT), then known as Kansas Forestry Fish and Game, and land acquisition totaling 8,036 hectares in the southeast portion of the Cheyenne Bottoms basin was completed in 1956 (Schwilling 1985). This area is known today as the Cheyenne Bottoms Wildlife Area (CHBW), and is owned by the residents of the state of Kansas, and managed in trust by KDWPT (Appendix D).

The first large-scale construction effort by KDWPT to provide alternative water sources for CHBW was completed in 1957. This effort divided the Cheyenne Bottoms basin into five pools to facilitate water level management. The goal of this effort was to supplement natural inflow from precipitation by diverting water from the Arkansas River to the Wet Walnut and Dry Walnut creeks, through a 37 kilometer network of diversion dams, ditches, and creek beds, eventually flowing into CHBW through an inlet canal on the west side of the property (Zimmerman 1990).

The second large-scale construction effort by KDWPT was completed in the late 1990s, and further divided the basin into nine diked pools, which are connected by multiple water control structures throughout the interior dike system (Grover 1998). This sub-division of the Cheyenne Bottoms basin allows KDWPT employees to better circumvent drought conditions through storage of water in three large pools in the center of the Cheyenne Bottoms basin. These reservoir pools can be used to supplement water in the perimeter pools if needed, and also allow the de-watering of different pools through mechanical pump systems. This de-watering provides an opportunity for various management activities, such as the control of cattails (Grover 2004) and the removal of accumulated silt deposits (Grover 1993), both of which subsequently foster native emergent vegetation, including alkali bulrush (*Bolboschoenus* spp.) and smartweed (*Polygonum* spp.) as well as other moist soil plants known to be valuable to wildlife.

The purchase of CHBW by KDWPT, and the two large-scale construction efforts, allow KDWPT employees to better achieve their primary and secondary management goals: to provide a diverse marsh habitat for waterfowl and shorebirds during the spring and fall migration periods, and to increase the production of waterfowl and shorebirds that nest on the area (Grover 2009). These renovations also allow KDWPT to improve opportunities for hunters (Vogler et al. 1987).

Cheyenne Bottoms is the largest freshwater marsh in the United States, and was designated a "Wetland of International Importance" in 1988 by the Ramsar Convention (Zimmerman 1990). Cheyenne Bottoms also has been recognized as an extremely important wetland to shorebirds by the Western Hemisphere Shorebird Reserve Network (Vogler et al. 1987). Of the 417 species of birds known to occur in Kansas, 328 species have been documented using CHBW as a stopover during their migrations, including 25 species of ducks and geese (Vogler et al. 1987). During times of peak migration, waterfowl numbers sometimes reach into the hundreds of thousands.

With approximately 5,260 hectares of the CHBW portion of the Cheyenne Bottoms basin open to the public for waterfowl hunting and birdwatching, CHBW is a "tangible and quantifiable economic asset to Barton County and the State of Kansas" (Vogler et al. 1987). According to the 2006 Economic Impact of Waterfowl Hunting

Report (Carver and Daudill 2007), the economic impact of waterfowl hunting is of great importance to the state of Kansas. Kansas ranks 15th in the United States relative to waterfowl hunting participation, with approximately 30,000 licensed waterfowl hunters over the age of 16. In 2006, Kansas waterfowl hunters spent approximately $16.8 million on trip and equipment expenses, while supporting an estimated 439 waterfowl-related jobs within the state of Kansas. In conjunction with federal and state taxes, almost $25 million dollars in revenue was generated by Kansas waterfowl hunters in 2006. More specifically, waterfowl hunters are also of great economic importance to Cheyenne Bottoms Wildlife Area, as it is 100% funded by waterfowl hunters' dollars through both the Federal Aid in Wildlife Restoration Act, also known as the Pittman-Robertson Act, and the sale of hunting licenses (Karl Grover, Kansas Department of Wildlife, Parks and Tourism, pers. comm.).

**Survey Design**

The alternative management strategies included in the survey (Appendix A) consisted of: 1) the creation of a refuge-in-time where hunting would be allowed for the entire day, but only on odd-numbered calendar dates, 2) the designation of an existing pool as a primitive pool, i.e., no motorized watercraft allowed, and 3) the creation of a refuge-in-time where hunting would only be allowed in a given pool from ½ hour before sunrise to 1300 hours, but hunting would be allowed every day during that time. The survey asked waterfowl hunters to rate their support for the three alternative management practices using Likert Scale response choices (Likert 1932) (Appendix B) ranging from one through five, with one being no support and five being complete support for each of the three management strategies on the survey. The management alternatives included in the survey were devised by Karl Grover, Area Manager at CHBW.

As stated at the top of the survey, these potential management practices would apply only when there is water in three or more of the hunting pools at CHBW. During seasons with limited water, hunters are already restricted by the dry pools, and alternative management strategies would not be implemented as they would further restrict waterfowl hunter opportunity, participation, and subsequently, satisfaction.

There were three waterfowl season frameworks at CHBW during both the 2007-2008 and 2008-2009 waterfowl seasons, which were comprised of the following segments: 1) September teal season, 2) early duck season, and 3) late duck and goose season. The 2007-2008 and 2008-2009 waterfowl seasons involved in this study will hereafter be referred to as the 2007 waterfowl season and the 2008 waterfowl season, respectively. Each of these waterfowl seasons was comprised using the three aforementioned frameworks, and designated "2007 teal season," for example.

The September teal season is a special waterfowl season in which blue-winged teal (*Anas discors*), American green-winged teal (*Anas crecca*), and cinnamon teal (*Anas cyanoptera*) are the only legally harvested waterfowl species. All three species are known to be early migrants, especially blue-winged and cinnamon teal (Wesley and Leitch 1987). The special teal season provides an opportunity for hunters to harvest teal during the peak of their southward migration, as there are years when the majority of the teal have migrated through the area prior to the opening of general duck season in October (Karl Grover, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

Teal season for 2007 and 2008 was 08 September - 23 September and 13 September - 28 September, respectively. Hunters were surveyed from 08 September 2007 - 23 September 2007 and 13 September 2008 - 20 September 2008.

During the early duck season at CHBW all species of ducks, including teal, can be legally harvested. There are many species of ducks on the property during the early duck season, providing hunters the opportunity for a diverse harvest. Early waterfowl season for 2007 and 2008 was 13 October - 09 December and 11 October - 07 December, respectively. Hunters were surveyed from 13 October 2007 - 28 October 2007 and 11 October 2008 - 18 October 2008.

During the late waterfowl season at CHBW waterfowl hunters can legally harvest both ducks and geese. These hunters have a multitude of hunting options, as some waterfowl hunters specifically pursue geese, others focus their attention solely on ducks, and some choose to hunt both. Late waterfowl seasons for 2007 and 2008 were 07 November - 17 February and 05 November - 15 February, respectively. Hunters were surveyed from 10 November 2007 - 25 November 2007 and 09 November 2008 - 15 November 2008.

This survey was designed to assess the level of support for alternative management strategies of the different constituents of waterfowl hunters during three season frameworks at CHBW. Each of the season frameworks expose hunters to different conditions in the marsh; consequently different management strategies might be desired by each constituent. Teal hunters often experience relatively warm weather and an abundance of early-migrating teal on the property, with both morning and evening hunts being productive. Early season duck hunters are normally faced with more competition for hunting locations, as there are more hunters present at CHBW during the early season framework than in either the teal season or late season framework (Table 1.1). During the late duck and goose season at CHBW, waterfowl hunters often have less competition for hunting locations, coupled with a greater abundance of waterfowl on the property (Table 1.2)

As the 2007 and 2008 waterfowl seasons progressed, the number of hunters decreased, and surveying was terminated when waterfowl hunter numbers were too low to justify the survey effort. Each waterfowl hunter was asked to complete the survey only once, in an effort to reduce bias introduced from multiple surveys being completed by an individual.

**Survey Implementation**

Waterfowl hunters were surveyed in perimeter parking areas, boat ramp parking areas, and interior parking areas at CHBW during the 2007 and 2008 survey periods. There were two main methods of survey distribution. During times with high hunter density, a single parking area with an abundance of vehicles was chosen to monitor, and hunters were surveyed as they returned to the parking area after their hunt. At times when hunter density was lower, surveyors moved around CHBW as hunters exited the marsh and returned to their respective parking areas, at which point they were approached and surveyed.

A specific waterfowl hunter demographic relative to age, sex, or hunting pool at CHBW was not targeted, although the focus was to survey waterfowl hunters. Other hunters, such as those in the goose hunting zones along the southern edge of the property, or those hunting ring-necked pheasant (*Phasianus colchicus*) or white-tailed deer (*Odocoileus virginianus*), were not surveyed as those activities are less dependent on management strategies specifically pertaining to the waterfowl hunting pools at CHBW.

Non-resident hunters at CHBW also were surveyed during the 2007 and 2008 survey periods; however, the non-resident hunters' surveys were not analyzed separately. Formal interviews with waterfowl hunters were not conducted during this survey effort, and the survey questions outlining the three alternative management strategies were not discussed with waterfowl hunters prior to their completion of the survey. Once hunters had completed and returned the survey, however, there were often informal discussions with them relative to the alternative management strategies listed in the survey.

All data were analyzed by using the SPSS 11.5 ® (SPSS Inc. 2003) statistical software package. To determine if the different constituents of waterfowl hunters present at CHBW during the two waterfowl season survey periods preferred different management alternatives, descriptive statistics were calculated for each season framework (teal, early, and late) for both the 2007 and 2008 waterfowl season survey periods (Table 1.3, Table 1.4, Table 1.5). The waterfowl season frameworks of the 2007 and 2008 waterfowl seasons were compared among and between groups statistically with Multivariate Analysis of Variance (MANOVA) (Zar 1999) to determine if season framework influenced the survey responses relative to the three alternative management strategies evaluated (Table 1.6). The general trends of these survey data also were investigated to better understand the desires of all hunters, regardless of a discrete season framework, relative to the alternative management strategies included in the survey.

## RESULTS

During the 2007 teal season survey period, 65 waterfowl hunters completed the alternative management strategies survey, which was approximately 14.2% of the total hunters on the property. In the 2007 early duck season survey period, 75 hunters completed the survey, which was approximately 9.2% of the total hunters. During the 2007 late season survey period, 19 waterfowl hunters were surveyed, or approximately 4.4% of the total hunters at CHBW. For the 2007 waterfowl season survey period collectively, 159 hunters completed the alternative management options survey.

During the 2008 teal season survey period 36 hunters completed the alternative management strategies survey, which was approximately 4.6% of all hunters at CBHW. In the 2008 early duck season survey period, 44 hunters were surveyed, which was 1.8% of the total hunters at CHBW. During the 2008 late season survey period 32 hunters, or approximately 2.4% of the total, completed the alternative management options survey. A total of 271 ($n$ = 159, 2007; $n$ = 112, 2008) surveys were completed by waterfowl hunters, collectively, during the teal, early, and late season frameworks of the 2007 and 2008 waterfowl seasons (Table 1.1).

### Statistical Comparisons

There were no significant differences in survey responses within the season frameworks during the 2007 ($F$ = 1.029; df = 6, 308; $p$ = 0.406; Power = 0.406) or 2008

($F$ = 2.175; df = 6, 214; $p$ = 0.047; Power = 0.765) waterfowl season survey periods. There were no significant differences in survey responses for comparisons between ($F$ = 1.660; df = 15, 726; $p$ = 0.054; Power = 0.882) or among ($F$ = 2.242; df = 6, 532; $p$ = 0.038, Power = 0.788) the 2007 and 2008 waterfowl season survey periods. These results indicated season framework (teal, early, or late) did not have an effect on waterfowl hunters' Likert Scale choices for the three alternative wetland management strategies evaluated in the survey.

## DISCUSSION

Teal hunters, early duck season hunters, and late season duck and goose hunters have similar desires relative to alternative management strategies for the public waterfowl hunting marshes at CHBW. This concept was further supported by the number of specific individual waterfowl hunters encountered multiple times throughout the three season frameworks at CHBW during both the 2007 and 2008 waterfowl season survey periods. This suggested waterfowl hunters that participated in one season framework most likely participated in the other two season frameworks as well. This also suggested a teal hunter at CHBW might simply be a general waterfowl hunter whose options are limited by the season framework, as teal would be the only legally harvestable species during that particular segment of the waterfowl hunting season. These repeated encounters with the same individuals also affected the number of surveys completed within each season framework, as there were fewer first-encounter waterfowl hunters remaining to complete the survey as the 2007 and 2008 survey periods progressed.

To better understand the waterfowl hunting constituents at CHBW as a whole, the results from all season frameworks were combined, for both the 2007 and 2008 survey periods. The compilation of these data helped detect general trends relative to hunters' support of the three alternative management strategies.

**Alternative Management Strategy One: Hunting on odd number dates only.**

With all survey respondents pooled together for the 2007 and 2008 survey periods, the majority of the waterfowl hunters surveyed showed no support for a pool at CHBW to be limited to hunting on odd-numbered dates only (Fig. 1.1, Fig. 1.2). Once waterfowl hunters had completed the survey, discussions relative to the different management strategies often ensued. Waterfowl hunters at CHBW made it clear the federal and state waterfowl regulations were already difficult for them to follow, and they were reluctant to support any alternative strategy they felt would further complicate waterfowl hunting regulations. Also, several waterfowl hunters stated their options on what days they could hunt were already limited due to personal obligations, and they did not favor the idea of additional limitations which might prevent them from hunting on a day when they otherwise could. This mindset also was expressed by hunters who had traveled long distances to hunt at CHBW for a specific period, as they did not want to have days in their trip where hunting opportunity was limited due to additional regulations.

### Alternative Management Strategy Two: Primitive pool.

With all survey respondents pooled together for the 2007 and 2008 survey periods, the majority of waterfowl hunters at CHBW were in complete support for a pool managed as a primitive pool only, i.e., no motorized watercraft allowed (Fig. 1.3, Fig. 1.4). Many waterfowl hunters at CHBW access the public portions of the marsh by walking in from the perimeter parking areas and access points. These hunters expressed their desire to be able to isolate themselves from hunters who used motorized watercraft. They indicated it was disheartening to walk to a hunting location only to have a hunter boat in and hunt nearby. These walk-in hunters also felt motorized boats caused waterfowl to depart from, or avoid, a given area. This is supported by studies that have documented waterfowl disturbance by boating intrusions (Kahl 1991, Korschgen et al. 1985). Disturbance of waterfowl has been shown to have negative consequences, such as displacement from preferred habitat, and high energetic costs associated with avoiding disturbance (Dahlgren and Korschgen 1992). Furthermore, Kenow et al. (2003) determined a voluntary waterfowl avoidance area established on Lake Onalaska in the Upper Mississippi River increased waterfowl use of the study area.

### Alternative Management Strategy Three: Hunting from ½ hour before sunrise to 1300 hours

With all survey respondents pooled together for the 2007 and 2008 survey periods, the majority of waterfowl hunters surveyed were neutral relative to a hunting pool at CHBW being open to hunting from ½ hour before sunrise to 1300 hours only (Fig. 1.5, Fig. 1.6). However, the next largest group of survey respondents indicated they had no support for this management alternative. Informal discussions with the waterfowl hunters surveyed suggested that although they were reluctant to further complicate waterfowl hunting regulations, they were much more in favor of a management strategy that would allow hunting on all days of the week, even if it limited the hunting opportunity to half-days only.

## MANAGEMENT IMPLICATIONS

Waterfowl hunters at CHBW had little or no support for refuges-in-time, although the value of waterfowl refuges has been established and documented. Hunters often complain about refuge areas holding too many waterfowl and providing too much protection, although waterfowl harvest has been shown to be higher in locations where refuge areas are provided (Bellrose 1954). Private waterfowl area managers noted the importance of refuges within their hunting club lands as long ago as the early 1900's, stating that duck numbers increased on the property, and the ducks stayed on the property longer, when a refuge area was established (Bellrose 1954). Thus, refuges are important to both waterfowl and waterfowl hunters (Bellrose 1954).

Given the documented value of refuges and the absence of support for refuges-in-time by the waterfowl hunters surveyed at CHBW, perhaps an educational program should be implemented. If waterfowl hunters were more informed about the value of refuges, and the potential increase in harvest opportunity in areas with waterfowl refuges, they might begin to look at refuges-in-time differently. Rather than refuges-in-time merely being viewed as restrictive to the amount of time one could hunt and an additional complication to hunting regulations, they could begin to see refuges-in-time as an opportunity for increased success during the periods when the CHBW marshes are open to hunting.

The framework for this potential educational effort is already in place. The KDWPT Area Manager at CHBW, Karl Grover, has a monthly radio program in place, during which he discusses current topics at CHBW, and other wildlife related news. There also is a monthly CHBW newsletter (prepared by KDWPT staff at CHBW) which is free to all interested parties. In addition, there is an annual public meeting held in August of each year to inform the public of CHBW news and to discuss any topics of which the attendees are interested. These avenues could provide the opportunity to inform waterfowl hunters of the potential benefits of implementing alternative management strategies involving refuges-in-time at CHBW.

Although statistical analyses did not detect any significant differences between the desires of the different waterfowl hunting constituents within the 2007 and 2008 teal, early, and late season frameworks relative to alternative management strategies, these data collected from the surveys could be used to help direct future management decisions. This potentially could increase the overall satisfaction of the CHBW waterfowl hunting constituents, especially those already showing strong support for a primitive pool where no motorized watercraft are allowed.

Future research efforts at CHBW should include additional human dimension surveys, as they have been shown to increase hunter satisfaction (Thomas F. Bidrowski, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.), and higher levels of hunter satisfaction have positive impacts on wildlife agencies (Schroeder et al. 2006).

Future surveying efforts at CHBW relative to alternative management strategies for the public hunting pools should include formal interviews with waterfowl hunters. During the course of this investigation, the informal discussions with hunters were very informative, and much could be learned by formally interviewing each hunter surveyed as to the reasons they selected a specific Likert Scale choice for a specific management strategy. Boat-in waterfowl hunters and walk-in waterfowl hunters should be analyzed separately. Also, hunters traveling long distances to hunt at CHBW should be analyzed separately from hunters of local origin. By changing these portions of the survey design, waterfowl hunters at CHBW would be better categorized for more accurate comparisons, which could help determine if hunters during the three season frameworks had different desires relative to alternative management strategies, assuming sample sizes would increase to accommodate the different frameworks.

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## CHAPTER TWO

## WATERFOWL HUNTER COMPLIANCE WITH THE DAILY HUNT PERMIT SYSTEM AT CHEYENNE BOTTOMS WILDLIFE AREA


### ABSTRACT

Wildlife managers use harvest registration systems based on self-reporting by hunters, including report cards, to monitor harvests and make management decisions. Not all hunters comply with these systems, even when mandatory. The inconsistency in reporting has been shown to cause errors in harvest estimates, yet evaluation of reporting-rate variability rarely occurs. The primary goal of this research was to assess the rates of waterfowl hunter compliance with the Daily Hunt Permit (DHP) registration system at CHBW during the 2007-2008 and 2008-2009 waterfowl seasons. A secondary goal was to evaluate the accuracy of the self-reported rates of harvest for the waterfowl species the participating hunters harvested at CHBW. Waterfowl hunter origins at CHBW also were investigated by using the information provided. During my study, waterfowl hunters traveled from 38 Kansas counties and eight states to participate in the 2007 and 2008 waterfowl seasons. Reporting rates for the waterfowl species harvested at CHBW were found to be highly variable, with an average reporting rate for all species during the study period of 63.7%. Compliance with the DHP system at CHBW was found to be significantly different between survey weeks within a season and the 2007 and 2008 waterfowl seasons collectively. The overall compliance rate was 55.4%. These results indicated nearly one-third of the waterfowl harvest at CHBW remains unreported each year, with nearly half of all hunters not being compliant with the DHP system.

## INTRODUCTION

Management of harvest is essential in game management (Dasmann 1966), and management programs for harvested populations are often centered on reliable harvest estimates (Roseberry and Wolff 1991). State wildlife agencies use a variety of methods to obtain harvest data, such as telephone and mail questionnaires, in-person check stations, report cards, or a combination of these methods (Rupp et al. 2000, Hansen et al. 2006). Many wildlife managers use harvest registration systems based on self-reporting by hunters, including report cards, to monitor harvests and make management decisions (Rupp et al. 2000). Not all hunters comply with these systems, even when mandatory (Strickland et al. 1994, Rupp et al. 2000). The inconsistency in reporting has been shown to cause errors in harvest estimates (Roseberry and Wolff 1991), especially when hunters are not truthful or do not respond at all (Taylor et al. 2000, Hansen et al. 2006). Managers are encouraged to consider this source of error (Skalski and Millspaugh 2002), yet evaluation of reporting-rate variability rarely occurs (Rosenberry et al. 2004).

In Kansas, wildlife areas owned by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) are required to provide hunters with Daily Hunt Permits (DHP), as stated in statute KSA 115-8-1 (Appendix E) (Karl Grover, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.). No research has been conducted to evaluate compliance rates with the DHP registration system at Cheyenne Bottoms Wildlife Area (CHBW) (Karl Grover, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

These data provided by hunters at CHBW through the DHP registration system are used to inform hunters about hunting success during the current waterfowl season, and are also a portion of each CHBW annual report. These annual reports contain specific information relative to the number of hunters using the wildlife area, the origin of those hunters, and harvest statistics based on the data as self-reported by hunters.

The primary goal of my research was to assess the rates of waterfowl hunter compliance with the DHP registration system at CHBW (see page five for a complete description of the study site). A secondary goal was to evaluate the accuracy of the self-reported rates of harvest for the waterfowl species the participating hunters harvested at CHBW. Waterfowl hunter origins at CHBW also were investigated by using the information provided.

## METHODS

Each DHP is a two piece card (Appendix F), with the top consisting of hunter origin information, and the bottom portion being harvest information, including the specific hunting pool and the number and species of waterfowl harvested. By law, hunters at CHBW are required to complete the top portion of the DHP and deposit it into a permit drop box prior to hunting. Hunters are required to have the bottom portion of the DHP in their possession while hunting. For the evaluation of hunter origins, there were two main categories. Hunters from Kansas were classified as resident hunters and were reported by county of origin. Non-resident hunters were classified as being from a state other than Kansas, and were reported by state of origin. Upon completion of the hunt, hunters are required to complete the bottom portion of the DHP with that particular day's hunting location and harvest information, and place it in a permit drop box.

The DHP system is based on self-reporting by hunters, and each hunter is required to complete one DHP for each day of hunting. To better quantify DHP compliance rates, the permits used in this study had 5-digit numbers on the top and bottom portions of the DHP, so the top and bottom portions of the DHP could be matched for waterfowl hunters compliant with the DHP registration system. This also served to identify and match DHPs placed in permit drop boxes other than the one in the monitoring area for a given observation period.

Data were collected during both the September teal season and the duck and goose seasons during the 2007-2008 and 2008-2009 waterfowl seasons. Teal season data were collected from 08-16 September and 13-27 September, respectively, for the 2007-2008 and 2008-2009 waterfowl seasons. Duck and goose season data were collected from 13-21 October and 11 October - 08 November, respectively, for the 2007-2008 and 2008-2009 waterfowl seasons. The 2007-2008 and 2008-2009 waterfowl seasons will hereafter be referred to as the 2007 and 2008 waterfowl seasons, respectively.

These data, relative to compliance rates with the DHP system at CHBW, were obtained by monitoring parking areas, boat ramps, and public access points at CHBW. The areas to be monitored were chosen by the number of hunters present in each, with the locations of highest hunter density selected. Observers arrived at the chosen locations at approximately the beginning of legal hunting time (1/2 hour before sunrise) and remained at the chosen location until the last hunter had exited the marsh and departed the area. During the observation periods, the number of waterfowl hunters present was monitored and recorded, daily waterfowl harvests were evaluated via hunter bag checks, and the DHPs deposited into the permit drop boxes by CHBW waterfowl hunters were collected and tabulated. To disguise the evaluation of DHP compliance rates at CHBW, compliance data were collected unbeknownst to the hunters while on-site surveys were conducted and samples for avian influenza testing were collected from hunter-harvested waterfowl.

Compliance with the DHP system at CHBW was evaluated based on three categories: 1) Top DHP compliance was defined by a hunter completing the DHP top and placing it in a permit drop box, but the hunter did not complete the corresponding bottom portion of the DHP; 2) Bottom DHP compliance was defined by a hunter completing a DHP bottom and placing in the permit drop box, but the hunter did not complete the corresponding top portion of the DHP; 3) Complete DHP compliance was defined by the completion of both the corresponding top and bottom portions of a DHP by the hunter, and the placement of both completed parts of the DHP in a permit drop box at CBHW.

Although each hunter is required by law to obtain and complete a DHP, the address portion of the origin information on the top of the DHPs used in this study was listed as “optional” for the hunter to complete. As such, for the purposes of evaluating DHP compliance, a hunter that did not complete the hunter origin portion of the DHP top was still considered to be in compliance with the DHP top requirements; however, the harvest information requested on the DHP bottoms was not listed as “optional.” Therefore, hunters that did not complete the bottom portion of the DHP were not considered to be compliant with the DHP system, as area managers glean no harvest information from blank DHPs. Furthermore, in the assessment of waterfowl hunter origins at CHBW, blank, incomplete, or illegible DHPs were acknowledged and reported, but these DHPs were not included in the compilation, evaluation, or analyses of CHBW waterfowl hunter data.

Reporting rates for the various waterfowl species most commonly harvested at CHBW were calculated by comparing the composition of the waterfowl hunter bag checks to the number and species of waterfowl reported by waterfowl hunters on the bottom portions of the DHPs placed in the permit drop boxes. Four-letter designations were assigned to waterfowl species listed in tables and figures, following methodology similar to the American Ornithologists’ Union (AOU). The waterfowl species included in this study are listed alphabetically by both the common name and the four-letter designation of species, irrespective of harvest or reporting rates.

Only those waterfowl species with numbers of 30 or greater in the hunter bag checks were included in the assessment, because those species represented the most harvested waterfowl at CHBW and provided more accurate calculations of the self-reported harvest rates. Of the waterfowl species with less than 30 present in the bag checks, an over-estimation of reporting rates could occur. For example, if there were only one of a particular waterfowl species harvested and it was self-reported by a hunter, it would artificially represent 100% of that species being self-reported by all hunters at CHBW.

The self-reporting rates of each species of waterfowl where hunters harvested 30 or more waterfowl were calculated and discussed; however, these rates were not statistically compared relative to DHP compliance rates, as the study design did not link individual hunters, their corresponding bag checks, and their DHP number, as the DHP observations were conducted unbeknownst to the waterfowl hunters. By asking the hunters for their DHP number, it is possible DHP compliance rates would have been artificially inflated. Hunters would have known their DHP activity was being monitored, and would have possibly become compliant with the DHP system when they would not have done so otherwise.

All data were analyzed by using SPSS 11.5 ® (SPSS Inc. 2000) statistical software package. In addition to an evaluation of the general trends of compliance rates, a Multivariate Analysis of Variance (MANOVA) (Zar 1999) was performed to determine if season framework (early teal season and duck season) and/or survey week impacted top, bottom, and complete compliance rates with the DHP registration system during the 2007 and 2008 waterfowl season survey periods. Independent sample t-tests (Zar 1999) were conducted to test for differences between top, bottom, and complete compliance rates with the DHP registration system during the 2007 and 2008 waterfowl seasons, treating each season as a whole with no separation by survey week or season framework.

# RESULTS

## CHBW Waterfowl Hunter Origins

Of the 54 waterfowl hunters that provided origin information on the DHP during the 2007 teal season survey period at CHBW, the largest percentage (25.9%, *n* = 14) were from Johnson County, Kansas, and the second largest percentage (24.1%, *n* = 13) were from Barton County, Kansas. The third largest group of hunters were non-residents, totaling 11.1% (*n* = 6). Forty-one hunters (43.2%) did not provide demographic information during the 2007 teal season survey period.

During the 2007 duck season survey period, 88 hunters provided origin information on their DHP, and 43.2% (*n* = 38) of those hunters were from Barton County, Kansas, with the second largest group (11.4%, *n* = 10) being from Ellis County, Kansas. Non-resident hunters during the 2007 duck season comprised 4.6% (*n* = 4) of the total number of hunters participating. Sixty-two hunters (41.3%) did not provide origin information during the 2007 duck season survey period.

As seen during the 2007 teal season survey period, the first and second largest groups of waterfowl hunters participating in the 2008 teal season survey period were from Barton and Johnson counties, with 36.2% (*n* = 34) and 17.0% (*n* = 16) of the total hunters, respectively. There were no non-resident hunters present in my observations in the 2008 teal season survey period. A total of 48 hunters (33.8%) did not provide demographic information during the 2008 teal season survey period.

During the 2008 duck season survey period, the two largest groups of waterfowl hunters of known origin were again from Barton and Johnson counties, with 19.6%

(*n* = 41) and 9.6% (*n* = 20), respectively, and non-residents comprised 5.7% (*n* = 12). A total of 88 hunters (29.6%) did not provide origin information during the 2008 duck season survey period.

During the course of this investigation for both the 2007 and 2008 waterfowl seasons at CHBW, a total of 684 hunters were observed, 445 (65.1%) of which provided information relative to their origin (Table 2.1). These waterfowl hunters traveled from 38 Kansas counties and eight states to participate in the waterfowl seasons at CHBW. The two largest groups of waterfowl hunters were from Barton and Johnson counties, with 28.3% (*n* = 126) and 12.6% (*n* = 56), respectively. Overall, non-residents comprised 4.9% (*n* = 22) of the participants of known origin in the 2007 and 2008 survey periods. A total of 239 hunters (34.9%) did not provide demographic information during the 2007 and 2008 waterfowl season survey periods (Table 2.2).

**Waterfowl Hunter Bag Checks**

During the 2007 teal season survey period, 95 waterfowl hunter bag checks were conducted with a total of 207 ducks harvested. The most common duck harvested by hunters was the blue-winged teal (*Anas discors*) (*n* = 161, 77.8%), followed in number by the American green-winged teal (*Anas crecca*) (*n* = 46, 22.2%) (Fig. 2.1). The average harvest during the 2007 teal season survey period was 2.2 teal per hunter (Fig. 2.2).

During the 2007 duck season survey period, 150 waterfowl hunter bag checks were conducted with a total of 227 ducks harvested. The species most commonly harvested were American green-winged teal (*n* = 84, 37.0%), mallard (*Anas platyrhynchos*) (*n* = 60, 26.4%), and northern pintail (*Anas acuta*) (*n* = 31, 13.7%), respectively (Fig. 2.3). The average harvest during the 2007 duck season survey period was 1.5 ducks per hunter (Fig. 2.2).

For the 2007 teal and duck season survey periods collectively, 245 waterfowl hunter bag checks were conducted with a total of 434 ducks harvested. The most common species of waterfowl revealed in waterfowl hunter bag checks were blue-winged teal (*n* = 177, 40.78%), American green-winged teal (*n* = 130, 30.0%), and mallard (*n* = 60, 13.8%) (Fig. 2.4). The season average for the 2007 survey period was 1.8 ducks per hunter. (Fig. 2.2).

During the 2008 teal season survey period, 142 waterfowl hunter bag checks were conducted with a total of 318 ducks harvested. The most common duck harvested by waterfowl hunters at CHBW was the blue-winged teal (*n* = 254, 79.9%), followed by the American green-winged teal (*n* = 64, 20.1%) (Fig. 2.5). The average number of teal harvested per hunter was 2.2 in the 2008 teal season survey period, which was 0.5 teal per hunter higher than in the 2007 teal season survey period (Fig. 2.2).

During the 2008 duck season survey period, 297 waterfowl hunter bag checks were conducted with a total of 896 ducks harvested. These hunter bag checks showed blue-winged teal (*n* = 423, 47.2%), American green-winged teal (*n* = 161, 18.0%), and American wigeon (*Anas americana*) (*n* = 71, 7.9%) were the three species of waterfowl most commonly harvested (Fig. 2.6). The average harvest per hunter during the 2008 duck season survey period was 3.0 ducks, doubling the average harvest rate per hunter for the 2007 duck season survey period (Fig. 2.2).

For the 2008 teal and duck season survey periods collectively, 439 waterfowl hunter bag checks were conducted with a total of 1,214 ducks harvested. The most common species of waterfowl revealed in hunter bag checks during the 2008 survey periods collectively were blue-winged teal (*n* = 677, 55.8%), American green-winged teal (*n* = 225, 18.5%), and American wigeon (*n* = 71, 5.9%), respectively (Fig. 2.7). The average harvest during the 2008 waterfowl season survey period was 2.8 ducks per hunter, which was one duck per hunter higher than the 2007 waterfowl season survey period (Fig. 2.2).

During the 2007 and 2008 waterfowl seasons collectively, 684 waterfowl hunter bag checks revealed a total of 1,648 harvested waterfowl, comprised of 12 species. The three most abundant waterfowl species harvested by hunters were blue-winged teal (*n* = 854, 51.8%), American green-winged teal (*n* = 355, 21.5%), and mallard (n = 118, 7.2%), respectively (Fig. 2.8). During the course of the 2007 and 2008 waterfowl season survey periods at CHBW, the overall harvest rate was 2.4 ducks per hunter (Fig. 2.2).

**Reporting Rates of Waterfowl Species Harvested at CHBW**

The assessment of the self-reported rates of waterfowl harvest for the 2007 and 2008 waterfowl season survey periods included the following species: blue-winged teal, American green-winged teal, mallard, gadwall (*Anas strepera*), American wigeon, Northern shoveler (*Anas clypeata*), Northern pintail, and redhead (*Aythya americana*). The waterfowl species excluded from this portion of our assessment due to numbers less than 30 in waterfowl hunter bag checks were ring-necked duck (*Aythya collaris*), lesser scaup (*Aythya affinis*), wood duck (*Aix sponsa*), and canvasback (*Aythya valisineria*) (Fig. 2.8).

During the 2007 teal season survey period, hunters reported a greater proportion of their harvest of American green-winged teal (63.0%) than blue-winged teal (59.0%) (Fig. 2.9). During the 2007 duck season survey period, the self-reported rates of harvest through the DHP system ranged from a low of 0.0% for redhead to a high of 75.0% for northern shoveler (Fig. 2.10).

The self-reported rates of teal harvest were higher during the 2008 teal season survey period than the 2007 teal season survey period, by a margin of 16.7% for American green-winged teal and 11.1% for blue-winged teal. Once again, hunters reported a greater proportion of their harvest of American green-winged teal (79.7%) than blue-winged teal (70.1%) (Fig. 2.11). During the 2008 duck season survey period, the self-reported rates of harvest through the DHP system at CHBW ranged from a low of 64.7% for northern shoveler, which had the highest reporting rate during the 2007 duck season survey period, to a high of 108.9% for the gadwall (Fig. 2.12). This particular instance of a waterfowl species being "over-reported," as the gadwall was during the 2008 duck season survey period, was the only instance of its kind during the two years of this study. The reporting rate of 108.9% resulted from waterfowl hunters reporting 61 gadwall harvested through the DHP system, when bag checks indicated only 56 gadwall were actually harvested.

The self-reported rates of harvest through the DHP system at CHBW were averaged through all survey periods during the 2007 and 2008 waterfowl seasons, for each species in which hunters harvested 30 or more. The self-reported rates of harvest were found to vary from a low of 34.6% for redhead, to a high of 77.4% for mallard. Four of the eight species included in this portion of the study were found to have reporting rates in the 60 percent range: American green-winged teal (64.8%), American wigeon (65.1%), Northern pintail (66.8%), and Northern shoveler (69.9%) (Fig. 2.13).

The proportion of the total harvest self-reported by hunters during the 2007 and 2008 waterfowl season survey periods also was evaluated. This evaluation had no emphasis on a species by species basis, but looked at the proportion of the total harvest reported by hunters in each of the survey periods (Fig. 2.14). During the 2007 teal season survey period, the self-reported rate of harvest through the DHP system at CHBW was found to be 59.9% of the total number of teal harvested. The total proportion of the 2007 duck season survey period harvest self-reported through the DHP system was determined to be slightly lower, at 47.1% of the total harvest. Self-reporting rates of harvest during the 2008 teal season survey period were higher than either of the 2007 survey periods, at 72.0% of the total 2008 teal harvest. The self-reporting rates of the 2008 duck season were even higher than any of the previous survey periods in 2007 or 2008, at 75.6% of the total harvest. When evaluated through both the teal and duck season survey periods for the 2007 and 2008 hunting seasons, with no emphasis on species or season framework, the self-reported rate of harvest through the DHP system at CHBW was found to be 63.7% of the total waterfowl harvest at CHBW during this study (Fig. 2.14).

## Top, Bottom, and Complete DHP Compliance Rates

During the 2007 and 2008 waterfowl season survey periods at CHBW as a whole, a total of 226.8 hours (Fig. 2.15) were spent monitoring parking areas. In this time, a total of 684 waterfowl hunters were monitored for compliance with the DHP system (Fig. 2.16).

With the exception of teal season 2007, the general trend across each of the 2007 and 2008 waterfowl season survey periods was for DHP top compliance to be highest, followed by DHP bottom compliance, with DHP complete compliance being the lowest of the three (Table 2.3) (Fig. 2.17).

DHP top compliance ranged from a low of 59.0% during the 2007 teal season survey period, to a high of 79.8% during the 2008 duck season survey period. When averaged across all 2007 and 2008 waterfowl season survey periods, the final DHP top compliance rate was determined to be 72.7%.

DHP bottom compliance ranged from a low of 46.0% during the 2007 duck season survey period, to a high of 71.7% during the 2008 duck season survey period. When averaged across all 2007 and 2008 waterfowl season survey periods, the final DHP bottom compliance rate was determined to be 62.4%.

DHP complete compliance ranged from a low of 36.7% during the 2007 duck season survey period, to a high of 66.0% during the 2008 duck season survey period. When averaged across all 2007 and 2008 waterfowl season survey periods, the final DHP complete compliance rate was determined to be 55.4%.

During the 2007 teal season survey period, 2.1% (*n* = 2) of the DHP bottoms placed in the permit drop boxes were blank, along with 8.7% (*n* = 13) blank DHP bottoms being deposited in permit drop boxes during the 2007 duck season survey period. During the 2008 teal season survey period, 5.6% (*n* = 8) of DHP bottoms placed in the permit drop boxes were blank, along with 7.1% (*n* = 21) blank DHP bottoms being placed in the permit boxes during the 2008 duck season survey period. This total of 6.4% (*n* = 44) blank DHP bottoms submitted during the 2007 and 2008 survey periods at CHBW were excluded from both the statistical analyses relative to compliance and the DHP self-reporting rates of waterfowl species harvested by hunters (Table 2.2).

**Survey Week and DHP Compliance Rates**

Multivariate Analysis of Variance (MANOVA) produced significant models for comparisons between survey week and top, bottom, and complete DHP compliance rates ($F$ = 2.129, df = 24, 1944, $p$ = 0.001, Power = 0.997) (Table 2.4). Top DHP compliance during the first weekend of teal season 2007 (survey week 1) was different from the first weekend of teal season 2008 (survey week 6) ($p$ = 0.003) and the first weekend of duck season 2008 (survey week 9) ($p$ = 0.028). Top DHP compliance during the first weekend of duck season 2007 (survey week 3) was different from the first weekend of teal season 2008 (survey week 6) ($p$ = 0.031). There was also a difference in top DHP compliance between the first (survey week 6) and second (survey week 7) weekends of teal season 2008 ($p$ = 0.330). A difference also existed between top DHP compliance rates for the second week of teal season 2008 (survey week 7) and the first weekend of duck season 2008 (survey week 9) ($p$ = 0.020).

Relative to bottom DHP compliance rates, the first weekend of duck season 2007 (survey week 3) was different than the first weekend of teal season 2008 (survey week 6) ($p = 0.006$). Bottom DHP compliance rates during the first weekend of duck season 2007 (survey week 3) were also different than the first weekend of duck season 2008 (survey week 9) ($p < 0.001$), the second weekend of duck season 2008 (survey week 10) ($p = 0.043$), the third weekend of duck season 2008 (survey week 11) ($p = 0.038$), and the fourth weekend of duck season 2008 (survey week 12) ($p = 0.010$).

Relative to complete DHP compliance rates, the first weekend of duck season 2007 (survey week 3) was different than the first weekend of teal season 2008 (survey week 6) ($p = 0.001$). Complete DHP compliance rates during the first weekend of duck season 2007 also were different than the first weekend of duck season 2008 (survey week 9) ($p < 0.001$), the second weekend of duck season 2008 (survey week 10) ($p = 0.014$), and the third weekend of duck season 2008 (survey week 11) ($p = 0.038$).

**Season Framework and DHP Compliance Rates**

Multivariate Analysis of Variance (MANOVA) also produced significant models for comparisons between season framework and top, bottom, and complete DHP compliance rates ($F = 6.327$, df = 9, 1651, $p < 0.001$, Power = 1.000) (Table 2.4). Top DHP compliance during teal season 2007 was different than duck season 2008 ($p < 0.001$). Top DHP compliance during duck season 2007 was different than duck season 2008 ($p = 0.023$). Relative to bottom DHP compliance, there was a difference between duck season 2007 and duck season 2008 ($p < 0.001$). Furthermore, complete

DHP compliance during duck season 2007 was different than teal season 2008 ($p = 0.005$) and duck season 2008 ($p < 0.001$).

### Season Year and DHP Compliance Rates

Top DHP compliance rates were significantly different between the 2007 and 2008 waterfowl seasons ($t = -3.795$, df = 6, $p < 0.001$) (Table 2.5). Bottom DHP compliance rates were different between the 2007 and 2008 waterfowl seasons ($t = -3.983$, df = 6, $p < 0.001$). Complete DHP compliance rates were significantly different between the 2007 and 2008 waterfowl seasons ($t = -5.186$, df = 6, $p = 0.017$).

## DISCUSSION

### CHBW Waterfowl Hunter Origins

In addition to being an important wetland to migratory birds of many species, CHBW is also an important economic asset to Barton County and the state of Kansas (Vogler et al. 1987). When evaluating the origins of the waterfowl hunting constituency at CHBW, this became even more apparent. During this two-year study, the waterfowl hunters observed and checked represented 38 of the 105 counties in Kansas. In only two research seasons, roughly one-third of the state was represented in the sample of waterfowl hunters, indicating hunters from all over the state of Kansas travel to Barton County in pursuit of waterfowl at CHBW. In addition to the Kansas resident waterfowl hunters, seven additional states were represented. Hunters traveled from as far away as California and North Carolina to partake in the waterfowl hunting opportunities available to them at CHBW. This emphasized the nationwide importance of CHBW to the waterfowl hunting community, and illustrates the economic importance of CHBW to the KDWPT, and to the state of Kansas as well.

**Waterfowl Hunter Bag Checks**

Through evaluations of waterfowl hunters' harvests at CHBW, the repetitive presence of blue-winged teal and American green-winged teal illustrated the use of CHBW by those species, and the importance of those species to the hunters who choose to pursue waterfowl at CHBW. Although a total of 12 waterfowl species were represented in the waterfowl hunter bag checks, in three of the four waterfowl season survey periods during the 2007 and 2008 waterfowl seasons, blue-winged teal and American green-winged teal were the first and second most harvested species, respectively. In the one survey period where blue-winged teal were not the most abundant species in hunters' harvests, which was the 2007 duck season, the American green-winged teal took its place as the most abundant species in the waterfowl hunter bag checks.

Through the course of this study, the third most abundant waterfowl species in hunters' harvests was the mallard. The mallard is the most abundant duck in the United States, in North America, and in the entire Northern Hemisphere (Bellrose 1978). The mallard is the most commonly harvested species of waterfowl in Kansas, with an average harvest of 91,129 per year from 1999-2010 (Kruse 2011). The abundance of the mallard in hunters' harvests is especially important, as the mallard is not only the most sought after waterfowl species in the waterfowl hunting community, but it is also the species which drives a large majority of the waterfowl management decisions, on both the state and federal levels (Thomas F. Bidrowski, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

**Reporting Rates of Waterfowl Species Harvested at CHBW**

The self-reported rates of the waterfowl harvest at CHBW during the 2007 and 2008 waterfowl season survey periods were found to be highly variable. Reporting rates were found to be lower for all species during both the 2007 teal season survey period and the 2007 duck season survey period than during the teal and duck season survey periods of 2008. With a range from 0.00% reporting accuracy for redhead in the 2007 duck season survey period, to an incorrect high of a 108.93% reporting rate for gadwall in the 2008 duck season survey period, this variability is even more evident.

While the two examples above certainly represent the extremes, reporting rate variability was seen, although to a lesser degree, in other species of waterfowl harvested at CHBW. There were instances where the self-reported rates of harvest were more consistent throughout the 2007 and 2008 waterfowl season survey periods. For example, the reporting rate of the mallard was found to be one of the most consistently accurate, and in the 2008 duck season survey period the self-reported rate of harvest was found to be 96.6%, perhaps due to the importance of the mallard to the majority of waterfowl hunters, and the status arbitrarily assigned to harvesting the mallard. However, the reporting rate of the Northern shoveler also was found to be fairly consistent throughout the 2007 and 2008 waterfowl season survey periods, and this might be due to the fact that the large, spatulate bill of the Northern shoveler makes it readily identifiable to most all waterfowl hunters, regardless of their individual level of experience.

As for the case of "over-reporting" for the gadwall, which was the only instance of its kind during the course of the study, interactions with waterfowl hunters during bag checks and a description of the gadwall itself provided some explanation. The gadwall was a fairly non-descript duck in comparison to other species. Especially notable is the difference between the drake gadwall and the drakes of other species, relative to the bright and distinct coloration of drakes in alternate or nuptial plumage in species other than the gadwall. There was also a distinct difference between the hens and drakes of many waterfowl species other than the gadwall. Bellrose (1978) states gadwall, with their drab plumage, often appear to observers as hen mallards. During the course of the waterfowl hunter bag checks, there were several occasions where hunters had mistakenly identified a hen of another species as a gadwall until the difference was explained to them. This common misidentification might lead to "over-reporting" of the gadwall. As stated by Bellrose (1978), the speculum of the wing provides sufficient clues for identification of both the hen and the drake gadwall through both the nuptial and basic stages of plumage.

A very similar argument could be made for the misidentification of redhead ducks, as the hens of this species resemble the hens of many other species of diving ducks encountered at CHBW. During the bag checks of waterfowl hunters, there also were instances where waterfowl hunters had misidentified a hen redhead as a hen canvasback or a hen ring-necked duck. Again, this misidentification could potentially reduce the accuracy of the self-reported rates of redhead harvest through DHP systems.

In an effort to reduce these waterfowl identification problems, and to increase the accuracy of self-reported harvest rates through DHP registration systems, all waterfowl hunters are strongly encouraged to educate themselves and become more familiar with identifying the waterfowl they harvest, especially once they have retrieved the duck and have it in hand. Not only would this increase the accuracy of reporting rates, it could potentially prevent the issue of a citation to a waterfowl hunter for unknowingly breaking the law relative to waterfowl limits.

The overall self-reported rate of harvest through the 2007 and 2008 teal season survey periods was 65.7%. This estimate was relatively close to the self-reported rate of harvest calculated for the 2007 and 2008 duck season survey periods, which was 61.4%. Through the duration of this study, including all of the 2007 and 2008 waterfowl season survey periods, the overall self-reporting rate of harvest through the DHP system at CHBW was 63.7% of the total waterfowl harvest. These calculations indicated almost a third of the waterfowl harvest at CHBW remained unreported by waterfowl hunters through the DHP self-registration system, regardless of the waterfowl species or the season framework, for any given waterfowl season.

**General Trends in Top, Bottom, and Complete DHP Compliance Rates**

From a management perspective, the base compliance rates with the DHP system at CHBW were very important. The DHP cards not only provided data relative to harvest, hunter success, and the demographics of hunters using CHBW, but also provide direct estimates of the number of hunters participating in the hunting opportunities at CHBW. Area managers are required to prepare annual reports on the public’s use of their wildlife areas (Karl Grover, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.). For wildlife areas without manned check stations, which mandatorily require hunters to check in and out of an area and report their harvest directly, self-registration and reporting through DHP systems are critical to acquiring this valuable information.

The general trends of DHP compliance by waterfowl hunters at CHBW detected in this study showed DHP top compliance increased from the 2007 teal season to the 2007 duck season. Opposite of that trend, DHP bottom compliance decreased during the same season frameworks. Following the trend of DHP bottom compliance decreasing, DHP complete compliance decreased at an even greater rate from the 2007 teal season through the 2007 duck season.

The general trends of DHP compliance during the 2008 waterfowl season were different than the general trends seen during the 2007 waterfowl season. During 2008, DHP top compliance increased from the teal season through the duck season. The same trend also held true for both the DHP bottom and the DHP complete compliance rates, leading to higher DHP compliance rates overall for the 2008 waterfowl season survey periods.

## Survey Week and DHP Compliance Rates

DHP top, DHP bottom, and DHP complete compliance rates differed significantly between the 2007 and 2008 waterfowl seasons. DHP top compliance rates increased significantly from the first weekend of the 2007 teal season to the first weekend of the 2008 teal season and the first weekend of the 2008 duck season. There was also a significant increase in DHP top compliance rates from the first weekend of the 2007 duck season to the first weekend of the 2008 teal season. A significant increase in DHP top compliance rates from the first weekend of the 2008 teal season to the second weekend of the 2008 teal season also was detected. Furthermore, there was a significant increase in DHP top compliance rates from the second weekend of the 2008 teal season to the first weekend of the 2008 duck season.

There were also significant increases in compliance rates from the first weekend of the 2007 duck season to the first weekend of the 2008 teal season. Significant increases in DHP bottom compliance rates also were detected between the first weekend of the 2007 duck season and the first, second, third, and fourth weekends of the 2008 duck season.

There were also significant increases in compliance rates from the first weekend of the 2007 duck season to the first weekend of the 2008 teal season. Significant increases in DHP complete compliance rates also were detected between the first weekend of the 2007 teal season and the first, second, and third weekends of the 2008 duck season.

**Season Framework and DHP Compliance Rates**

There was an increase in compliance rates from the 2007 waterfowl season to the 2008 waterfowl season. For DHP top compliance rates, a significant increase was detected from the 2007 teal season to the 2008 duck season. Furthermore, there was a significant increase in DHP top compliance rates from the 2007 duck season to the 2008 duck season. There was also a significant increase in DHP bottom compliance rates from the 2007 duck season to the 2008 duck season. This same trend was true for DHP complete compliance rates, as there was a significant increase in DHP complete compliance rates from the 2007 duck season to both the 2008 teal season and the 2008 duck season.

**Season Year and DHP Compliance Rates**

There was a significant increase in DHP compliance rates from the 2007 waterfowl season to the 2008 waterfowl season. DHP top compliance was significantly higher in the 2008 waterfowl season than in the 2007 waterfowl season. DHP bottom compliance also was higher in the 2008 waterfowl season than in the 2007 waterfowl season. The same trend was true for DHP complete compliance, where a significant increase occurred from the 2007 to the 2008 waterfowl season.

**An Explanation of the General and Statistical Trends**

An explanation for the general trends detected in this study, and the significant increases in top, bottom, and complete DHP compliance rates might be explained through an examination of the conditions at CHBW during the 2007 and 2008 waterfowl seasons. During 2007, CHBW was recovering from a major flood event (Appendix G), and habitat conditions for waterfowl were poor. The floodwaters were receding from an all-time high, which left behind large mud flats devoid of vegetation, as persistent high water had eliminated most vegetation. The conditions and accessibility for hunters were even poorer than the conditions for waterfowl, as access to CHBW public hunting areas was extremely limited due to road and parking lot closures from the remaining floodwater. Furthermore, once hunters were able to access the public hunting areas, there was no vegetation to conceal themselves from an already limited number of ducks. These conditions negatively affected harvest rates, as well as the morale of the hunters present on the area, which was very obvious through interactions with hunters at CHBW during the 2007 waterfowl season. In addition to decreased morale, floodwaters made the DHP drop boxes difficult to access. The low morale, in conjunction with the difficulty associated with maneuvering through CHBW, might have decreased compliance with the DHP system during the 2007 season.

Conversely, the 2008 waterfowl season found improved habitat conditions at CHBW. There was abundant water and emergent vegetation in the refuge pools and hunting pools, resulting in excellent conditions for both waterfowl and hunters. In addition, there were no road or parking lot closures due to floodwater, the DHP drop boxes were readily accessible, and waterfowl harvest rates per hunter were considerably higher than they were during the 2007 waterfowl season. Based on interactions with waterfowl hunters during the 2008 season, morale was much better than that of the waterfowl hunters encountered the previous year. The optimal conditions during the 2008 waterfowl season, in conjunction with the ease of navigation through CHBW due to the absence of floodwaters, might have contributed to an increase in DHP compliance rates.

The DHP complete compliance rates increased by 4.1% from the 2007 teal season to the 2008 teal season, resulting in a DHP complete compliance rate of 55.6%. The DHP complete compliance rates increased by 29.3% from the 2007 duck season to the 2008 duck season, resulting in a compliance rate of 66.0%. Even when considering these increases in compliance from the 2007 waterfowl season with poor habitat conditions, to the 2008 waterfowl season with optimum habitat conditions, the overall rate of DHP complete compliance throughout all the 2007 and 2008 waterfowl season survey periods was estimated to be 55.4%. This rate of compliance with the DHP self-registration system at CHBW suggested nearly half of all hunters were not compliant with the DHP registration and harvest reporting system at CHBW.

## MANAGEMENT IMPLICATIONS

Partially due to the low compliance rates with the DHP registration system at CHBW, new DHP boxes have been designed, fabricated, and installed at CHBW by KDWPT employees. This project was completed in an effort to increase compliance rates with the DHP registration system. New instructional signs relative to the DHP procedure and requirements also were placed at each DHP box, which should better inform hunters visiting CHBW of their responsibility to obtain and complete the necessary permits. The style of the DHP boxes was improved, with the cards hanging vertically in a steel enclosure with a clear Lexan© face, making the DHP cards highly visible and more accessible to hunters at CHBW. This change could increase compliance with the DHP system as the DHP cards are no longer hidden from view inside steel boxes with no viewing window.

A new DHP box also was installed in the North Hub area of CHBW, at the intersection of Pools 3A, 3B, and 4A, all of which are open to public waterfowl hunting. This area traditionally has a large number of both boat-in and walk-in hunters, and the decision was made to place a DHP box there in anticipation of increasing DHP compliance by hunters frequenting that particular area.

The DHP cards also have been redesigned to gain more accurate information from the hunters at CHBW (Appendix H). The DHP cards used in the study during the 2007 and 2008 waterfowl season survey periods listed the hunter origin information as "optional." The new DHP cards require waterfowl hunters at CHBW to provide information relative to their origin. These changes should increase the amount of hunter origin data collected from the DHP cards, and should increase knowledge for KDWPT staff relative to the origin of hunters visiting CHBW.

An additional change that might increase compliance with the DHP registration system at CHBW was new signage at each of the four main entrances to the property, which have been discussed but not yet implemented. This potential new signage would bring better attention to the fact that it is a law, mandated by Kansas Statute: KAR 115-8-1, that each hunter must complete a DHP while hunting at CHBW, and failure to do so might result in a citation and fine. KDWPT Conservation Officers at CHBW are currently not issuing citations to waterfowl hunters that fail to complete a DHP while hunting waterfowl on the property. The issuing of citations at CHBW for DHP violations also might help to convince hunters that participation in the DHP registration is not optional, but mandatory, which could subsequently increase DHP compliance rates. This could be complemented with educating waterfowl hunters at CHBW that failure to comply with the DHP system could lead future area managers to revert to a mandatory in-person check station.

Future research needs to include the collection of additional DHP compliance data at CHBW, preferably conducted in two consecutive waterfowl seasons with approximately the same conditions, i.e., not during flood years. The additional DHP compliance data collected in the future could be compared to the results of this study, to determine if the new DHP design and installation helped to increase compliance rates with the DHP registration system. Furthermore, an evaluation of the factors possibly affecting compliance rates could be an integral part of future studies. In addition to future research conducted at CHBW, it potentially could be helpful to compare DHP compliance rates and the accuracy of the self-reported harvest information at CHBW to the data collected through self-registration systems at other KDWPT Wildlife Areas across the state.

## Conclusion

The findings of this DHP self-registration system research agree with the findings of several other related studies, indicating report-card registration systems often have variable reporting rates (Rosenberry et al. 2004). Although registration stations are a common method for hunters to report harvest rates, the rates of compliance with the permit systems are often difficult or impossible to quantify (Strickland et al. 1994, Rupp et al. 2000, Rosenberry et al. 2004). The results of this study on compliance rates with the DHP system at CHBW, and the results of several other closely related studies, demonstrated the need for methods to improve DHP system compliance rates. An increase in compliance rates with report-card registration systems would result in more accurate estimates of waterfowl hunter numbers, increased knowledge of the origins of those waterfowl hunters, and a better estimate of the overall waterfowl harvest at CHBW and other wildlife areas that rely on hunter compliance with a self-registration system.

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# CHAPTER THREE

# WATERFOWL HUNTER ATTITUDES RELATIVE TO AVIAN INFLUENZA

## ABSTRACT

Understanding how the perceived and actual threats and risks associated with wildlife diseases affect hunters is becoming increasingly important to wildlife agencies in the United States. To assess the degree to which avian influenza has influenced the attitudes of waterfowl hunters in Kansas, and to evaluate the effects of avian influenza on waterfowl hunter participation in Kansas, a survey that asked Kansas waterfowl hunters to rate their knowledge and concerns relative to avian influenza was developed. The survey was mailed to 1,000 hunters that purchased Harvest Information Program (HIP) stamps in Kansas during the 2005-2006 and 2006-2007 waterfowl seasons, with a return rate of 41.7%. The results of this survey indicated fears of avian influenza are very low in Kansas, and avian influenza is having very little influence on hunter participation.

## INTRODUCTION

Influenza viruses are not novel, as characteristic influenza outbreaks have occurred nearly every year since record keeping began in the early 1500s. Pandemic influenza outbreaks occurred in 1743 and 1889, and the influenza strain known as the “Spanish Flu” caused approximately forty million deaths globally from 1918 to 1919 (Peiris et al. 2007), with approximately one-half million deaths in the United States alone (MacKenzie 2005). In 1957 there was an outbreak of the “Asian Flu,” followed in 1968 by an outbreak of the “Hong Kong Flu” (Peiris et al. 2007), and these pandemics claimed 70,000 and 34,000 lives in the United States, respectively (MacKenzie 2005). An exchange of genes between human and avian influenza viruses caused the pandemic outbreaks in both 1957 and 1968 (MacKenzie 2005).

Viral influenza infections in animals are primarily respiratory diseases caused by one of three strains of viruses: A, B, and C (Perdue and Swayne 2005). All three strains of influenza viruses belong to the family Orthomyxoviridae, and almost every year influenza type A and B viruses cause epidemics (Peiris et al. 2007). The surface of the influenza virus contains two glycoproteins, hemagglutinin (H) and neuraminidase (N), and virologists further classify influenza A viruses into sixteen H subtypes (H1-H16) and nine N (N1-N9) subtypes based on serologic reactions to these surface glycoproteins (Perdue and Swayne 2005). The H and N subtypes are further classified into two pathotypes: high-pathogenicity (HP) and low-pathogenicity (LP), with the HP pathotype causing >75% mortality and the LP pathotype causing <75% mortality (Perdue and Swayne 2005). This classification system provides basis for influenza nomenclature, and most people recognize avian influenza as "H5N1" as a result. All avian influenza strains are influenza A viruses (Swayne and Halvorson 2003). The majority of avian influenza viruses are LP; however, genetic reassortment and viral mutations have transformed some LP viruses to HP viruses, and these HP viruses have caused 24 epizootics of HP avian influenza since 1959 (Perdue and Swayne 2005).

From 1996 to 2005, the majority of HP avian influenza (Type H5N1) was confined to infected poultry and commensal, non-migratory, wild birds (Terakado 2004, Sims et al. 2005). However, Qinghai Lake, China, a site thought to be isolated from contact with poultry, experienced an outbreak of H5N1 in May 2005 (Yasue et al. 2006).

Following this event in 2005 and early 2006, Erhel Lake in Mongolia and several locations throughout Europe experienced avian influenza outbreaks in populations of wild birds apparently unrelated to outbreaks in poultry (Munster et al. 2006, Olsen et al. 2006). In 2008, avian influenza outbreaks in poultry and wild birds were reported in Russia, Japan, Vietnam, and Pakistan (Tom Roffe, United States Geological Survey, pers. comm.). These outbreaks of avian influenza caused virologists and other scientists to more closely examine the role of wild bird populations as vectors for H5N1 (Yasue 2006, Keawcharoen et al. 2008).

Friend et al. (2001) emphasized the challenges facing wildlife managers in the twenty-first century because of disease emergence in birds. Some of the avian threats include viral infections in Antarctic Adelie penguins (*Pygoscelis adelaiae*) (Gardner et al. 1997), foreign pathogens infecting Darwin's finches (Geospizinae) in the Galapagos Islands (Vargas 2000), and infectious viruses in nesting populations of spectacled eiders (*Somateria fischeri*) in western Alaska and the Gulf of Finland (Hollmen et al. 2000). These studies indicate wildlife diseases are global in nature, and viruses can attack wildlife populations anywhere (Bolen and Robinson 2003).

Since that time, the avian influenza virus subtypes possibly affecting human health have been detected in wild bird populations, with waterfowl being the primary reservoir (Clark and Hall 2006). Dudley (2004) stated that globalization has caused the physical distance from zoonotic outbreaks to no longer safeguard against infection. Consequently, societies are now concerned with the serious challenge of managing zoonotic diseases (Peterson et al. 2006), and the research to address the changes in the social dimensions of wildlife disease management recently has begun (Dorn and Mertig 2005).

Wild birds function as vectors for a variety of diseases in humans (zoonoses) and domestic animals (Friend et al. 2001), causing growing concern in some segments of society, especially those in close proximity to populations of wild waterfowl (Graczyk et al. 1998, Saltoun et al. 2000). Human health concerns related to avian diseases have inspired the international development of many scientific research projects, collaborative efforts, and publications focused on addressing the issues related to human health and avian disease (Friend et al. 2001).

Furthermore, Friend et al. (2001) suggested disease emergence must be aggressively addressed on behalf of avifauna, or the resulting effects will cause not only biological issues, but also social and economic losses, such as revenue lost from ecotourism and recreational hunting due to declines in bird populations. According to the United States Fish and Wildlife 2006 Economic Impact of Waterfowl Hunting Report (Carver and Caudhill 2007) the economic impact of waterfowl hunting is of great importance to the state of Kansas. Kansas ranks 15$^{th}$ in the United States relative to waterfowl hunting participation, with approximately 30,000 licensed waterfowl hunters over the age of 16. These waterfowl hunters spent approximately $16.8 million on trip and equipment expenses, while supporting an estimated 439 waterfowl-related jobs in the state of Kansas. In conjunction with federal and state taxes, almost $25 million dollars in revenue was generated by Kansas waterfowl hunters in 2006. More specifically, waterfowl hunters are also of great economic importance to Cheyenne Bottoms Wildlife

Area (CHBW), as it is 100% funded by hunters' dollars through both the Federal Aid in Wildlife Restoration Act, also known as the Pittman-Robertson Act, and the sale of hunting licenses (Karl Grover, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

Understanding how the perceived and actual threats and risks associated with wildlife diseases affect hunters is becoming increasingly important to wildlife agencies in the United States, especially those agencies that rely on revenues from sales of hunting licenses and stamps. While no documented cases of HP avian influenza have been recorded in birds nor humans in North America, HP avian influenza infection of humans has been a concern since it was identified in Asia in 1997 (Berns et al. 2012). Furthermore, the spread of HP avian influenza across Europe and Asia raises the level of concern in the United States. No known studies of waterfowl hunters' knowledge and concerns relative to avian influenza have been conducted in the United States (Tom Roffe, United States Geological Survey, pers. comm.).

With the goal of assessing the degree to which avian influenza has influenced the attitudes of waterfowl hunters in Kansas, and to evaluate the effects of avian influenza on waterfowl hunter participation in Kansas, a survey that asked Kansas waterfowl hunters to rate their knowledge and concerns relative to avian influenza was developed (Appendix I). In addition, the survey evaluated waterfowl hunter attitudes toward the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) role in monitoring waterfowl populations for the presence of avian influenza in Kansas. Additional sections of this survey addressed hunters' concerns regarding human health and the health of waterfowl populations. This survey also assessed the level of waterfowl hunters' misconceptions relative to avian influenza, and ranked several factors, unrelated to wildlife disease, that might cause declines in hunter numbers and participation, consequently affecting the future of waterfowl hunting in Kansas.

The survey had the following objectives: 1) determine whether waterfowl hunters trust KDWPT to properly monitor for avian influenza, 2) determine whether waterfowl hunters expect KDWPT to keep the public informed of the latest avian influenza reports, 3) determine whether current educational efforts are providing waterfowl hunters with enough information, 4) determine how this information is being received, 5) determine whether waterfowl hunters are concerned about the effect of avian influenza on human health, 6) determine whether waterfowl hunters think avian influenza is a significant factor affecting the health of North American waterfowl populations, 7) determine whether waterfowl hunters are concerned about the future of waterfowl hunting due to avian influenza, and 8) determine whether fears of avian influenza are enough reason for some waterfowl hunters to choose not to participate in a given hunting season.

## METHODS

For the purposes of my survey, hunters were considered to be active and participating if they hunted one or more times in a given waterfowl season. The evaluation of hunter responses to the survey was achieved by making comparisons between waterfowl hunters who actively hunted in the 2005-2006 and 2006-2007 hunting seasons. The 2005-2006 waterfowl season is important because that was the year before KDWPT started swabbing hunter-harvested waterfowl for avian influenza and before avian influenza received national attention in the media. The 2006-2007 waterfowl season was the first year KDWPT swabbed hunter-harvested waterfowl for avian influenza and the first year avian influenza outbreaks in Asia were heavily reported by the national media (Helen Hands, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

The survey begins with basic questions designed to categorize survey respondents (e.g., “Did you hunt waterfowl in the 2006-2007 waterfowl season?” and “Did KDWPT or other agency personnel swab any of the ducks you harvested for bird flu?”). The first series of questions are followed by additional opinion-based questions and statements to which potential respondents were asked to select a best-fit answer, based on 3-point or 5-point Likert Scale choices (Appendix B) (Likert 1932). The wording of the Likert Scale choices was adjusted to fit the questions, if necessary. Our survey followed the methodology of Stafford et al. (2007), in which a survey was conducted that assessed hunter and nonhunter beliefs relative to chronic wasting disease.

A stratified, random sample of potential respondents for our survey was selected from KDWPT records of Harvest Information Program (HIP) stamp sales for the 2006-2007 and 2007-2008 waterfowl seasons. The HIP program is a mandatory registry for all migratory bird hunters, not just waterfowl hunters. Hunters purchasing HIP stamps were considered waterfowl hunters if they hunted either ducks or geese, or both, based on their answers to the HIP screening questions (e.g., “Did you hunt ducks last year?” and “Did you hunt geese last year?”). Our survey followed the methodology of other hunter surveys, and was based on an estimated response rate of 40-50% (Hands

2001, Rodgers 2001), with a desired sample size of approximately 500 respondents with 95% confidence interval goals (Childress and Williams 2006). Therefore, a stratified random sample of 1,000 names was selected randomly from the population of hunters who purchased a HIP stamp from fall 2006 - winter 2008. The random sample was stratified into 4 groups: 1) those who hunted only during the 2005-2006 season, 2) those who hunted only during the 2006-2007 season, 3) those who hunted in both the 2005-2006 and 2006-2007 seasons, 4) and those that did not hunt in either the 2005-2006 or the 2006-2007 waterfowl seasons (Table 3.1). The first three survey questions were designed to further divide the sample into two additional groups, based on exposure to agency personnel collecting samples from harvested waterfowl (Table 3.1).

This random selection of HIP stamp purchasers included both Kansas resident and non-resident waterfowl hunters; however, our survey had not been designed to compare differences in survey responses between these two groups. The random sample included waterfowl hunters throughout the state of Kansas, not just those who hunted at CHBW. Approximately three weeks after the initial survey had been mailed, KDWPT sent out reminder postcards in an effort to increase response rates. Finally, 4-5 weeks after the initial survey had been mailed, KDWPT sent additional surveys by mail to all non-respondents, in an effort to further increase the rate of return.

The data obtained from the surveys were analyzed by evaluating the general trends of these data, and by calculating descriptive statistics for each of the survey questions (Table 3.2). All data were analyzed by using the SPSS 11.5 ® (SPSS Inc. 2000) statistical software package. Differences between and among the groups of respondents shown in Table 3.1 were compared statistically by using the independent samples t-test (Table 3.3), Analysis of Variance (ANOVA) (Table 3.4), Kruskal-Wallis (Table 3.5), and Chi-square goodness-of-fit test (Table 3.6) (Zar 1999). For the Chi-square goodness-of-fit test, the expected values were equal numbers of responses for each of the Likert scale choices for each survey question. The Chi-square goodness-of-fit analysis included all the returned surveys as a single group, i.e., the surveys were not divided into groups based on levels of hunter participation or having avian influenza samples collected from harvested waterfowl.

## RESULTS

Of the 1,000 surveys mailed to waterfowl hunters, 417 surveys were returned, resulting in a 41.7% response rate. Of the 417 returned surveys, 22 were completed incorrectly, and these data were removed prior to analyses resulting in an overall sample size of 395. An additional portion of the surveys were only partially completed, which caused a slight reduction in sample size for some survey questions (Table 3.7). The proportions of respondents that selected each of the Likert scale response choices were rounded to the nearest percent.

### Categorical Questions

The results of the survey indicated 60% ($n$ = 232) of the survey respondents were active waterfowl hunters during the 2005-2006 waterfowl hunting season (Question 1.) (Fig. 3.1). During the 2006-2007 waterfowl hunting season, 59% ($n$ = 229) of survey respondents actively pursued waterfowl (Question 2.) (Fig. 3.2). Of these waterfowl hunters, 4% (*n* = 15) had avian influenza samples collected from waterfowl they harvested by KDWPT personnel (Question 3.) (Fig. 3.3).

## Concerns for Human Health

### Question 8. Do you think the bird flu is a serious risk to the health of waterfowl hunters and their families?

Of 392 survey respondents, the largest proportion (48%, *n* = 181) indicated they had "no opinion / did not know" if avian influenza was a serious risk, with the second largest proportion of respondents (28%, *n* = 106) indicating they agreed avian influenza could be considered a serious risk to the health of waterfowl hunters and their families. The third largest proportion of respondents (12%, *n* = 45) indicated they "slightly disagreed" avian influenza was a serious risk to human health. The mean Likert scale response was 2.69 (*SD* = 0.88, *N* = 377) on a 5-point scale, with 1 being "strongly agree" and 5 being "strongly disagree" (Fig. 3.4).

There was no difference in the mean Likert score between waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t = -1.032$, df = 89, $p = 0.310$). Furthermore, there were no differences in mean Likert scores among the four waterfowl hunter groups based on hunter participation ($H = 0.419$, df = 3, $p = 0.981$). More survey respondents than expected indicated they "did not know / had no opinion" if avian influenza was a serious risk to themselves and their families ($\chi^2 = 73.08$, df = 2, $p < 0.0001$) (Fig. 3.5).

**Question 9. How concerned is your family about getting bird flu from eating the waterfowl you harvest?**

Of 397 survey respondents, the largest proportion (29%, $n$ = 110) indicated their family was "not concerned at all" relative to consumption of harvested waterfowl. The second largest proportion of survey respondents (28%, $n$ = 106) indicated they had "no opinion / did not know," and the third largest proportion of respondents (24%, $n$ = 95) indicated they were "slightly concerned" over getting avian influenza from the consumption of harvested waterfowl. The mean Likert score was 3.31 ($SD$ = 1.31, $N$ = 379) on a 5-point scale, with 1 being "very concerned" and 5 being "not concerned at all" (Fig. 3.6).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -0.239, df = 72, $p$ = 0.812). There were no differences in mean Likert scores among the four waterfowl hunter groups based on hunter participation ($H$ = 1.758, df = 3, $p$ = 0.780) (Fig. 3.10). The number of each of the Likert scale response choices selected was different than the expected value ($\chi^2$ = 10.43, df = 2, $p$ = 0.0054) (Fig. 3.7).

**Question 10. How concerned are you that your dog will get bird flu from retrieving ducks shot by waterfowl hunters?**

Of 393 survey respondents, the largest proportion (32%, $n$ = 126) indicated they had "no opinion / did not own a dog." The second largest proportion of respondents (28%, $n$ = 110) indicated they were "not concerned at all," and the third largest proportion of respondents (22%, $n$ = 86) indicated they were "slightly concerned" about their retrievers getting avian influenza from retrieving harvested waterfowl. The mean Likert scale response was 3.23 (*SD* = 1.33, *N* = 378) on a 5-point scale, with 1 being “very concerned” and 5 being “not concerned at all” (Fig. 3.8).

There was no difference in the mean Likert scale response choices between waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t = 0.858$, df = 199, $p = 0.392$). There were no differences in the mean Likert scale response choices among waterfowl hunter groups based on hunter participation ($F = 0.669$, df = 375, $p = 0.572$). The number of each of the Likert scale response choices did not differ from our expectations ($\chi^2 = 2.611$, df = 2, $p = 0.2711$) (Fig. 3.9).

## General Avian Influenza Knowledge and the Adequacy and Availability of Information and Educational Efforts

### Question 4. How many kinds of bird flu are there?

Of 395 survey respondents, the largest proportion (73%, *n* = 288) indicated they “did not know.” The second largest proportion of respondents (11%, *n* = 43) selected the correct answer, which is there are “many” types of avian influenza. The Likert scale choices “few” and “one” were each selected by 8% (*n* = 32) of our respondents (Fig 3.10).

There was no difference in the mean Likert scores between waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t = -1.087$, df = 197, $p = 0.279$). Differences were detected among mean Likert scores of the four waterfowl hunter groups based on hunter participation, as hunters with constant participation had mean Likert scores slightly more accurate than those who hunted waterfowl during neither season ($H$ = 11.380, df = 3, $p$ = 0.023). The number of each of the Likert scale response choices selected was different than the expected value ($\chi^2$ = 494.65, df = 2, $p$ = <0.0001) (Fig. 3.11).

**Question 5. Are all types of bird flu equally dangerous to waterfowl?**

Of 395 survey respondents, the largest proportion (75%, $n$ = 296) indicated they "did not know." The second largest proportion of respondents (16%, $n$ = 63) selected "no," all types of bird flu are not equally dangerous to waterfowl, which is the most accurate answer. The remaining respondents (9%, $n$ = 36) indicated there was "one" type of avian influenza (Fig. 3.12).

There was no difference in the mean Likert scores between waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t$ = -0.998, df = 197, $p$ = 0.320). There were no differences detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($H$ = 5.616, df = 3, $p$ = 0.230). The number of each of the Likert scale response choices selected was different than the expected value ($\chi^2$ = 299.81, df = 2, $p$ = <0.0001) (Fig. 3.13).

**Question 6. Are all types of bird flu equally dangerous to people?**

Of 390 survey respondents, the largest proportion (69%, $n$ = 270) indicated they "did not know." The second largest proportion of respondents (23%, $n$ = 90) selected "yes," which is the most accurate answer, as all types of bird flu are not equally dangerous to people. The remaining respondents (8%, $n$ = 31) selected "yes" (Fig. 3.14).

There was no difference in the mean Likert scores between waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t$ = -1.873, df = 199, $p$ = 0.063). There were no differences detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($F$ = 1.145, df = 374, $p$ = 0.331). The number of each of the Likert scale response choices selected was significantly different than expected ($\chi^2$ = 240.02, df = 2, $p$ = <0.0001) (Fig. 3.15).

**Question 7. How much do you need or want to know about bird flu?**

Of 380 survey respondents, the largest proportion (54%, $n$ = 205) indicated they wanted to know “only as much as necessary to be safe” from avian influenza. The second largest proportion of respondents (34%, $n$ = 129) selected “as much as possible.” The remaining respondents (13%, $n$ = 49) selected “no need / no interest” when asked how much they needed or wanted to know about avian influenza (Fig. 3.16).

There was no difference in the mean Likert scores between waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t$ = 0.170, df = 199, $p$ = 0.865). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation, as hunters with constant participation had slightly lower mean Likert scores than hunters who did not pursue waterfowl during either season ($F$ = 7.716, df = 376, $p$ = <0.05). The number of each of the Likert scale response choices selected was different than expected ($\chi^2$ = 96.09, df = 2, $p$ = <0.0001) (Fig. 3.17).

**Question 17. Depending on how you *currently* obtain most of your information about bird flu, please rate the importance of the choices listed as High, Medium, or Low.**

The results of the survey indicated the most important methods currently used by waterfowl hunters to obtain avian influenza information were the television, outdoor magazines, and newspapers. These three choices were ranked as being of “High” importance to 54% ($n$ = 163), 50% ($n$ = 152), and 42% ($n$ = 127) of survey respondents, respectively (Fig. 3.18).

The KDWPT website, along with obtaining avian influenza news from friends, ranked in the middle, according to the survey. Thirty six percent ($n$ = 109) of the survey respondents rated the KDWPT website as high importance, 30% ($n$ = 91) as medium, and 35% ($n$ = 106) rated it as being of low importance. Friends were rated as high importance by 19% ($n$ = 58) of respondents, as medium by 36% ($n$ = 109), and were rated as low importance by 46% ($n$ = 139) of the waterfowl hunters surveyed (Fig. 3.18).

The least important sources for waterfowl hunters to currently obtain their avian influenza information were indicated to be public meetings, internet sites other than KDWPT, and the radio. Seventy two percent ($n$ = 218) of the survey respondents rated public meetings as being of low importance. Fifty three percent ($n$ = 161) of respondents rated internet sites other than KDWPT as low importance, and 51% ($n$ = 155) of the survey respondents rated the radio as being of low importance relative to obtaining avian influenza information (Fig. 3.18).

**Question 18. Please list any additional sources for obtaining bird flu information that are *currently* more important to you than the choices listed in the previous question.**

The respondents to the survey provided several different sources of avian influenza information currently important to them. The three sources most commonly listed were the hunting regulations booklet provided when purchasing a hunting license (20%, $n = 9$), Ducks Unlimited (9%, $n = 4$), and The Center for Disease Control (7%, $n = 3$), respectively. Other sources provided by hunters completing our survey included farm and health care publications (4%, $n = 2$), poultry magazines (4%, $n = 2$), and employer newsletters (4%, $n = 2$).

**Question 19. Depending on how you would *most prefer* to obtain your bird flu information, please rate the importance of the choices listed as High, Medium, or Low.**

The results of our survey indicate waterfowl hunters would most prefer to obtain their avian influenza information from outdoor magazines, television, newspapers, and the KDWPT website. Sixty three percent ($n = 188$) of the survey respondents rated outdoor magazines as being the most preferred source of avian influenza information, and 62% ($n = 185$) rated television as a highly preferred source of information. Newspapers and the KDWPT website were each rated as being a highly preferred source of information by 57% ($n = 170$) of survey respondents (Fig. 3.19).

The least preferred sources of obtaining avian influenza information were public meetings, internet sites other than KDWPT, and friends. These three choices were rated as “low” by 57% (*n* = 170), 49% (*n* = 146), and 46% (*n* = 137) of survey respondents, respectively (Fig. 3.19).

**Question 20. Please list any additional sources for delivery of bird flu information that would be *more preferred* than the choices listed in the previous question.**

The respondents to the survey provided several sources they would prefer to use to obtain their avian influenza information. The three sources most commonly listed were mailed newsletters from KDWPT (31%, *n* = 16), additional information relative to avian influenza printed in the hunting regulations booklet (18%, *n* = 9), and e-mails from KDWPT (14%, *n* = 7). Other sources provided by survey respondents indicate some hunters would prefer information to be posted on public hunting areas (8%, *n* = 4), and some prefer to rely on Ducks Unlimited (6%, *n* = 3) for their avian influenza information.

**Question 21. Do you wish to be informed about bird flu news by KDWPT?**

Of 368 survey respondents, 83% (*n* = 305) answered “yes,” demonstrating they wanted to be informed of avian influenza news by KDWPT. The remaining respondents (17%, *n* = 63) did not want to be informed by KDWPT (Fig. 3.20).

A difference was detected between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from their harvested waterfowl and those who had not ($t$ = -3.728, df = 186, $p$ = <0.05). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation, as hunters with constant participation had a slightly greater proportion that wanted avian influenza information from KDWPT than the hunters who did not pursue waterfowl during either season ($H$ = 15.146, df = 3, $p$ = 0.004). The number of each of the Likert scale response choices selected was different than expected ($\chi^2$ = 160.45, df = 1, $p$ = <0.0001) (Fig. 3.21).

## Hunter Opinions of Avian Influenza Surveillance Efforts

### Question 22. Are KDWPT bird flu surveillance and monitoring efforts sufficient for detecting bird flu in Kansas?

Of 380 survey respondents, the largest proportion (34%, $n$ = 124) "somewhat agreed" surveillance efforts were sufficient for avian influenza detection in Kansas, and the second largest proportion (32%, $n$ = 113) indicated they "strongly agreed" surveillance efforts were sufficient. The third largest proportion of survey respondents (31%, $n$ = 110) indicated they had "no opinion." The mean Likert score was 2.09 ($SD$ = 0.92, $N$ = 365) on a 5-point scale, with 1 being "strongly agree" and 5 being "strongly disagree" (Fig. 3.22).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -2.627, df = 197, $p$ = 0.091). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($F$ = 5.635, df = 360, $p$ = <0.05), as hunters with constant participation more strongly agreed surveillance efforts were sufficient for avian influenza detection in Kansas. The number of each of the Likert scale response choices selected was different than the expected value ($\chi^2$ = 201.52, df = 4, $p$ = <0.0001) (Fig. 3.23).

### Question 23. Are waterfowl the correct group of birds to be monitoring for the presence of bird flu?

Of 386 survey respondents, the largest proportion (38%, $n$ = 147) "somewhat agreed" waterfowl were the correct group of birds to monitor for avian influenza, yet the second largest proportion of survey respondents (35%, $n$ = 135) indicated they had "no opinion." The third largest proportion of respondents (20%, $n$ = 77) indicated they "strongly agreed" waterfowl were the correct group of birds to monitor. The mean Likert score was 2.31 ($SD$ = 0.93, $N$ = 368) on a 5-point scale, with 1 being "strongly agree" and 5 being "strongly disagree" (Fig. 3.24).

There was no difference between the mean Likert scores of waterfowl hunters whose harvested ducks were sampled for possible avian influenza and those whose were not ($t$ = -1.624, df = 199, $p$ = 0.096). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation. Hunters with constant participation more strongly agreed waterfowl were the correct group of birds to monitor for avian influenza ($F$ = 8.023, df = 365, $p$ = <0.05). The number of each of the Likert scale response choices selected was different than the expected value ($\chi^2$ = 205.73, df = 4, $p$ = <0.0001) (Fig. 3.25).

### Question 24. Should KDWPT be monitoring wild waterfowl for the presence of bird flu?

Of 380 survey respondents, the largest proportion (46%, $n$ = 175) "strongly agreed" the KDWPT should be monitoring waterfowl for the presence of avian influenza, and the second largest proportion of survey respondents (35%, $n$ = 133) indicated they "somewhat agreed." The third largest proportion of respondents (18%, $n$ = 68) indicated they had "no opinion." The mean Likert score was 1.73 ($SD$ = 0.80, $N$ = 367) on a

5-point scale, with 1 being "strongly agree" and 5 being "strongly disagree" (Fig. 3.26).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -0.181, df = 197, $p$ = 0.856). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($F$ = 10.483, df = 365, $p$ = <0.05), as hunters with constant participation more strongly agreed KDWPT should be monitoring waterfowl for the presence of avian influenza. The number of each of the Likert scale response choices selected was different than expected ($\chi^2$ = 311.23, df = 4, $p$ = <0.0001) (Fig. 3.27).

**Question 25. Should the Kansas Department of Agriculture be monitoring domestic fowl for bird flu**?

Of 380 survey respondents, the largest proportion (47%, $n$ = 179) "strongly agreed" the Kansas Department of Agriculture (KDA) should be monitoring domestic fowl for the presence of avian influenza, and the second largest proportion of survey respondents (33%, $n$ = 125) indicated they "somewhat agreed." The third largest proportion of respondents (16%, $n$ = 61) indicated they had "no opinion." The mean Likert score was 1.76 ($SD$ = 0.91, $N$ = 366) on a 5-point scale, with 1 being "strongly agree" and 5 being "strongly disagree" (Fig. 3.28).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -0.979, df = 198, $p$ = 0.329). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($F$ = 6.461, df = 363, $p$ = <0.05), as hunters with constant participation more strongly agreed the KDA should be monitoring domestic fowl for the presence of avian influenza. The number of each of the Likert scale response choices selected was different than expected ($\chi^2$ = 300.92, df = 4, $p$ = <0.0001) (Fig. 3.29).

## **Concerns for Waterfowl Health and the Future of Waterfowl Hunting**

### **Question 11. Do you think that bird flu could be a significant factor affecting the health of North American waterfowl populations?**

Of 389 survey respondents, the largest proportion (40%, $n$ = 156) selected "no opinion / don't know." The second largest proportion of survey respondents (36%, $n$ = 140) indicated they "agreed" avian influenza could be a significant factor affecting waterfowl health, as well as the third largest proportion of respondents (16%, $n$ = 62), who "strongly agreed." The mean Likert score was 2.43 ($SD$ = 0.91, $N$ = 378) on a 5-point scale, with 1 being "strongly agree" and 5 being "strongly disagree" (Fig. 3.30).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -1.003, df = 199, $p$ = 0.317). There was no difference among the mean Likert scores of the four waterfowl hunter groups based on hunter participation

($H$ = 8.654, df = 3, $p$ = 0.070) relative to avian influenza being a significant factor affecting the health of waterfowl populations in North America. The number of each of the Likert scale response choices selected was different than expected ($\chi^2$ = 222.19, df = 4, $p$ = <0.0001) (Fig. 3.31).

**Question 12. Are you concerned that the United States Fish and Wildlife Service will close waterfowl seasons due to bird flu?**

Of 389 survey respondents, the largest proportion (35%, $n$ = 136) selected "no opinion / don't know." The second largest proportion of survey respondents (30%, $n$ = 117) indicated they were "slightly concerned" and the third largest proportion (19%, $n$ = 74) indicated they were "very concerned" the United States Fish and Wildlife Service (USFWS) would close waterfowl seasons due to threats from avian influenza. The mean Likert score was 2.53 ($SD$ = 1.11, $N$ = 378) on a 5-point scale, with 1 being "very concerned" and 5 being "not concerned at all" (Fig. 3.32).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -1.003, df = 199, $p$ = 0.317). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($H$ = 13.619, df = 3, $p$ = 0.009), as hunters with constant participation were more concerned over the closure of waterfowl seasons by the USFWS due to avian influenza. The number of each of the Likert scale response choices selected was significantly different than expected ($\chi^2$ = 121.50, df = 4, $p$ = <0.0001) (Fig. 3.33).

**Question 13. Are you concerned that the Kansas Department of Wildlife, Parks, and Tourism will close waterfowl seasons due to bird flu?**

Of 392 survey respondents, the largest proportion (32%, *n* = 125) selected "no opinion / don't know." The second largest proportion of survey respondents (30%, *n* = 118) indicated they were "slightly concerned" and the third largest proportion (20%, *n* = 79) indicated they were "very concerned" the KDWPT would close waterfowl seasons due to threats from avian influenza. The mean Likert score was 2.56 (*SD* = 1.19, *N* = 379) on a 5-point scale, with 1 being "very concerned" and 5 being "not concerned at all" (Fig. 3.34).

There was no difference between the mean Likert scores of waterfowl hunters who had avian influenza samples collected from harvested waterfowl and those who had not ($t$ = -1.070, df = 199, $p$ = 0.286). A difference was detected among the mean Likert scores of the four waterfowl hunter groups based on hunter participation ($H$ = 14.216, df = 3, $p$ = 0.007), as hunters with constant participation were more concerned over the closure of waterfowl seasons by the KDWPT due to avian influenza. The number of each of the Likert scale response choices selected was different than expected ($\chi^2$ = 93.81, df = 4, $p$ = <0.0001) (Fig. 3.35).

**Question 14. If you did not hunt waterfowl at all during the 2006-2007 or 2007-2008 waterfowl seasons, did bird flu have anything to do with your decision not to hunt?**

Of 176 survey respondents, the largest proportion (95%, *n* = 167) selected "not at all." The second largest proportion of survey respondents (3%, *n* = 5) indicated fears of avian influenza "somewhat" affected their decision not to hunt waterfowl during the 2006 – 2007 and 2007 – 2008 hunting seasons. The remaining 2% (*n* = 4) of survey respondents indicated fears of avian influenza "definitely" affected their decision not to hunt waterfowl. The mean Likert score was 2.94 (*SD* = 0.31, *N* = 170) on a 3-point scale, with 1 being "definitely" and 3 being "not at all" (Fig. 3.36). The number of each of the Likert scale response choices selected was significantly different than expected ($\chi^2$ = 305.70, df = 2, *p* = <0.0001) (Fig. 3.37).

**Question 15. If you chose not to hunt waterfowl at all during the 2006-2007 or 2007-2008 waterfowl season, please select the one reason that most contributed to your decision not to hunt.**

Of 128 survey respondents, the largest proportion (34%, *n* = 44) selected "not enough time to hunt" as the reason they decided not hunt waterfowl during the 2006 - 2007 or 2007 - 2008 waterfowl seasons. The second largest proportion of survey respondents (29%, *n* = 37) indicated "other interests" most affected their decision not to hunt, and the third largest proportion (12%, *n* = 15) indicated "a lack of places to hunt" most affected their decision not to hunt (Fig. 3.38).

**Question 16. If you did not hunt during the 2006-2007 or 2007-2008 waterfowl seasons, please rate the importance of the reasons why you did not hunt as High, Medium, or Low in importance.**

The results of the survey indicated the three most important reasons waterfowl hunters choose not to hunt waterfowl were "not enough time to hunt," a "lack of places to hunt," and the "cost of gasoline." These three reasons were ranked of high importance by 46% (*n* = 51), 44% (*n* = 49), and 32% (*n* = 36) of the survey respondents, respectively.

The three reasons indicated to be the least important by our survey were "fears and concerns associated with avian influenza," "too few waterfowl," and "poor hunting conditions." These three reasons were ranked of low importance by 79% (*n* = 88), 61% (*n* = 68), and 58% (*n* = 64) of the survey respondents, respectively (Fig. 3.39).

## DISCUSSION

### Human Health Concerns

Wildlife diseases are natural phenomena, thus outbreaks of disease should not always be viewed with alarm; however, managers should be aware of how wildlife diseases might affect those who use wildlife resources (Bolen and Robinson 2003). The results of this survey indicated concerns for human health were lower than expected for both waterfowl hunters and their families. This was true throughout all respondents, regardless of the level of hunter participation or exposure to agency personnel collecting avian influenza samples from harvested waterfowl. There was little concern among survey respondents regarding consumption of harvested waterfowl due to avian influenza, which suggested there were few unjustified fears relative to contracting avian influenza from consumption of harvested waterfowl. These results differ from studies of chronic wasting disease (CWD) in white-tailed deer (*Odocoileus virginianus*) relative to hunters' and nonhunters' attitudes, as both were concerned about the safety of eating venison (Stafford et al. 2007).

## Current Information and Educational Efforts

Informing and educating the public about wildlife-related topics is included in the mission of most wildlife agencies (Eschenfelder 2006, Stafford et al. 2007). Decisions by hunters not to participate in open hunting seasons due to incomplete or inaccurate knowledge relative to wildlife disease could negatively affect a state's economy (Bishop 2004, Needham et al. 2004, Stafford et al. 2007). The results of this survey indicated general knowledge of avian influenza was determined to be low in all groups of survey respondents; however, levels of general knowledge were slightly higher in the group of waterfowl hunters with more constant participation. The results indicated waterfowl hunters with more constant participation have a slightly higher desire for additional avian influenza information, and higher expectations for KDWPT to provide avian influenza reports to waterfowl hunters. The survey results suggested exposure to agency personnel and the avian influenza sampling process did not affect the level of general knowledge of avian influenza, but this exposure did increase the desire for additional information. The results of the survey also indicated waterfowl hunters' desire for avian influenza information and KDWPT avian influenza reports was higher than expected throughout all groups of respondents, as 84% of all respondents indicated they wanted more information. These same trends were evident in studies of CWD relative to white-tailed deer hunters, as avid deer hunters were the most interested in receiving information relative to CWD (Stafford et al. 2007). However, the majority of respondents to this survey indicated they want to know “only enough to feel safe,” which could create difficulty in allocating finances to avian influenza education efforts.

The results of the survey indicated the most important sources of avian influenza information for Kansas waterfowl hunters are newspapers, television, and outdoor magazines. The least important sources of information were the Internet, public meetings, and radio, which might be due to the average age of Kansas waterfowl hunters, which is 47 years old (Thomas F. Bidrowski, Kansas Department of Wildlife, Parks and Tourism, pers. comm.). These results indicated efforts should be made to increase awareness on the current availability of avian influenza information.

### Support for KDWPT Avian Influenza Surveillance and Monitoring

Public trust is a crucial component of wildlife agencies, relative to support of an agency’s management actions (Slovic 1993, Earle and Cvetkovich 1995, Vaske et al. 2004, Stafford et al. 2007). The results of this survey indicated high levels of support for KDWPT’s avian influenza surveillance and monitoring program, throughout all groups of survey respondents. Only one of 417 survey respondents (0.2%) “disagreed” that KDWPT should be monitoring migratory waterfowl populations for the presence of avian influenza. The survey results also indicated waterfowl hunters with more constant participation provided more support for agency surveillance efforts, and also think waterfowl are the correct group of migratory birds to monitor for the presence of avian influenza. These results indicated waterfowl hunters trust KDWPT to adequately conduct avian influenza testing in Kansas. Furthermore, the results indicated Kansas waterfowl hunters support other state agencies’ monitoring of domestic fowl for the presence of avian influenza. These results differ greatly from studies of CWD relative to hunters' attitudes in Wisconsin, where 48% of hunters indicated they had little trust in the Wisconsin Department of Natural Resources to manage CWD in white-tailed deer herds (Stafford et al. 2007).

**Concerns of Waterfowl Health and the Future of Waterfowl Hunting**

Wildlife diseases are only part of the array of issues wildlife managers face, and managing disease is as important as knowledge of wildlife food habits and habitat requirements (Bolen and Robinson 2003). Management of wildlife disease not only deals directly with wildlife, but it also deals with the impacts of those diseases on hunters' attitudes (Stafford et al. 2007). As expected, the survey indicated waterfowl hunters with more constant participation were more concerned about declines in waterfowl health due to avian influenza. Throughout all groups of survey respondents, more hunters than expected indicated they did not know how avian influenza would affect waterfowl health. This was true for all survey questions regarding waterfowl health and avian influenza.

Throughout all groups of survey respondents, the survey indicated there is concern among waterfowl hunters of possible hunting season closures due to avian influenza. Waterfowl hunters with more constant participation were more concerned regarding possible hunting season closures due to declines in waterfowl health as a result of avian influenza outbreaks. These results agrees with the findings of Stafford et al. (2007), where hunters were determined to be slightly concerned about the health of white-tailed deer herds relative to CWD, and more concerned about the impacts of CWD on deer hunting.

The survey indicated a 1% decline in the number of licensed Kansas waterfowl hunters between the 2005 and 2006 waterfowl hunting seasons. This agrees with long-term license sales data of KDWPT, which indicates a 50% decline in the number of waterfowl hunters in Kansas during the last 50 years (Karl Grover, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.). The survey respondents indicated limited time and other interests are responsible for their decline in participation, not fears of avian influenza, which seem to be having very little influence on waterfowl hunter participation. In conclusion, the survey indicated the reasons for the declining number of waterfowl hunters in Kansas might be beyond agency influence or control.

## MANAGEMENT IMPLICATIONS

The survey indicated low levels of concern relative to the impacts of avian influenza on hunters' health and attitudes, and high levels of trust in KDWPT to manage avian influenza in Kansas, the current management scenario could be considered status quo. If KDWPT wishes to provide additional information to hunters relative to influenza, the best methods of delivering that information would be through the channels indicated as most important by survey respondents, such as newspapers and outdoor magazines. However, increasing the awareness of the availability of existing avian influenza information might be a more financially feasible management option than launching additional informational efforts. Given the reasons for the decline in waterfowl hunter participation in Kansas, as they are not related to avian influenza, the findings of this survey suggest KDWPT's efforts towards stabilizing or increasing waterfowl hunter numbers in Kansas might best be directed toward the "Pass It On" Program and the

Youth Waterfowl Clinics, as these programs serve to increase waterfowl hunter recruitment and to increase the retention of existing waterfowl hunters. Another effort of KDWPT relative to increasing the number of waterfowl hunters in Kansas also could be to focus on the fastest growing demographic of hunting license purchasers, which are adult females (Mike Miller, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

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## CHAPTER FOUR

## FEATHER STABLE ISOTOPES, DIET, AND THE NATAL ORIGINS OF WATERFOWL HARVESTED AT CHEYENNE BOTTOMS WILDLIFE AREA


### ABSTRACT

During the past century, the food habits and natal origin of migratory waterfowl have been studied extensively. Establishing scientific linkages between the different sites used by migratory bird populations, throughout their flyways, helps to better understand their demographic characteristics and overall health. A relatively new dimension of waterfowl research has emerged during the last few decades: stable isotopes. Isotope patterns can be used to investigate the food habits and natal origin of migratory waterfowl. Significant differences were detected among the $\delta^{13}C$ and $\delta^{15}N$ values of the waterfowl species sampled at CHBW; however, the on-site food habits investigation indicated waterfowl migrating through CHBW were primarily consuming the same groups of food items, with slight differences in the percent occurrence of the five most frequently occurring food items among the species investigated. Comparisons were made between the $\delta^{2}H$ values of hunter-harvested waterfowl feathers and United States Geological Survey (USGS) Kansas waterfowl band recovery data for the 2007 and 2008 waterfowl seasons, in order to make inferences relative to the natal origin of waterfowl harvested at CHBW. The general trend across the waterfowl species investigated indicated the northernmost areas of the waterfowl breeding grounds were more

represented by the $\delta^2H$ values obtained in my sample, in comparison to USGS waterfowl banding data.

## INTRODUCTION

During the past century, the diet and natal origin of migratory waterfowl have been studied extensively (Bartsch 1952, Baldassarre and Bolen 1994, McKnight and Hepp 1998). The first birds were marked with serially numbered bands in the United States in 1902 (Bartsch 1952), and some of the first published studies of waterfowl diet were conducted in the early 1900's (McAtee 1911). By the 1930's large-scale and comprehensive analysis of waterfowl gizzard contents to investigate waterfowl diet had been completed (Cottam 1939, Martin and Uhler 1939, Baldassarre and Bolen 1994).

Researchers have continued to investigate many aspects of waterfowl food habits and feeding ecology since that time. Some studies were quite broad, such as the Rogers and Korschgen (1966) investigation of the diet of the lesser scaup (*Aythya affinis*) in different regions of its migratory path, whereas Bartonek and Hickey (1969) took a more refined approach and focused on selective feeding by juvenile diving ducks. Other studies range from an examination of the diet of Northern pintail (*Anas acuta*) during their breeding cycle (Krapu 1974), to the relationship of diet and body condition in waterfowl harvested by hunters (Sheeley and Smith 1989). The study of the natal origin of birds has continued as well, with tens of thousands of waterfowl and other birds now banded annually (Baldassarre and Bolen 1994). Traditionally, waterfowl researchers have relied on fitting large numbers of waterfowl with aluminum leg bands to compensate for the low number of recoveries (Hebert and Wassennaar 2005a). As stated by Hobson et al. (2004), establishing scientific linkages between sites used by migratory bird populations throughout their flyways helps to monitor their demographic characters and manage their overall health.

A relatively new dimension of waterfowl research has emerged during the last few decades: stable isotopes. Isotopes are alternate forms of chemical elements, differing from one another in the number of neutrons they contain (Inger and Bearhop 2008). Two or more isotopes exist for most elements, though not in the same abundances (Hoefs 1980, Ehleringer and Osmond 1991). Some isotopes decay over time, but others are considered stable because they undergo no decay (Inger and Bearhop 2008).

Stable isotope analyses can be conducted on a variety of tissues; however, biologically active tissues, such as liver and blood, fluctuate in isotopic composition more quickly relative to inert tissues such as feathers (Hobson and Clark 1993). Feathers provide quality samples for stable isotope analyses because they are biologically stable (Mizutani et al. 1992) and are comprised of, and therefore represent, the environmental conditions in which the individual grew and developed feathers (Hobson and Clark 1992).

The photosynthetic pathways of different types of plants, and the patterns in which these plants are dispersed across the landscape ($C_3$ in cooler climates, and $C_4$ in warmer climates; Peterson and Fry 1987, Lajtha and Michener 1994), are known to influence the composition of biotic tissues relative to the carbon ($\delta^{13}C$) and nitrogen ($\delta^{15}N$) isotopes (Harrington et al. 1998, Wassenaar and Hobson 1998, Wassenaar and Hobson 2000, Hebert and Wassenaar 2001, Syzmanski et al. 2007). The hydrogen isotope ratio ($\delta^2H$) is known to correspond to precipitation patterns that occur across latitudinal differences from southeastern to northwestern North America, as $\delta^2H$ values decrease with increases in latitude (Hobson and Wassenaar 1997, Hebert and Wassenaar 2005b, Hobson and Wassenaar 2008). The discovery of the $\delta^2H$ patterns relative to latitude and precipitation gradients has influenced scientific inferences relative to the natal origin of migratory birds (Chamberlain et al. 1997, Hobson and Wassenaar 1997, Syzmanski et al. 2007).

Although some scientists are skeptical of stable isotope analyses (Inger and Bearhop 2008), studies using stable isotopes and the patterns in which they are known to vary have become more prevalent in waterfowl research during the last two decades, and these studies have been applied in a number of ecological contexts (Caccamise et al. 2000). These applications include many diverse avian studies, ranging from evaluations of site fidelity to molt locations by King eider (*Somateria spectabilis*) in Alaska (Knoche et al. 2007), tracing nutrient allocation to reproduction in Barrow's goldeneye (*Bucephala islandica*) in Canada (Hobson et al. 2005), evaluating the diet of the canvasback (*Aythya valisineria*) in Chesapeake Bay, Virginia (Haramis et al. 2001), and the delineation of natal origins of waterfowl (Hebert and Wassenaar 2005a, Hobson et al. 2006, Syzmanski et al. 2007), among numerous others.

The first objective of my study was to compare the $\delta^{13}C$ and $\delta^{15}N$ values of hunter-harvested waterfowl feathers to the results of on-site waterfowl food habit studies, and to compare trends between the two. The second objective of my study was to compare $\delta^2H$ values of hunter-harvested waterfowl feathers to Kansas waterfowl band recovery data for the 2007 and 2008 waterfowl seasons, to make inferences relative to the natal origin of waterfowl harvested at Cheyenne Bottoms Wildlife Area (CHBW).

## METHODS

Waterfowl gizzard and feather samples were collected from hunter-harvested waterfowl at the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) CHBW, Barton County, KS, during the 2007-2008 and 2008-2009 waterfowl seasons (see page five for a complete description of the study site). These seasons will hereafter be referred to as 2007 and 2008, respectively. Samples were collected from September to December in both 2007 and 2008, by monitoring public parking lots at CHBW and haphazardly collecting gizzard and feather samples from hunters' harvests when the waterfowl hunters returned to their vehicles.

Relative to gizzard collection and analyses, the method used in previous food habits studies by KDWPT staff at CHBW was followed (Hands 1993), with the exception of temporarily storing the gizzards in cold storage until the contents could be removed and placed in 95% alcohol. Gizzard contents were sorted and the seeds contained within the gizzard were identified, when possible, by comparing them against reference specimens collected by KDWPT staff. Percent occurrence, which is the number of gizzards containing the seed of interest divided by the number of gizzards containing food, multiplied by 100, was used to summarize the data (Hands 1993).

Relative to feather collection, the first secondary feather from the dextral wing of each duck was collected and placed in a numbered, zipper-seal, plastic bag. The feathers were immediately stored in ice-filled coolers, and then transferred to a freezer at the end of each sampling day. The feathers temporarily remained in cold storage until they could be transported to the laboratory at the end of each discrete sampling period.

Once transported to the laboratory at Fort Hays State University, the feathers were thoroughly cleaned by using methods outlined by Hobson and Wassenaar (2008). The cleansing process began by soaking the feathers in a 2:1 solution of chloroform and methanol for 24 hours to remove surface oils and contaminants. Once soaked, the feathers were rinsed with a solution of the same concentration and composition, and the cleaned feathers were then allowed to dry for 48 hours in a fume hood. When the chemical cleaning process was complete, the upper most distal portion of the feather was clipped, chopped, weighed, and placed into tin capsules for $\delta^{13}C$ and $\delta^{15}N$ analyses. Feather samples for $\delta^{13}C$ and $\delta^{15}N$ analyses ranged from 0.300-0.500 mg. The same methods were used to prepare feather samples for $\delta^{2}H$ (deuterium) analyses, except the prepared feathers were placed in silver capsules rather than tin, and the mass of the samples ranged from 0.340-0.360 mg.

Through the use of mass spectrometers, the abundance of these isotopes can be measured, and the result is expressed as a ratio of heavy to light forms, relative to a standard (Inger and Bearhop 2008). The accepted isotopic standards are atmospheric air for nitrogen, PeeDee Belemnite (limestone) for carbon, and Standard Mean Ocean Water (SMOW) for hydrogen (Elheringer and Osmond 1991). The use of differential notation allows researchers to focus on the differences between samples relative to those standards (Friedman and O’Neil 1978, Elheringer and Osmond 1991). The formula

[$\delta X_{std} = (R_{sam} / R_{std} – 1) 1000$] is used for calculating and expressing the differential notation of stable isotopes in a sample, where $\delta X_{std}$ is the isotope ratio in delta units relative to a standard, and $R_{sam}$ and $R_{std}$ are representative of the isotope abundance ratios of the sample and standard, respectively. The values are then multiplied by 1000 so the result can be expressed on a part per thousand, or per mil, basis (‰). The feather samples were analyzed by using a Costech Elemental Analyzer (Valencia, CA) interfaced to a GV Instruments Isoprime Mass Spectrometer (Manchester, UK) (Dr. Raymond W. Lee, Washington State University, pers. comm.). The stable isotope data were statistically compared among and between waterfowl species by using Analysis of Variance (ANOVA) (Zar 1999) and the SPSS 11.5 ® (SPSS Inc. 2000) statistical software package.

The $\delta^2H$ isoscape map used with ArcMap (Environmental Systems Research Institute 2011) to evaluate the results of the $\delta^2H$ analyses of waterfowl feathers relative to waterfowl banding data was provided by the University of Wisconsin-Madison's (UWM) Gratton Lab (UWM 2013). This map was divided into zones to illustrate comparisons between waterfowl feather $\delta^2H$ data and United States Geological Survey (USGS) waterfowl banding data. Banding data used in the analyses were obtained from the USGS Patuxent Wildlife Research Center Bird Banding Laboratory, Laurel, Maryland. The USGS software Bandit 3.1 Band Manager was used to query waterfowl banding data (USGS 2013). Waterfowl banding data were queried to include only hatch-year waterfowl banded during 2007 and 2008, with subsequent band recoveries of those same waterfowl within the state of Kansas during the same time frame. Hatch-year waterfowl bandings were selected because hatch-year waterfowl are captured and banded prior to developing flight capability, and are therefore of known natal origin. The $\delta^2H$ analyses of waterfowl feathers collected from hatch-year waterfowl at CHBW during the 2007 waterfowl season was compared to the queried USGS banding data of hatch-year waterfowl, in order to focus on assessing the natal origin of waterfowl harvested at CHBW. Four-letter designations were assigned to waterfowl species listed in tables and figures, following methodology similar to the American Ornithologists' Union (AOU).

## RESULTS

### Waterfowl Gizzard Contents

The contents of 80 waterfowl gizzards total, from five species, were analyzed. This sample included bufflehead (*Bucephala albeola*) (*n* = 7), gadwall (*Anas strepera*) (*n* = 13), Northern pintail (*n* = 20), Northern shoveler (*Anas clypeata*) (*n* = 20), and redhead (*Aythya americana*) (*n* = 20) (2008, *N* = 80). Only the gizzards collected during the 2008 waterfowl season at CHBW were used to summarize the diet of hunter-harvested waterfowl. Gizzard contents from the 2007 sampling effort were negligible for the majority of specimens, as the increased water depths at CHBW due to flooding likely prevented seeds from being readily available for consumption. With the water levels returning to a normal level during 2008, emergent vegetation was abundant, making the 2008 sample of gizzard contents more representative of waterfowl food habits at CHBW.

Based on percent occurrence across all species combined, the ten most abundant seeds found in the 2008 sample of waterfowl gizzards were smartweed (*Polygonum* spp.), alkali bulrush (*Bolboschoenus maritimus*), spikerush (*Eleocharis* spp.), vervain (*Verbena* spp.), millet (*Echinochloa* spp.), sprangletop (*Leptochloa* spp.), dock (*Rumex* spp.), softstem bulrush (*Schoenoplectus tabernaemontoni*), pondweed (*Potamogeton* spp.), and velvetleaf *(Abutilon* spp.), respectively (Fig. 4.1). An additional category of "other seeds" was included in calculations of percent occurrences. This category included miscellaneous seeds found in gizzards, in much lower abundance than the plant species listed above. The "other seeds" category included pigweed (*Amaranthus* spp.), sunflowers (*Helianthus* spp.), corn (*Zea mays*), saltgrass (*Distichlus* spp.), and other grasses (Poaceae), in no particular order. In addition, the percent occurrence for invertebrates also was calculated, although invertebrates were included as a single entity, and not subdivided by taxonomic designation.

When percent occurrence of the gizzard contents was evaluated on a per waterfowl species basis, although there were slight differences, the diets of waterfowl at CHBW appeared to be similar across all species. Bufflehead gizzards contained smartweed, invertebrates, millet, alkali bulrush, and vervain, the most often. Gadwall gizzards contained spikerush, smartweed, sprangletop, other seeds, and alkali bulrush, the most often. Gizzards of Northern pintail most often contained smartweed, spikerush, vervain, alkali bulrush, and sprangletop. Gizzards of Northern shoveler contained smartweed, alkali bulrush, spikerush, invertebrates, and other seeds. Redhead gizzards were found to have alkali bulrush in the greatest percent occurrence, followed by spikerush, smartweed, vervain, and invertebrates. Across all waterfowl gizzards analyzed, the five food categories with the highest percent occurrence were determined to be smartweed, alkali bulrush, spikerush, invertebrates, and vervain. These results agree with previous waterfowl food habits studies conducted by KDWPT staff at CHBW that included blue-winged teal, American green-winged teal, gadwall, mallard, Northern pintail, and Northern shoveler (H. Hands 1993, unpublished data).

**Isotopic Assessment of Waterfowl Feathers**

A total of 397 feather samples (2007, $n$ = 233; 2008, $n$ = 164; $N$ = 397) (Table 4.1) were collected from hunter-harvested waterfowl during the 2007 and 2008 waterfowl seasons at CHBW. The species represented in the sample included American wigeon (*Anas americana*), bufflehead, blue-winged teal (*Anas discors*), gadwall, American green-winged teal, mallard, Northern pintail, Northern shoveler, and redhead.

The 2007 $\delta^{13}C$ and $\delta^{15}N$ analyses had representative samples from all nine of the species listed above; however, the mallard was excluded from analyses of the 2008 sample year $\delta^{13}C$ and $\delta^{15}N$ data due to mechanical complications with the Costech elemental analyzer (Dr. Raymond W. Lee, Washington State University, pers. comm.). $\delta^{2}H$ isotope data were analyzed for the hatch-year age class of American wigeon, blue-winged teal, gadwall, American green-winged teal, mallard, Northern pintail, and Northern shoveler waterfowl feather samples collected during the 2007 waterfowl season ($n$ = 103).

**Interspecific Comparisons Among $\delta^{13}C$ Values**

There were significant differences in $\delta^{13}C$ values among species in the 2007 sample year waterfowl feathers ($F$ = 15.811, $df$ = 8, 225, $p$ < 0.001) (Table 4.2) (Table 4.3). The $\delta^{13}C$ values of American wigeon feathers were enriched relative to the blue-winged teal ($p = 0.008$), American green-winged teal ($p < 0.001$), and Northern shoveler ($p = 0.021$) (Fig. 4.2). The $\delta^{13}C$ of blue-winged teal was depleted relative to gadwall ($p < 0.001$), mallard ($p < 0.001$), and redhead ($p = 0.001$) (Fig. 4.3). The $\delta^{13}C$ values of gadwall were enriched relative to American green-winged teal ($p < 0.001$) and Northern shoveler ($p < 0.001$) (Fig. 4.4). The $\delta^{13}C$ values of American green-winged teal were depleted relative to mallard ($p < 0.001$), Northern pintail ($p = 0.001$), and redhead ($p < 0.001$) (Fig. 4.5), whereas the mallard was enriched in $\delta^{13}C$ relative to Northern shoveler ($p = 0.002$) (Fig. 4.6). Northern shoveler had depleted $\delta^{13}C$ values in comparison to redhead ($p = 0.003$) (Fig. 4.7).

There were significant differences in $\delta^{13}C$ values among species in the 2008 waterfowl feathers collected at CHBW ($F = 14.052$, $df = 7, 155$, $p < 0.001$) (Table 4.2) (Table 4.3). American wigeon $\delta^{13}C$ values were enriched relative to American green-winged teal ($p < 0.001$) and Northern shoveler ($p = 0.004$) (Fig. 4.8). The $\delta^{13}C$ values of bufflehead were depleted relative to gadwall ($p = 0.005$) and redhead ($p = 0.020$) (Fig. 4.9). Blue-winged teal $\delta^{13}C$ values were determined to be depleted relative to gadwall ($p < 0.001$) and redhead ($p = 0.012$) (Fig. 4.10), whereas the gadwall was enriched in $^{13}C$ relative to American green-winged teal ($p < 0.001$), Northern pintail ($p = 0.034$), and Northern shoveler ($p < 0.001$) (Fig. 4.11). The American green-winged teal was depleted in $^{13}C$ relative to Northern pintail ($p = 0.007$) and redhead ($p < 0.001$) (Fig. 4.12), with the redhead ($p < 0.001$) being enriched in $^{13}C$ relative to Northern shoveler (Fig. 4.13).

## Interspecific Comparisons Among $\delta^{15}N$ Values

There were significant differences in $\delta^{15}N$ values among waterfowl species during the 2007 sample year at CHBW ($F = 3.264$, $df = 8, 225$, $p = 0.002$) (Table 4.3) (Table 4.4). Northern pintail ($p = 0.008$) and American green-winged teal ($p = 0.038$) were both depleted in $\delta^{15}N$ relative to the gadwall (Fig. 4.14).

There were similar patterns between the $\delta^{15}N$ values of the 2008 waterfowl feathers compared to the 2007 samples ($F = 6.059$, $df = 7, 155$, $p < 0.001$) (Table 4.3) (Table 4.4). The American wigeon was depleted in $\delta^{15}N$ relative to gadwall ($p = 0.033$) and Northern shoveler ($p = 0.006$) (Fig. 4.15). The bufflehead was enriched in $\delta^{15}N$ relative to American green-winged teal ($p = 0.023$) (Fig. 4.16), and gadwall were enriched in $\delta^{15}N$ relative to American green-winged teal ($p = 0.002$) (Fig. 4.17). The Northern shoveler was enriched in $\delta^{15}N$ relative to American green-winged teal ($p = 0.001$) (Fig. 4.18).

## Interspecific Comparison of the $^2H$ Isotope

There were significant differences in $\delta^2H$ values among waterfowl species from which samples were collected at CHBW ($F = 8.667$, $df = 6, 96$, $p < 0.001$) (Table 4.3) (Table 4.5). The $\delta^2H$ values of American wigeon feathers were different from blue-winged teal ($p = 0.003$) and mallard ($p < 0.001$), with the American wigeon being relatively depleted in $\delta^2H$. Gadwall ($p = 0.001$), American green-winged teal ($p < 0.001$), and Northern pintail ($p = 0.008$) were found to be depleted in $\delta^2H$ relative to the mallard.

# DISCUSSION

A crucial component of waterfowl management is an understanding of the foods and feeding behavior of waterfowl (Baldassarre and Bolen 1994). Previous research has shown waterfowl consume a vast array of plant and animal matter, from both wetland habitats and agriculturally produced foods (Bellrose 1976, Baldassarre and Bolen 1994). Dietary shifts occur during the annual cycle of waterfowl, depending upon their nutritional requirements and the availability of food sources (Bellrose 1976, Baldassarre and Bolen 1994).

Waterfowl migrating through CHBW primarily were consuming the same groups of food items, with slight differences in the percent occurrence of the five most frequently occurring food items among the species investigated. The five most frequently occurring food items in this study were smartweed, alkali bulrush, spikerush, invertebrates, and vervain. Inferences relative to waterfowl preference of these food choices available at CHBW could not be made here, as that requires an index of abundance (Baldassarre and Bolen 1994), which was not a component of my study. However, the general trends of the waterfowl gizzard contents could be compared to the trends seen in the $\delta^{13}C$ and $\delta^{15}N$ stable isotope analyses.

## $\delta^{13}C$ and Waterfowl Food Habits

The analyses of gizzard contents did not reveal disparity between the food items ingested among the waterfowl species studied at CHBW. However, there were many significant differences among the $\delta^{13}C$ values of the feathers of the waterfowl species sampled at CHBW. For example, American wigeon and gadwall were found to have enriched $\delta^{13}C$ values relative to American green-winged teal and Northern shoveler in both study years. Although no American wigeon gizzard contents were analyzed in my study, gadwall and Northern shoveler gizzards both included spikerush, smartweed, alkali bulrush, and other seeds in the greatest percent occurrence. Bellrose (1976) stated American wigeon and gadwall diets were very similar, with a preference for eating the shoots and stems of wetland plants relative to the consumption of seeds. This dietary preference might have contributed to the enrichment of the American wigeon and gadwall $\delta^{13}C$ values.

Corn, a $C_4$ monocot, has been documented to be enriched in $\delta^{13}C$ (Tieszen and Boutton 1988, Haramis et al. 2001). Waterfowl species known to feed heavily on corn, such as the mallard and Northern pintail (Bellrose 1976), would be predicted to have $\delta^{13}C$ values enriched relative to those species that do not feed heavily on corn, such as blue-winged teal, American green-winged teal, and Northern shoveler. This trend was supported in both the 2007 and 2008 sample years, as the $\delta^{13}C$ values of Northern pintail were found to be enriched relative to the American green-winged teal.

**$\delta^{15}N$ and Waterfowl Food Habits**

Bufflehead, Northern shoveler, and redhead had a higher frequency of occurrence of invertebrates in their gizzard contents compared to other waterfowl species. Consumption of animal matter has been shown to increase $\delta^{15}N$ values in the consumer (Becker et al. 2007). Bufflehead and Northern shoveler were enriched in $\delta^{15}N$ relative to American green-winged teal. The Northern shoveler was enriched in $\delta^{15}N$ relative to the American wigeon. These results suggested invertebrates were a greater component of bufflehead and Northern shoveler diet relative to the American green-winged teal and American wigeon, which has been documented in previous life history accounts of these species (Bellrose 1976).

Another documented source of $\delta^{15}N$ enrichment in organisms is agriculturally produced foods, as the use of fertilizers increases nitrogen levels (Syzmanski et al. 2007). Based on that information, waterfowl species known to forage in agricultural fields, such as the mallard and Northern pintail (Bellrose 1976), would be predicted to be enriched in $\delta^{15}N$ relative to other waterfowl species. However, the results of this study did not support this prediction, as mallard and Northern pintail $\delta^{15}N$ values collected at CHBW were not enriched in $\delta^{15}N$ compared to other waterfowl species.

### Stable $\delta^{13}C$ and $\delta^{15}N$ Isotopes and Waterfowl Food Habits

Previous studies have outlined several factors that might cause variation of $\delta^{13}C$ and $\delta^{15}N$ values across the landscape. Syzmanski et al. (2007) and Marra et al. (1998) suggest the physiological traits of $C_3$ plants, along with land-use practices, can greatly impact isotope values within ecological systems. This suggests forested areas could be more depleted in $\delta^{13}C$ and $\delta^{15}N$ relative to croplands and grasslands (Syzmanski et al. 2007). Various studies (Alexander et al. 1996, Hobson 1999, Hebert and Wassennaar 2001) have also reported animal waste tends to further enrich $\delta^{15}N$ values in agricultural landscapes.

These causes of variation, coupled with the results of my study, prohibited more than general comparisons between the trends of the waterfowl food habits and stable isotope data. To gain a more comprehensive understanding of waterfowl food habits at

CHBW through the use of stable isotopes, future research should implement alternative methods. Relative to the isotopic analyses, a biotic tissue with a rapid turnover rate should be considered, as opposed to feathers. The $\delta^{13}C$ and $\delta^{15}N$ values of feathers reflect the environmental conditions in which the feathers were grown, whereas a more active biotic tissue, such as blood plasma (Hobson and Clark 1993), would reflect local environmental conditions. Specimens of food samples also would need to be analyzed for their respective $\delta^{13}C$ and $\delta^{15}N$ values, to better understand how the food choices of waterfowl at CHBW affect their respective $\delta^{13}C$ and $\delta^{15}N$ values. This should be coupled with an abundance index of available food choices to more accurately evaluate the overall food habits of waterfowl at CHBW.

### $\delta^2H$ and Natal Origin

The precipitation patterns of the $\delta^2H$ isoscape (Fig. 4.19), with $\delta^2H$ values known to decrease with increases in latitude across the landscape from the southeast to the northwest, have been well documented in previous studies (Hobson and Wassenaar 1997, Wassenaar and Hobson 2000, Hebert and Wassenaar 2005a). The link between the $\delta^2H$ values of waterfowl feathers and the $\delta^2H$ isoscape patterns in precipitation previously have been used to infer the natal origins of migratory birds (Chamberlain et al. 1997, Hobson 1999, Hebert and Wassenaar 2005a). CHBW is situated in the heart of the Central Flyway, and historical band recovery data indicated the most relevant waterfowl production area to CHBW is the Prairie Pothole Region (Fig. 4.19) (Thomas F. Bidrowski, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.).

The $\delta^2H$ values were depleted in American wigeon feathers relative to blue-winged teal and mallard. These results agreed with life history accounts of these species, as it has been documented the American wigeon nests much further north in greater abundance than either of the other two species (Bellrose 1976), which would result in lower $\delta^2H$ values. The same trend was seen with gadwall, American green-winged teal, and Northern pintail, as these species were depleted in $\delta^2H$ relative to the mallard. The gadwall, American green-winged teal, and Northern pintail all nest further north than the mallard (Bellrose 1976), which would contribute to depleted $\delta^2H$ values in those species.

To relate $\delta^2H$ data analyzed to known band recovery data, each isoscape band was assigned an alphabetic zone designation, with Zone A representing the lowest $\delta^2H$ values and found the farthest north, while Zone G represents the highest $\delta^2H$ values and found the farthest south (Fig. 4.19). The $\delta^2H$ values of the waterfowl feathers and the USGS Patuxent Wildlife Research Center waterfowl banding data were then classified according to the zone designations of the $\delta^2H$ isoscape (Table 4.6).

The 16 $\delta^2H$ values of blue-winged teal sampled at CHBW represented three of the isoscape zones: one from Zone A, 10 from Zone B, and five from Zone C. These results represented more of the northern reaches of the breeding grounds than were represented by band return data (Table 4.6). Of the 11 blue-winged teal band recoveries occurring in Kansas during 2007 and 2008, none were banded in Zones A or B. There were six blue-winged teal banded in Zone C, four in Zone D, and one in Zone E (Fig. 4.20). Although none of the $\delta^2H$ data indicated the waterfowl sampled at CHBW originated in Zone E, which included CHBW, the single blue-winged teal banded in Zone E (Kansas) and recovered in Kansas was the only representative of waterfowl production in the state.

The 17 $\delta^2$H values of gadwall also represented three of the isoscape zones:  two from Zone A, 15 from Zone B, and one from Zone C.  These results also represent more of the northern reaches of the breeding grounds than were represented by band return data (Table 4.6).  Of the four gadwall band recoveries occurring in Kansas during 2007 and 2008, none were banded in Zones A or B.  There was one gadwall banded in Zone C, and three were banded in Zone D (Fig. 4.20).

The 26 $\delta^2$H values of American green-winged teal sampled at CHBW also represented three of the isoscape zones: eight from Zone A, 15 from Zone B, and three from Zone C.  Again these data represented more of the northern tier of the breeding grounds than were represented by band return data (Table 4.6).  Of the six American green-winged teal band recoveries occurring in Kansas during 2007 and 2008, none were banded in Zone A, two were banded in Zone B, and four were banded in Zone D (Fig. 4.20).

The 15 $\delta^2$H values of the mallard represented four of the isoscape zones:  two from Zone A, four from Zone B, nine from Zone C, and four from Zone D.  These data represented similar areas of the breeding grounds when compared to band return data (Table 4.6).  Of the 18 mallard band recoveries occurring in Kansas during 2007 and 2008, none were banded in Zone A, three were banded in Zone B, six were banded in Zone C, and nine were banded in Zone D (Fig. 4.20).

The eight $\delta^2H$ values of Northern pintail represented three of the isoscape: two from Zone A, five from Zone B, and one from Zone C. Once again, these data represented the more northern reaches of the breeding grounds than were represented by banding data (Table 4.6). Of the six Northern pintail band recoveries occurring in Kansas during 2007 and 2008, none were banded in Zone A, two were banded in Zone B, one was banded in Zone C, and three were banded in Zone D (Fig. 4.20).

The eight $\delta^2H$ values of American wigeon sampled at CHBW represented the two northernmost isoscape zones, with four each from Zones A and B; however, there were no reported band recoveries of American wigeon in Kansas during 2007 and 2008 (Table 4.6). These $\delta^2H$ data agree with life history accounts of the American wigeon, which indicate wigeon nest in abundance farther north than other puddle ducks, with the exception of the Northern pintail (Bellrose 1976).

The eight $\delta^2H$ values of Northern shoveler represented three of the isoscape zones: one from Zone A, five from Zone B, and two from Zone C; however, there were no reported band recoveries of Northern shoveler in Kansas during 2007 and 2008 (Table 4.6). These $\delta^2H$ data also agreed with life history accounts of the Northern shoveler, which state the largest breeding numbers occur in the mixed prairie association of Alberta and Manitoba, Canada (Bellrose 1976). The second largest breeding number of Northern shoveler can be found north of the mixed prairie association, in an area of Manitoba known as the parklands (Bellrose 1976). This also agrees with the $\delta^2H$ values of Northern shoveler data in this study.

The 103 $\delta^2H$ values of all waterfowl species included represent a total of four isoscape zones, with 20 from Zone A, 58 from Zone B, 21 from Zone C, and four from Zone D (Table 4.6). Once again these data represented the northernmost areas of the waterfowl breeding grounds when compared to band recovery data. Of the 45 waterfowl band recoveries occurring in Kansas during 2007 and 2008, there were none from Zone A, seven from Zone B, 14 from Zone C, 23 from Zone D, and one from Zone E (Fig. 4.20).

The general trend seen across all waterfowl species included in my study is the northernmost areas (Isoscape Zones A, B, and C) of the breeding grounds were better represented by the $\delta^2H$ values obtained in our sample, in comparison to waterfowl banding data. There is a degree of overlap between the $\delta^2H$ values and the banding data within the isoscape zones, and this suggested many waterfowl species from the traditional banding operations areas were represented in hunter's harvest at CHBW by both banding data and $\delta^2H$ data from hunter-harvested waterfowl. With the majority of the $\delta^2H$ values in the sample classified into the isoscape zones north of the traditional waterfowl banding areas, which are centered through the Prairie Pothole Region, the northernmost areas of the breeding grounds might be underrepresented in hunter's harvests through traditional banding data. These results agreed with recent studies suggesting waterfowl banding efforts might be biased, as banding stations are typically located in more accessible areas, and therefore are not proportional to production (Hebert and Wassenaar 2005a), especially when considering the remoteness of the northern regions of the waterfowl breeding grounds (Hebert and Wassenaar 2005b).

## MANAGEMENT IMPLICATIONS

For investigations relative to the food habits of waterfowl at CHBW specifically, these results indicate traditional gizzard content analyses would provide more pertinent information than does the use of stable isotope analyses on feathers. Abundance indices of available food choices should be used in conjunction with gizzard content analyses, to make inferences relative to waterfowl food preferences at CHBW. If stable isotopes are to be used, the future research needs listed above would help to make stable isotope analyses a more useful tool relative to on-site studies, as these changes in methods would help to establish a more direct connection between waterfowl and their specific food habits at CHBW.

The results of both the $\delta^2H$ data and USGS banding data analyses indicated hunter-harvested waterfowl at CHBW were sometimes of natal origin relative to the traditional breeding and banding areas. However, these results indicated a greater amount of the northern waterfowl breeding grounds were represented by the $\delta^2H$ data than was represented by the USGS banding data. The single exception to this trend was the mallard, which is the most abundant duck in the Northern Hemisphere (Bellrose 1976), and it plays a vital role in the management of waterfowl, due to its cosmopolitan distribution and widespread popularity among waterfowl hunters (Thomas F. Bidrowski, Kansas Department of Wildlife, Parks, and Tourism, pers. comm.). This suggested managers should be aware that a larger portion of the total waterfowl harvest at CHBW, when considering all waterfowl species, could come from outside the Prairie Pothole Region and the traditional banding areas represented by USGS banding data. Managers also should consider habitat conditions in areas further north than the traditional waterfowl banding areas when considering the annual production of waterfowl species other than the mallard, relative to estimating the magnitude of the fall migration of waterfowl through CHBW.

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**Table 1.1.** Total number of waterfowl hunters at Cheyenne Bottoms Wildlife Area during the 2007-2008 and 2008-2009 waterfowl seasons, and the percentages of hunters surveyed during the 2007-2008 and 2008-2009 waterfowl season survey periods.

| | **Season Framework** | | |
|---|---|---|---|
| **Waterfowl Season Year** | **Teal** | **Early** | **Late** |
| 2007 - 2008 | 458 | 820 | 432 |
| Number of Hunters Surveyed in 2007 - 2008 | 65 | 75 | 19 |
| Percentage of Hunters Surveyed in 2007 - 2008 | 14.20% | 9.15% | 4.40% |
| 2008 - 2009 | 778 | 2512 | 1330 |
| Number of Hunters Surveyed in 2008 - 2009 | 36 | 44 | 32 |
| Percentage Surveyed in 2008 - 2009 | 4.63% | 1.75% | 2.41% |
| Total Hunters Present in 2007 - 2008 and 2008 - 2009 | 1236 | 3332 | 1762 |
| Total Number of Hunters Surveyed | 101 | 119 | 51 |
| Total Percentage Surveyed | 8.17% | 3.57% | 2.90% |

**Table 1.2.** Total waterfowl estimated through bi-weekly waterfowl surveys at Cheyenne Bottoms Wildlife Area during the 2007-2008 and 2008-2009 waterfowl seasons.

| **Survey Period** | **Teal** | **Ducks** | **Geese** |
|---|---|---|---|
| 2007 - 2008 | | | |
| 07 September | 7,100 | 2,890 | 50 |
| 20 September | 8,350 | 5,025 | 150 |
| 04 October | n/a | 20,375 | 50 |
| 18 October | n/a | 17,295 | 76 |
| 01 November | n/a | 12,310 | 45,000 |
| 15 November | n/a | 8,125 | 120,000 |
| 2008 - 2009 | | | |
| 11 September | 2,250 | 2,300 | 100 |
| 25 September | 11,300 | 2,925 | 110 |
| 09 October | n/a | 17,555 | 2,914 |
| 23 October | n/a | 75,931 | 30,350 |
| 06 November | n/a | 83,290 | 93,200 |
| 20 November | n/a | 89,580 | 150,000 |

**Table 1.3.** Descriptive statistics for the survey assessing Cheyenne Bottoms Wildlife Area waterfowl hunters' support for Alternative Management Strategy One: One hunting pool open for hunting on odd number dates only (Question A). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

| **Season Framework** | **Mean** | **Median** | **Mode** | **SD** | **Variance** |
|---|---|---|---|---|---|
| 2007 | | | | | |
| Teal | 2.34 | 2 | 1 | 1.35 | 1.82 |
| Early | 2.61 | 3 | 1 | 1.39 | 1.94 |
| Late | 2.47 | 3 | 3 | 1.31 | 1.71 |
| All | 2.48 | 2 | 1 | 1.36 | 1.86 |
| 2008 | | | | | |
| Teal | 2.78 | 3 | 3 | 1.12 | 1.26 |
| Early | 3.14 | 4 | 4 | 1.47 | 2.17 |
| Late | 2.42 | 2 | 1 | 1.30 | 1.69 |
| All | 2.81 | 3 | 3 | 1.34 | 1.79 |
| 2007 & 2008 | | | | | |
| Teal | 2.50 | 3 | 1 | 1.29 | 1.65 |
| Early | 2.82 | 3 | 1 | 1.45 | 2.10 |
| Late | 2.39 | 2 | 3 | 1.25 | 1.56 |
| All | 2.62 | 3 | 1 | 1.36 | 1.85 |

**Table 1.4.** Descriptive statistics for the survey assessing Cheyenne Bottoms Wildlife Area waterfowl hunters' support for Alternative Management Strategy Two: One hunting pool managed as a primitive pool, i.e., closed to all motorized watercraft (Question B). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

| **Season Framework** | **Mean** | **Median** | **Mode** | **SD** | **Variance** |
|---|---|---|---|---|---|
| 2007 | | | | | |
| Teal | 3.60 | 4 | 5 | 1.56 | 2.43 |
| Early | 3.36 | 4 | 5 | 1.64 | 2.69 |
| Late | 3.11 | 4 | 4 | 1.52 | 2.32 |
| All | 3.43 | 4 | 5 | 1.59 | 2.54 |
| 2008 | | | | | |
| Teal | 4.00 | 5 | 5 | 1.37 | 1.89 |
| Early | 3.74 | 4 | 5 | 1.47 | 2.15 |
| Late | 3.30 | 3 | 5 | 1.42 | 2.03 |
| All | 3.70 | 4 | 5 | 1.44 | 2.07 |
| 2007 & 2008 | | | | | |
| Teal | 3.74 | 4 | 5 | 1.50 | 2.25 |
| Early | 3.51 | 4 | 5 | 1.58 | 2.51 |
| Late | 3.20 | 3 | 5 | 1.44 | 2.08 |
| All | 3.54 | 4 | 5 | 1.53 | 2.35 |

**Table 1.5.** Descriptive statistics for the survey assessing Cheyenne Bottoms Wildlife Area waterfowl hunters' support for Alternative Management Strategy Three: One hunting pool open to hunting from ½ hour before sunrise to 1300 hours daily (Question C). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

| **Season Framework** | **Mean** | **Median** | **Mode** | **SD** | **Variance** |
|---|---|---|---|---|---|
| 2007 | | | | | |
| Teal | 2.72 | 3 | 1 | 1.54 | 2.36 |
| Early | 2.83 | 3 | 3 | 1.47 | 2.17 |
| Late | 3.21 | 4 | 4 | 1.27 | 1.62 |
| All | 2.83 | 3 | 1 | 1.48 | 2.18 |
| 2008 | | | | | |
| Teal | 3.03 | 3 | 3 | 1.34 | 1.80 |
| Early | 3.35 | 3 | 3 | 1.38 | 1.90 |
| Late | 3.21 | 3 | 5 | 1.56 | 2.42 |
| All | 3.21 | 3 | 3 | 1.42 | 2.00 |
| 2007 & 2008 | | | | | |
| Teal | 2.83 | 3 | 1 | 1.47 | 2.16 |
| Early | 3.03 | 3 | 3 | 1.46 | 2.13 |
| Late | 3.18 | 3 | 4 | 1.44 | 2.07 |
| All | 2.99 | 3 | 3 | 1.46 | 2.13 |

**Table 1.6.** Statistical values for Wilk's Lambda Multivariate Analysis of Variance (MANOVA) comparisons (95% confidence intervals) within, between and among the waterfowl season frameworks during the 2007 and 2008 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

| **WILK'S LAMBDA MANOVA** | | | | |
|---|---|---|---|---|
| **Statistical Comparison** | ***F*** | **df** | ***P*** | **Power** |
| Within 2007 Framework | 1.029 | 6, 308 | 0.406 | 0.406 |
| Within 2008 Framework | 2.175 | 6, 214 | 0.047 | 0.765 |
| Between 2007 and 2008 Frameworks | 1.66 | 15, 726 | 0.054 | 0.882 |
| Among 2007 and 2008 Frameworks | 2.242 | 6, 532 | 0.038 | 0.788 |

**Table 2.1.** The origins of waterfowl hunters that provided information through the Daily Hunt Permit registration system at Cheyenne Bottoms Wildlife Area during the 2007 and 2008 survey periods. Percentages of hunters shown by Kansas county for resident hunters, and by state for non-resident hunters.

| | Number of Hunters | | | | 2007 and 2008 | |
|---|---|---|---|---|---|---|
| Hunter Origin | 2007 Teal | 2007 Duck | 2008 Teal | 2008 Duck | Total Number of Hunters | Percentage of Total |
| *Resident* | | | | | | |
| Barton | 13 | 38 | 34 | 41 | 126 | 28.3% |
| Butler | 5 | 2 | 3 | 9 | 19 | 4.3% |
| Clay | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Crawford | 0 | 2 | 0 | 5 | 7 | 1.6% |
| Cunningham | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Dickinson | 0 | 0 | 0 | 4 | 4 | 0.9% |
| Douglas | 3 | 0 | 0 | 0 | 3 | 0.7% |
| Edwards | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Ellis | 2 | 10 | 4 | 18 | 34 | 7.6% |
| Ellsworth | 2 | 0 | 7 | 4 | 13 | 2.9% |
| Geary | 0 | 0 | 4 | 1 | 5 | 1.1% |
| Harvey | 0 | 0 | 5 | 11 | 16 | 3.6% |
| Johnson | 14 | 6 | 16 | 20 | 56 | 12.6% |
| Kingman | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Leavenworth | 1 | 0 | 0 | 1 | 2 | 0.4% |
| Lincoln | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Linn | 0 | 2 | 0 | 7 | 9 | 2.0% |
| Lyon | 0 | 6 | 0 | 0 | 6 | 1.3% |
| Marion | 0 | 0 | 0 | 5 | 5 | 1.1% |
| McPherson | 0 | 0 | 0 | 4 | 4 | 0.9% |
| Miami | 0 | 0 | 0 | 6 | 6 | 1.3% |
| Mitchell | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Montgomery | 0 | 0 | 0 | 6 | 6 | 1.3% |
| Neosho | 0 | 0 | 0 | 2 | 2 | 0.4% |
| Osborne | 0 | 0 | 0 | 2 | 2 | 0.4% |
| Pottawatomie | 0 | 0 | 0 | 3 | 3 | 0.7% |
| Pratt | 0 | 0 | 2 | 0 | 2 | 0.4% |
| Republic | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Reno | 0 | 4 | 1 | 5 | 10 | 2.2% |
| Rice | 0 | 0 | 2 | 5 | 7 | 1.6% |

**Table 2.1. (continued)** The origins of waterfowl hunters that provided information through the Daily Hunt Permit registration system at Cheyenne Bottoms Wildlife Area during the 2007 and 2008 survey periods. Percentages of hunters shown by Kansas county for resident hunters, and by state for non-resident hunters.

| | Number of Hunters | | | | 2007 and 2008 | |
|---|---|---|---|---|---|---|
| Hunter Origin | 2007 Teal | 2007 Duck | 2008 Teal | 2008 Duck | Total Number of Hunters | Percentage of Total |
| *Resident* | | | | | | |
| Riley | 0 | 0 | 4 | 5 | 9 | 2.0% |
| Saline | 5 | 4 | 7 | 10 | 26 | 5.8% |
| Sedgwick | 2 | 6 | 1 | 6 | 15 | 3.4% |
| Seward | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Shawnee | 1 | 4 | 3 | 5 | 13 | 2.9% |
| Stafford | 0 | 0 | 1 | 0 | 1 | 0.2% |
| Sumner | 0 | 0 | 0 | 2 | 2 | 0.4% |
| Thomas | 0 | 0 | 0 | 2 | 2 | 0.4% |
| | | | | | | |
| *Non-resident* | | | | | | |
| California | 2 | 0 | 0 | 0 | 2 | 0.4% |
| Colorado | 3 | 0 | 0 | 0 | 3 | 0.7% |
| Iowa | 0 | 0 | 0 | 2 | 2 | 0.4% |
| Indiana | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Missouri | 1 | 4 | 0 | 6 | 11 | 2.5% |
| North Carolina | 0 | 0 | 0 | 1 | 1 | 0.2% |
| Oklahoma | 0 | 0 | 0 | 2 | 2 | 0.4% |

**Table 2.2.** Percentages of total waterfowl hunters of unknown origin due to illegible Daily Hunt Permits, blank Daily Hunt Permits, and non-compliance with the Daily Hunt Permit (DHP) registration system at Cheyenne Bottoms Wildlife Area during the 2007 and 2008 waterfowl season survey periods (2007 teal season, $n$ = 95; 2007 duck season, $n$ = 150; 2008 teal season, $n$ = 142; 2008 duck season, $n$ = 297; 2007 and 2008, $N$ = 684).

| Season Framework | Number of Hunters | Percentage |
|---|---|---|
| 2007 Teal | | |
| Blank DHP | 2 | 2.1% |
| Non-compliant | 39 | 41.1% |
| 2007 Duck | | |
| Blank DHP | 13 | 8.7% |
| Non-compliant | 49 | 32.7% |
| 2008 Teal | | |
| Blank DHP | 8 | 5.6% |
| Non-compliant | 39 | 27.5% |
| 2008 Duck | | |
| Illegible DHP | 2 | 0.7% |
| Blank DHP | 21 | 7.1% |
| Non-compliant | 60 | 20.2% |
| 2007 and 2008 Combined | | |
| Illegible DHP | 2 | 0.3% |
| Blank DHP | 44 | 6.4% |
| Non-compliant | 187 | 27.3% |

**Table 2.3.** Top, bottom, and complete Daily Hunt Permit (DHP) compliance rates, expressed as percentages, for the 2007 and 2008 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

| **Season Framework** | **Top DHP Compliance** | **Bottom DHP Compliance** | **Complete DHP Compliance** |
|---|---|---|---|
| Teal 2007 | 59.0% | 63.2% | 51.6% |
| Duck 2007 | 67.0% | 46.0% | 36.7% |
| All 2007 | 64.1% | 52.7% | 42.5% |
| Teal 2008 | 72.5% | 59.9% | 55.6% |
| Duck 2008 | 79.8% | 71.7% | 66.0% |
| All 2008 | 77.5% | 67.9% | 62.6% |
| 2007 and 2008 | 72.7% | 62.4% | 55.4% |

**Table 2.4.** Statistical values for Wilk's Lambda Multivariate Analysis of Variance (MANOVA) comparisons (95% confidence intervals) among top, bottom, and complete Daily Hunt Permit (DHP) compliance rates during the 2007 and 2008 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

| **MANOVA** | | | | |
|---|---|---|---|---|
| **Statistical Comparison** | ***F*** | **df** | ***P*** | **Power** |
| Survey Week | | | | |
| DHP Compliance Rates | 2.129 | 24, 1944 | 0.001 | 0.997 |
| Season Framework | | | | |
| DHP Compliance Rates | 6.327 | 9, 1651 | <0.001 | 1 |

**Table 2.5.** Results of independent samples t-test comparisons (95% confidence intervals) between top, bottom, and complete Daily Hunt Permit (DHP) compliance rates during the 2007 and 2008 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

| | **t-test** | | |
|---|---|---|---|
| **Statistical Comparison** | ***t-stat*** | **df** | ***p*** |
| 2007 and 2008 | | | |
| Top DHP Compliance Rates | -3.795 | 6 | <0.001 |
| Bottom DHP Compliance Rates | -3.983 | 6 | <0.001 |
| Complete DHP Compliance Rates | -5.186 | 6 | 0.017 |

**Table 3.1.** Group definitions for the subdivision of respondents to the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| Group | Definition |
| --- | --- |
| One | Hunted waterfowl in both the 2005 - 2006 and 2006 - 2007 waterfowl seasons, and were exposed to agency personnel and the AI swab collection process |
| Two | Hunted waterfowl in both the 2005 - 2006 and 2006 - 2007 waterfowl seasons, and had no exposure to agency personnel and the AI swab collection process |
| Three | Hunted waterfowl in both the 2005 - 2006 and 2006 - 2007 waterfowl seasons |
| Four | Hunted waterfowl in only the 2005 - 2006 waterfowl season |
| Five | Hunted waterfowl in only the 2006 - 2007 waterfowl season |
| Six | Did not hunt waterfowl in either the 2005 - 2006 or the 2006 - 2007 waterfowl seasons |

**Table 3.2.** Descriptive statistics (mean, median, mode, standard deviation, and variance) for the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| Question Number | Survey Question | Mean | Median | Mode | SD | Variance |
|---|---|---|---|---|---|---|
| 4 | How many kinds of bird flu are there? | 3.45 | 4 | 4 | 1.016 | 1.033 |
| 5 | Are all types equally dangerous to waterfowl? | 2.64 | 3 | 3 | 0.656 | 0.430 |
| 6 | Are all types of bird flu equally dangerous to people? | 2.60 | 3 | 3 | 0.633 | 0.400 |
| 7 | How much do you need or want to know about bird flu? | 1.78 | 2 | 2 | 0.644 | 0.414 |
| 8 | Serious risk to the health of waterfowl hunters? | 2.70 | 3 | 3 | 0.888 | 0.789 |
| 9 | Concerned about getting bird flu from eating waterfowl? | 3.29 | 3 | 5 | 1.313 | 1.725 |
| 10 | Concerned that your retriever will get bird flu? | 3.23 | 3 | 3 | 1.330 | 1.768 |
| 11 | Is bird flu a significant factor affecting waterfowl health? | 2.42 | 2 | 3 | 0.910 | 0.827 |

**Table 3.2. (continued.)** Descriptive statistics (mean, median, mode, standard deviation, and variance) for the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| Question Number | Survey Question | Mean | Median | Mode | SD | Variance |
|---|---|---|---|---|---|---|
| 12 | Concerned that USFWS will close waterfowl seasons? | 2.53 | 2 | 3 | 1.114 | 1.242 |
| 13 | Concerned that KDWPT will close waterfowl seasons? | 2.56 | 2 | 2 | 1.188 | 1.411 |
| 14 | Did bird flu influence your decision not to hunt? | 2.94 | 3 | 3 | 0.310 | 0.096 |
| 21 | Do you wish to be informed about bird flu news? | 1.16 | 1 | 1 | 0.366 | 0.134 |
| 22 | Are surveillance and monitoring efforts sufficient? | 2.08 | 2 | 2 | 0.917 | 0.842 |
| 23 | Are waterfowl the correct group of birds to monitor? | 2.30 | 2 | 2 | 0.932 | 0.870 |
| 24 | Should the KDWPT be monitoring wild waterfowl? | 1.73 | 2 | 1 | 0.791 | 0.625 |
| 25 | Should the KS Dept. of Ag monitor domestic fowl? | 1.76 | 2 | 1 | 0.906 | 0.820 |

**Table 3.3.** Results of independent samples t-test comparisons (95% confidence intervals) between Group One and Group Two of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects avian influenza on waterfowl hunter participation.

| Question Number | Survey Question | independent t-test results | | |
|---|---|---|---|---|
| | | ***t-stat*** | **df** | ***P*** |
| 4 | How many kinds of bird flu are there? | -1.087 | 197 | 0.279 |
| 5 | Are all types equally dangerous to waterfowl? | -0.998 | 197 | 0.320 |
| 6 | Are all types of bird flu equally dangerous to people? | -1.873 | 199 | 0.063 |
| 7 | How much do you need or want to know about bird flu? | 0.170 | 199 | 0.865 |
| 8 | Serious risk to the health of waterfowl hunters? | -1.032 | 89 | 0.310 |
| 9 | Concerned about getting bird flu from eating waterfowl? | -0.239 | 72 | 0.812 |
| 10 | Concerned that your retriever will get bird flu? | 0.858 | 199 | 0.392 |
| 11 | Is bird flu a significant factor affecting waterfowl health? | -1.003 | 199 | 0.317 |
| 12 | Concerned that USFWS will close waterfowl seasons? | -1.003 | 199 | 0.317 |

**Table 3.3. (continued.)** Results of independent samples t-test comparisons (95% confidence intervals) between Group One and Group Two of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| **Question Number** | **Survey Question** | **independent t-test results** | | |
|---|---|---|---|---|
| | | ***t-stat*** | **df** | ***P*** |
| 13 | Concerned that KDWPT will close waterfowl seasons? | -1.070 | 199 | 0.286 |
| 21 | Do you wish to be informed about bird flu news? | *-3.728* | *186* | *<0.05* |
| 22 | Are surveillance and monitoring efforts sufficient? | -2.627 | 197 | 0.091 |
| 23 | Are waterfowl the correct group of birds to monitor? | -1.624 | 199 | 0.096 |
| 24 | Should the KDWPT be monitoring wild waterfowl? | -0.181 | 197 | 0.856 |
| 25 | Should the KS Dept. of Ag monitor domestic fowl? | -0.979 | 198 | 0.329 |

**Table 3.4.** Results of Analysis of Variance (ANOVA) comparisons (95% confidence intervals) among Group Three, Group Four, Group Five, and Group Six of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| | | **Group Means** | | | | **ANOVA Results** | | |
|---|---|---|---|---|---|---|---|---|
| **Question Number** | **Survey Question** | **G1** | **G2** | **G3** | **G4** | ***F*** | **df** | ***P*** |
| 6 | Are all types of bird flu equally dangerous to people? | 2.55 | 2.68 | 2.71 | 2.68 | 1.145 | 3, 374 | 0.331 |
| 7 | How much do you need or want to know about bird flu? | *1.67* | 1.65 | 1.90 | *1.98* | *7.176* | 3, 376 | *<0.05* |
| 10 | Concerned that your retriever will get bird flu? | 3.24 | 3.38 | 2.85 | 3.22 | 0.669 | 3, 375 | 0.572 |
| 14 | Did bird flu influence your decision not to hunt? | x | 2.91 | 3.00 | 2.91 | 0.285 | 3, 155 | 0.753 |
| 22 | Are surveillance and monitoring efforts sufficient? | *1.93* | 2.09 | 2.00 | *2.36* | *5.635* | 3, 360 | *<0.05* |
| 23 | Are waterfowl the correct group of birds to monitor? | *2.09* | 2.57 | 2.33 | *2.58* | *8.023* | 3, 365 | *<0.05* |
| 24 | Should the KDWPT be monitoring wild waterfowl? | *1.57* | *1.57* | 1.67 | *2.05* | *10.48* | 3, 364 | *<0.05* |
| 25 | Should the KS Dept. of Ag monitor domestic fowl? | *1.59* | 1.74 | 1.71 | *2.03* | *6.461* | 3, 363 | *<0.05* |

**Table 3.5.** Results of Kruskal-Wallis comparisons (95% confidence intervals) among Group Three, Group Four, Group Five, and Group Six of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| | | **Group Means** | | | | **Kruskal-Wallis Results** | | |
|---|---|---|---|---|---|---|---|---|
| **Question Number** | **Survey Question** | **G3** | **G4** | **G5** | **G6** | ***H*** | **df** | ***P*** |
| 4 | How many kinds of bird flu are there? | *3.256* | 3.840 | 3.667 | *3.642* | *11.380* | 3, 373 | *0.023* |
| 5 | Are all types equally dangerous to waterfowl? | 2.562 | 2.760 | 2.571 | 2.744 | 5.616 | 3, 374 | 0.230 |
| 8 | Serious risk to the health of waterfowl hunters? | 2.696 | 2.696 | 2.619 | 2.720 | 0.419 | 3, 377 | 0.981 |
| 9 | Concerned about getting bird flu from eating waterfowl? | 3.380 | 3.000 | 3.238 | 3.208 | 1.758 | 3, 379 | 0.780 |
| 11 | Is bird flu a significant factor affecting waterfowl health? | 2.307 | 2.385 | 2.650 | 2.568 | 8.654 | 3, 378 | 0.070 |
| 12 | Concerned that USFWS will close waterfowl seasons? | *2.395* | 2.462 | 2.571 | *2.766* | *13.619* | 3, 378 | *0.009* |
| 13 | Concerned that KDWPT will close waterfowl seasons? | *2.420* | 2.385 | 2.524 | *2.832* | *14.216* | 3, 379 | *0.007* |
| 21 | Do you wish to be informed about bird flu news? | *1.069* | 1.087 | 1.150 | *1.328* | *15.146* | 3, 364 | *0.004* |

**Table 3.6.** Results of Chi-square goodness-of-fit comparisons of all survey data obtained from the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| Question Number | Survey Question | Chi-square Results $\chi^2$ | df | *p* |
|---|---|---|---|---|
| 4 | How many kinds of bird flu are there? | *494.65* | *3* | *<0.0001* |
| 5 | Are all types equally dangerous to waterfowl? | *299.82* | *2* | *<0.0001* |
| 6 | Are all types of bird flu equally dangerous to people? | *240.02* | *2* | *<0.0001* |
| 7 | How much do you need or want to know about bird flu? | *96.09* | *2* | *<0.0001* |
| 8 | Serious risk to the health of waterfowl hunters? | *73.08* | *2* | *<0.0001* |
| 9 | Concerned about getting bird flu from eating waterfowl? | *10.43* | *2* | *0.0054* |
| 10 | Concerned that your retriever will get bird flu? | *88.72* | *4* | *<0.0001* |
| 11 | Is bird flu a significant factor affecting waterfowl health? | *111.84* | *2* | *<0.0001* |

**Table 3.6. (continued.)** Results of Chi-square comparisons of all survey data obtained from the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| Question Number | Survey Question | Chi-square Results $\chi^2$ | df | $p$ |
|---|---|---|---|---|
| 12 | Concerned that USFWS will close waterfowl seasons? | *121.501* | *4* | *<0.0001* |
| 13 | Concerned the the KDWPT will close waterfowl seasons? | *93.8163* | *4* | *<0.0001* |
| 14 | Did bird flu influence your decision not to hunt? | *305.701* | *2* | *<0.0001* |
| 21 | Do you wish to be informed about bird flu news? | *160.45* | *1* | *<0.0001* |
| 22 | Are surveillance and monitoring efforts sufficient? | *201.526* | *4* | *<0.0001* |
| 23 | Are waterfowl the correct group of birds to monitor? | *205.736* | *4* | *<0.0001* |
| 24 | Should the KDWPT be monitoring wild waterfowl? | *311.237* | *4* | *<0.0001* |
| 25 | Should the KS Dept. of Ag monitor domestic fowl? | *300.921* | *4* | *<0.0001* |

**Table 3.7.** Final sample sizes for each of the 25 questions in the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| Question Number | Survey Question | *N* |
|---|---|---|
| 1 | Did you hunt waterfowl during the 2005 - 2006 waterfowl season? | 387 |
| 2 | Did you hunt waterfowl during the 2006 - 2007 waterfowl season? | 388 |
| 3 | Did KDWPT or other agency personnel swab the ducks you harvested for AI (bird flu)? | 363 |
| 4 | How many kinds of bird flu are there? | 373 |
| 5 | Are all types of bird flu equally dangerous to waterfowl? | 374 |
| 6 | Are all types of bird flu equally dangerous to people? | 376 |
| 7 | How much do you need or want to know about bird flu? | 378 |
| 8 | Do you think that the bird flu is a serious risk to the health of waterfowl hunters and their families? | 377 |
| 9 | How concerned is your family about getting bird flu from eating the waterfowl you bring home? | 379 |
| 10 | How concerned are you that your retriever will get bird flu from retrieving ducks shot by waterfowl hunters? | 378 |

**Table 3.7. (continued.)** Final sample sizes for each of the 25 questions in the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| **Question Number** | **Survey Question** | ***N*** |
|---|---|---|
| 11 | Do you think that bird flu could be a significant factor affecting the health of waterfowl population? | 378 |
| 12 | Are you concerned that the USFWS will close seasons due to bird flu? | 378 |
| 13 | Are you concerned the KDWPT will close waterfowl seasons due to bird flu? | 379 |
| 14 | If you did not waterfowl at all during the 2006 or 2007 seasons, did bird flu influence your decision? | 170 |
| 15 | If you chose not to hunt waterfowl, please select the reason that most contributed to your decision not to hunt. | 122 |
| 16 | If you chose not to hunt waterfowl, please rate the importance of the reasons why you did not hunt. | 111 |
| 17 | Please rate the importance of how you currently obtain most of your information about bird flu. | 303 |
| 18 | Please list any additional sources for obtaining bird flu information not listed in the choices above. | 45 |
| 19 | Please rate the importance of how you would most prefer bird flu updates to be provided to you. | 298 |

**Table 3.7. (continued.)** Final sample sizes for each of the 25 questions of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

| **Question Number** | **Survey Question** | ***N*** |
|---|---|---|
| 20 | Please list any additional sources for delivery of bird flu information not listed in the choices above. | 51 |
| 21 | Do you wish to be informed about bird flu news by the KDWPT? | 364 |
| 22 | Are the KDWPT bird flu surveillance and monitoring efforts sufficient for detecting bird flu in Kansas? | 365 |
| 23 | Are waterfowl the correct froup of birds to be monitoring for the presence of bird flu? | 368 |
| 24 | Should the KDWPT be monitoring wild waterfowl for the presence of bird flu? | 367 |
| 25 | Should the KS Department of Agriculture by monitoring domestic fowl for the presence of bird flu? | 366 |

**Table 4.1.** Final sample sizes for isotopic analyses of each species of waterfowl feather samples collected at Cheyenne Bottoms Wildlife Area during the 2007 ($n$ = 233) and 2008 (n = 164) waterfowl seasons ($N$ = 397).

| | 2007 | | | 2008 | |
|---|---|---|---|---|---|
| **Waterfowl Species** | **$\delta^{13}C$** | **$\delta^{15}N$** | **$\delta^{2}H$** | **$\delta^{13}C$** | **$\delta^{15}N$** |
| American wigeon (*Anas americana*) | 11 | 11 | 8 | 11 | 11 |
| Bufflehead (*Bucephala albeola*) | 8 | 8 | 0 | 7 | 7 |
| Blue-winged teal (*Anas discors*) | 18 | 18 | 16 | 18 | 18 |
| Gadwall (*Anas strepera*) | 24 | 24 | 18 | 24 | 24 |
| American green-winged teal (*Anas crecca*) | 65 | 65 | 26 | 65 | 65 |
| Mallard (*Anas platyrhynchos*) | 67 | 67 | 19 | n/a | n/a |
| Northern pintail (*Anas acuta*) | 20 | 20 | 8 | 20 | 20 |
| Northern shoveler (*Anas clypeata*) | 13 | 13 | 8 | 12 | 12 |
| Redhead (*Aythya americana*) | 7 | 7 | 0 | 7 | 7 |

**Table 4.2.** Descriptive statistics of $\delta^{13}C$ values (expressed as parts per thousand [‰]) of feathers collected from hunter-harvested waterfowl during the 2007 and 2008 waterfowl seasons at Cheyenne Bottoms Wildlife Area (2007, *n* = 233; 2008, *n* = 164).

| | **2007** | | | **2008** | | |
|---|---|---|---|---|---|---|
| | **$\delta^{13}C$ (‰)** | | | **$\delta^{13}C$ (‰)** | | |
| **Waterfowl Species** | **Mean** | **SD** | **Range** | **Mean** | **SD** | **Range** |
| American wigeon (*Anas americana*) | -22.1 | 4.68 | -30.24 to -16.56 | -21.96 | 4.96 | -27.48 to -14.98 |
| Bufflehead (*Bucephala albeola*) | -24.45 | 4.33 | -28.6 to -16.67 | -26.01 | 3.26 | -31.25 to -22.88 |
| Blue-winged teal (*Anas discors*) | -26.99 | 2.44 | -33.4 to -23.14 | -25.41 | 3.17 | -29.66 to -15.51 |
| Gadwall (*Anas strepera*) | -20.7 | 4.74 | -28.29 to -9.65 | -20.64 | 4.67 | -26.88 to -12.46 |
| American green-winged teal (*Anas crecca*) | -27.48 | 2.66 | -34.94 to -18.95 | -27.07 | 2.14 | -32.44 to -21.27 |
| Mallard (*Anas platyrhynchos*) | -22.64 | 3.44 | -28.66 to -11.95 | n/a | n/a | n/a |
| Northern pintail (*Anas acuta*) | -23.71 | 2.8 | -29.51 to -19.23 | -23.9 | 2.78 | -28.94 to -18.41 |
| Northern shoveler (*Anas clypeata*) | -26.99 | 2.83 | -31.3 to -21.52 | -27.38 | 1.88 | -30.35 to -24.62 |
| Redhead (*Aythya americana*) | -20.42 | 7.1 | -28.4 to -10.95 | -20.13 | 6.99 | -31.54 to -12.3 |

**Table 4.3.** Statistical values for One-Way Analysis of Variance (ANOVA) comparisons (95% confidence intervals) among mean $\delta^{13}C$, $\delta^{15}N$, and $\delta^{2}H$ (expressed in parts per thousand [‰]) values for each waterfowl species sampled during the 2007 and 2008 waterfowl seasons at Cheyenne Bottoms Wildlife Area (AMWI = American wigeon, BUFF = bufflehead, BWTE = blue-winged teal, GADW = gadwall, GWTE = American green-winged teal, MALL = mallard, NOPI = Northern pintail, NOSH = Northern shoveler, REDH = redhead).

| | Mean $\delta^{13}C$ (‰) | | | | | | | | | ANOVA results | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | AMWI | BUFF | BWTE | GADW | GWTE | MALL | NOPI | NOSH | REDH | *F* | df | *p* |
| 2007 | -22.10 | -24.45 | -26.99 | -20.70 | -27.48 | -22.64 | -23.71 | -26.99 | -20.42 | 15.811 | 8, 225 | < 0.001 |
| 2008 | -21.96 | -26.01 | -25.41 | -20.64 | -27.07 | n/a | -23.9 | -27.38 | -20.13 | 14.052 | 7, 155 | < 0.001 |
| | Mean $\delta^{15}N$ (‰) | | | | | | | | | *F* | df | *p* |
| 2007 | 7.73 | 10.23 | 7.96 | 11.00 | 8.10 | 9.54 | 7.81 | 10.05 | 10.6 | 3.264 | 8, 225 | 0.002 |
| 2008 | 6.89 | 11.11 | 7.61 | 9.74 | 7.39 | n/a | 8.55 | 10.72 | 9.31 | 6.059 | 7, 155 | < 0.001 |
| | Mean $\delta^{2}H$ (‰) | | | | | | | | | *F* | df | *p* |
| 2007 | -154.02 | n/a | -123.04 | -132.41 | -137.3 | -106.83 | -134.83 | -126.65 | n/a | 8.667 | 6, 96 | < 0.001 |

**Table 4.4.** Descriptive statistics of $\delta^{15}N$ values (expressed as parts per thousand [‰]) of feathers collected from hunter-harvested waterfowl during the 2007 and 2008 waterfowl seasons at Cheyenne Bottoms Wildlife Area (2007, *n* = 233; 2008, *n* = 164).

| | **2007** | | | **2008** | | |
|---|---|---|---|---|---|---|
| | **$\delta^{15}N$ (‰)** | | | **$\delta^{15}N$ (‰)** | | |
| **Waterfowl Species** | **Mean** | **SD** | **Range** | **Mean** | **SD** | **Range** |
| American wigeon (*Anas americana*) | 7.73 | 3.36 | 3.63 to 15.84 | 6.89 | 2.42 | 2.00 to 9.90 |
| Bufflehead (*Bucephala albeola*) | 10.23 | 2.01 | 7.80 to 13.94 | 11.11 | 4.22 | 7.04 to 19.39 |
| Blue-winged teal (*Anas discors*) | 7.96 | 1.93 | 4.33 to 11.85 | 7.61 | 1.98 | 4.60 to 11.52 |
| Gadwall (*Anas strepera*) | 11 | 4.94 | 4.68 to 25.92 | 9.74 | 3.15 | 3.24 to 14.27 |
| American green-winged teal (*Anas crecca*) | 8.1 | 2.41 | 2.02 to 14.55 | 7.39 | 1.87 | 3.71 to 11.97 |
| Mallard (*Anas platyrhynchos*) | 9.54 | 3.78 | -6.81 to 18.15 | n/a | n/a | n/a |
| Northern pintail (*Anas acuta*) | 7.81 | 2.99 | 0.08 to 12.47 | 8.55 | 2.5 | 3.61 to 13.24 |
| Northern shoveler (*Anas clypeata*) | 10.05 | 2.12 | 6.87 to 14.52 | 10.72 | 3.03 | 7.21 to 14.93 |
| Redhead (*Aythya americana*) | 10.6 | 4 | 6.06 to 16.83 | 9.31 | 1.84 | 6.62 to 11.54 |

**Table 4.5.** Descriptive statistics of $\delta^2$H values (expressed as parts per thousand [‰]) of feather samples collected from hunter-harvested waterfowl during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area (*n* = 103).

| | $\delta^2$H (‰) | | |
|---|---|---|---|
| **Waterfowl Species** | **Mean** | **SD** | **Range** |
| American wigeon (*Anas americana*) | -154.02 | 24.35 | -188.80 to -124.78 |
| Blue-winged teal (*Anas discors*) | -123.04 | 10.73 | -149.33 to -106.48 |
| Gadwall (*Anas strepera*) | -132.41 | 12.51 | -150.56 to -100.40 |
| American green-winged teal (*Anas crecca*) | -137.30 | 15.30 | -161.39 to -105.74 |
| Mallard (*Anas platyrhynchos*) | -106.83 | 27.26 | -168.20 to -70.69 |
| Northern pintail (*Anas acuta*) | -134.83 | 15.93 | -155.44 to -110.67 |
| Northern shoveler (*Anas clypeata*) | -126.65 | 17.97 | -154.75 to -98.97 |

**Table 4.6.** Isoscape zone designation and classification of both the $\delta^2$H values (expressed as parts per thousand [‰]) of hatch-year waterfowl feather samples collected at Cheyenne Bottoms Wildlife Area in 2007 and the United States Geological Survey waterfowl banding data from 2007 and 2008 (AMWI = American wigeon, BWTE = blue-winged teal, GADW = gadwall, GWTE = American green-winged teal, MALL = mallard, NOPI = Northern pintail, NOSH = Northern shoveler).

| Cheyenne Bottoms Wildlife Area Deuterium Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Zone | $^2$H Values (‰) | AMWI | BWTE | GADW | GWTE | MALL | NOPI | NOSH |
| A | -179 to -148 | 4 | 1 | 2 | 8 | 2 | 2 | 1 |
| B | -147.9 to -117 | 4 | 10 | 15 | 15 | 4 | 5 | 5 |
| C | -116.9 to -86 | 0 | 5 | 1 | 3 | 9 | 1 | 2 |
| D | -85.9 to -55 | 0 | 0 | 0 | 0 | 4 | 0 | 0 |
| E | -54.9 to -24 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| F | -23.9 to +7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| G | +6.9 to +38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

| USGS Waterfowl Banding Data | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Zone | $^2$H Values (‰) | AMWI | BWTE | GADW | GWTE | MALL | NOPI | NOSH |
| A | -179 to -148 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| B | -147.9 to -117 | 0 | 0 | 0 | 2 | 3 | 2 | 0 |
| C | -116.9 to -86 | 0 | 6 | 1 | 0 | 6 | 1 | 0 |
| D | -85.9 to -55 | 0 | 4 | 3 | 4 | 9 | 3 | 0 |
| E | -54.9 to -24 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |
| F | -23.9 to +7 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| G | +6.9 to +38 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |

**Figure 1.1.** The 2007 and 2008 Cheyenne Bottoms Wildlife Area waterfowl hunters' support, collectively, for Alternative Management Strategy One: One hunting pool at CHBW open to hunting on odd-numbered dates only, expressed as a proportion of the total survey responses (*N* = 271) (Question A). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

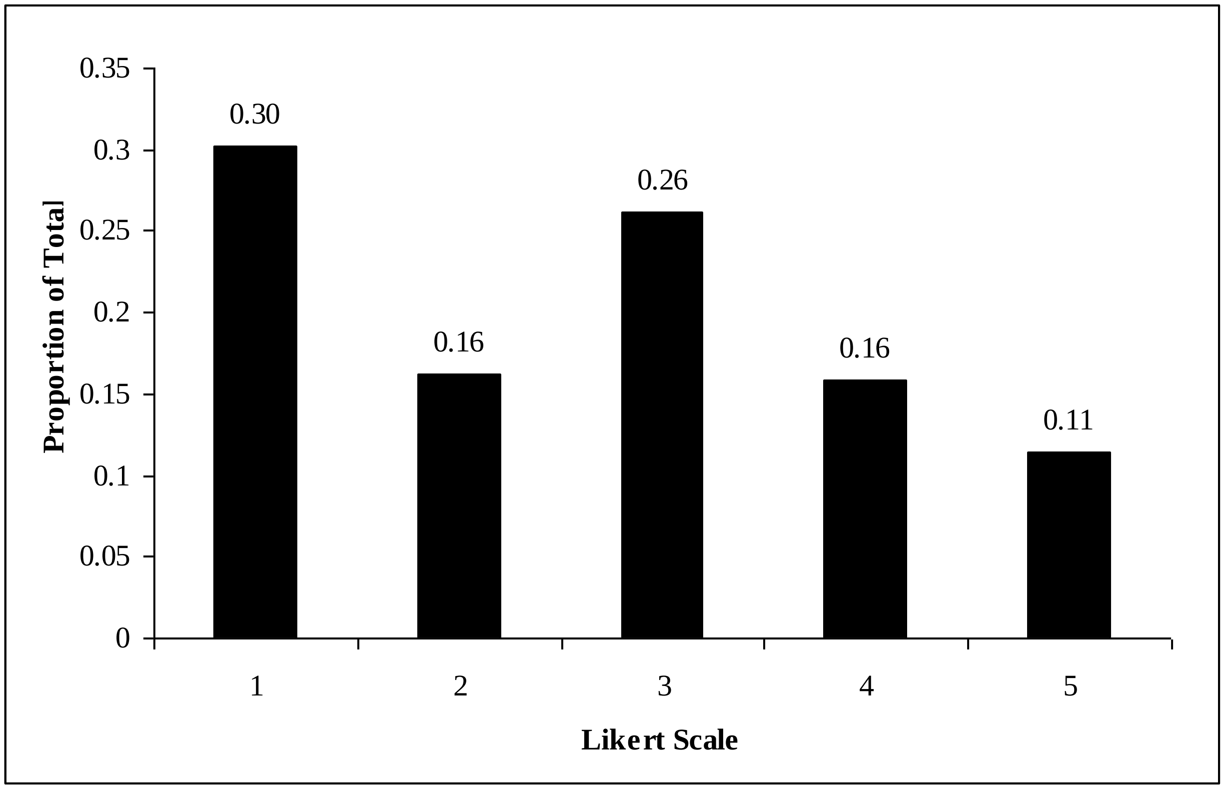


**Figure 1.2.** The 2007 and 2008 Cheyenne Bottoms Wildlife Area waterfowl hunters' support, by season framework, for Alternative Management Strategy One: One hunting pool open to hunting on odd-numbered dates only, expressed as a proportion of the total survey responses ($N$ = 271) (Question A). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

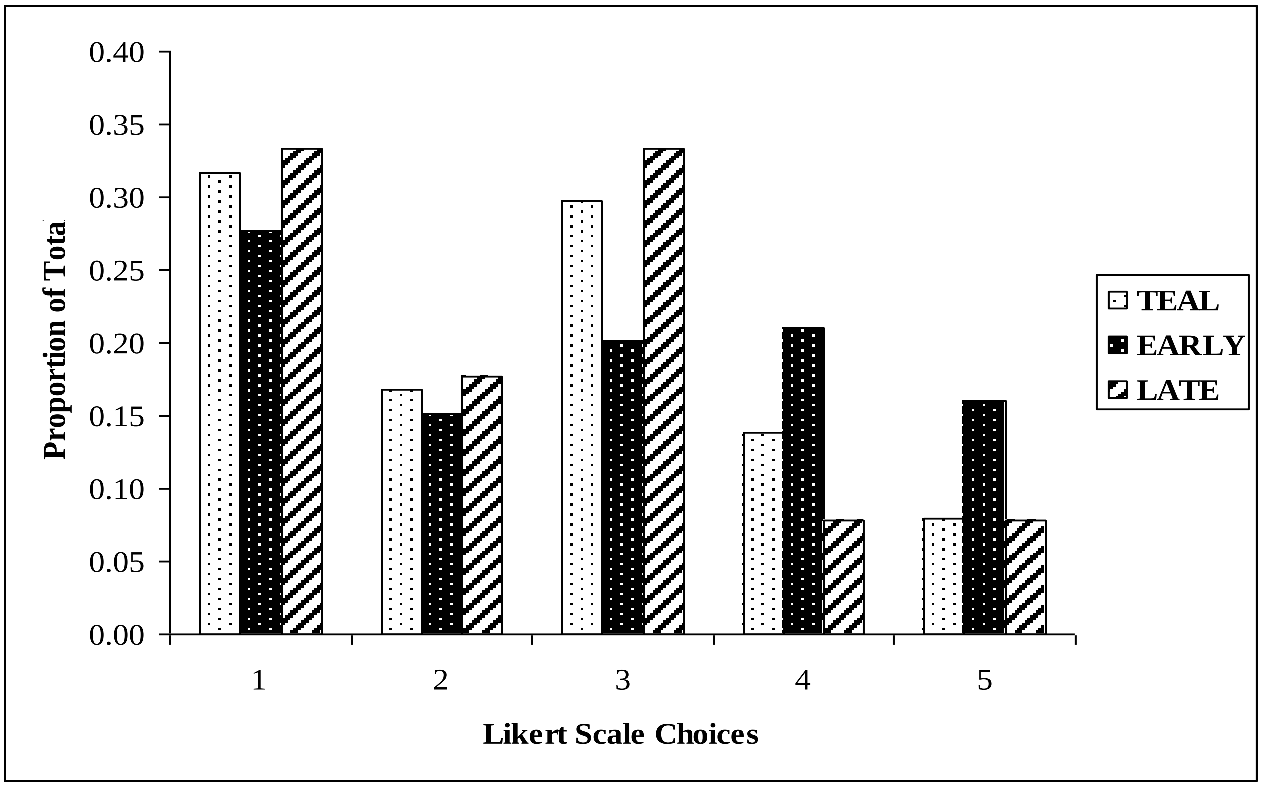


**Figure 1.3.** The 2007 and 2008 Cheyenne Bottoms Wildlife Area waterfowl hunters' support, collectively, for Alternative Management Strategy Two: One hunting pool managed as a primitive pool, i.e., no closed motorized watercraft allowed, expressed as a proportion of the total survey responses ($N$ = 271) (Question B). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

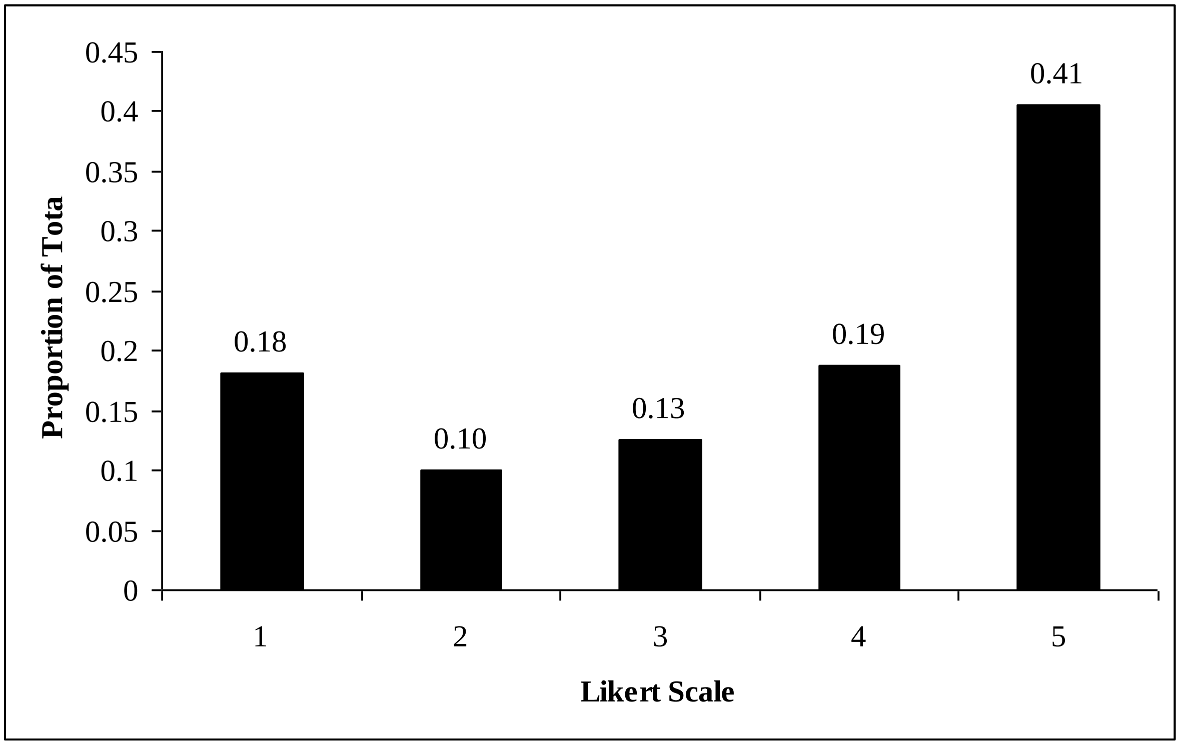


**Figure 1.4.** The 2007 and 2008 Cheyenne Bottoms Wildlife Area waterfowl hunters' support, by season framework, for Alternate Management Strategy Two: One hunting pool managed as a primitive pool, i.e., no motorized watercraft allowed, expressed as a proportion of the total survey responses ($N$ = 271) (Question B). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

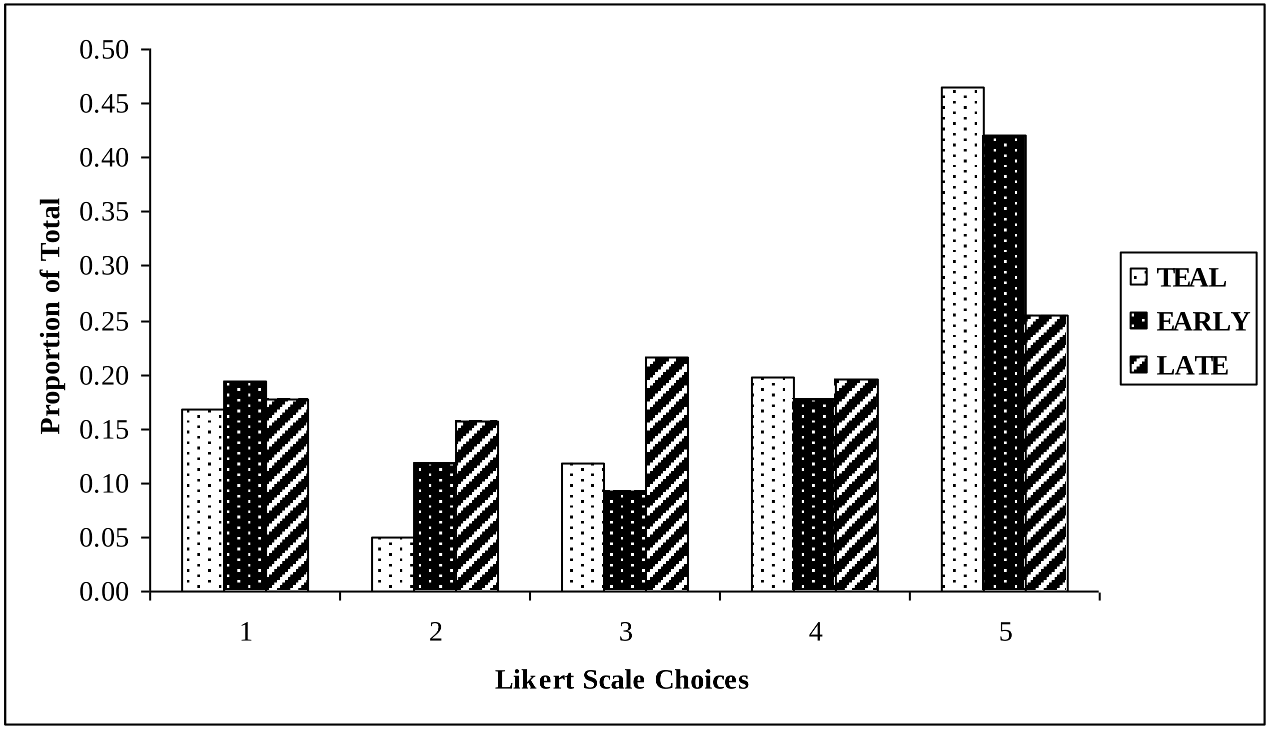


**Figure 1.5.** The 2007 and 2008 Cheyenne Bottoms Wildlife Area waterfowl hunters' support, collectively, for Alternative Management Strategy Three: One hunting pool open to hunting from ½ hour before sunrise to 1300 hours daily, expressed as a proportion of the total survey responses (*N* = 271) (Question C). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

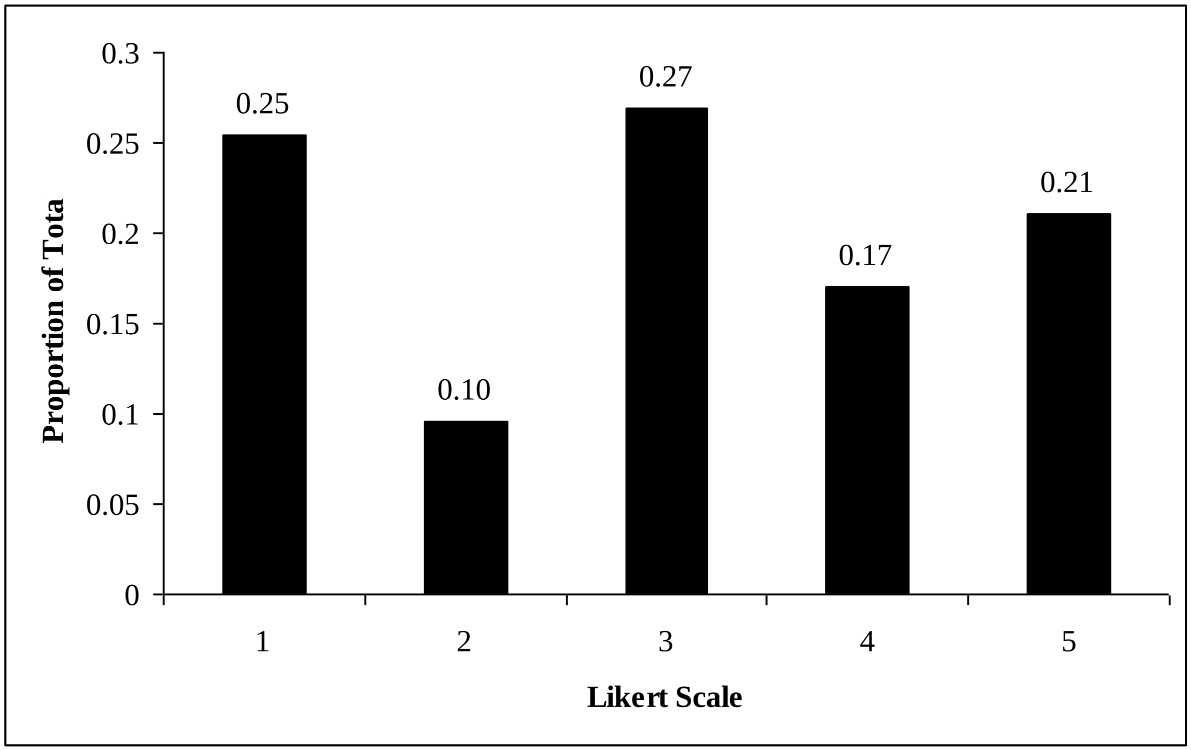


**Figure 1.6.** The 2007 and 2008 Cheyenne Bottoms Wildlife Area waterfowl hunters' support, by season framework, for Alternative Management Strategy Three: One hunting pool open to hunting from ½ hour before sunrise to 1300 hours daily, expressed as a proportion of the total survey responses ($N$ = 271) (Question C). Likert Scale choices on the survey ranged from one through five, with one being no support at all and five being complete support for the management strategy.

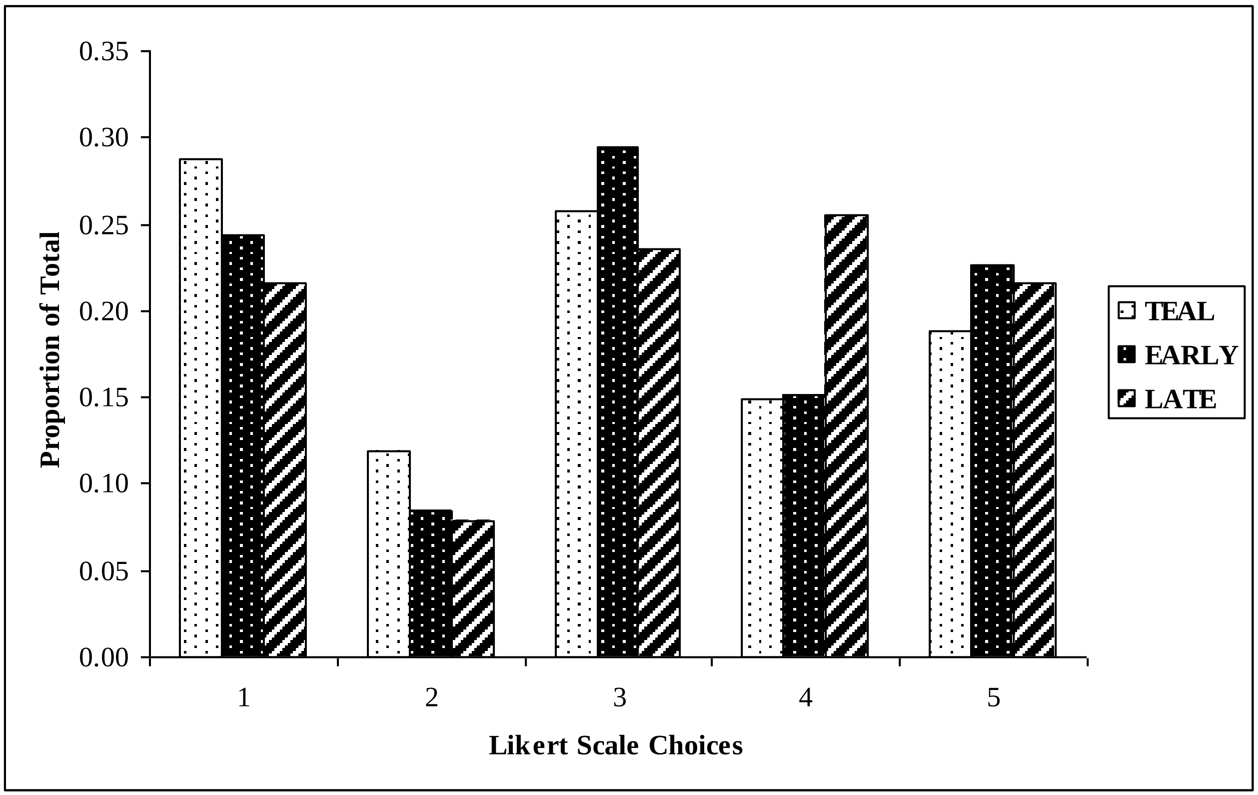


**Figure 2.1.** The species composition of 95 waterfowl hunter bag checks conducted during the 2007 teal season survey period at Cheyenne Bottoms Wildlife Area, which totaled 207 harvested ducks (BWTE = blue-winged teal, GWTE = American green-winged teal).

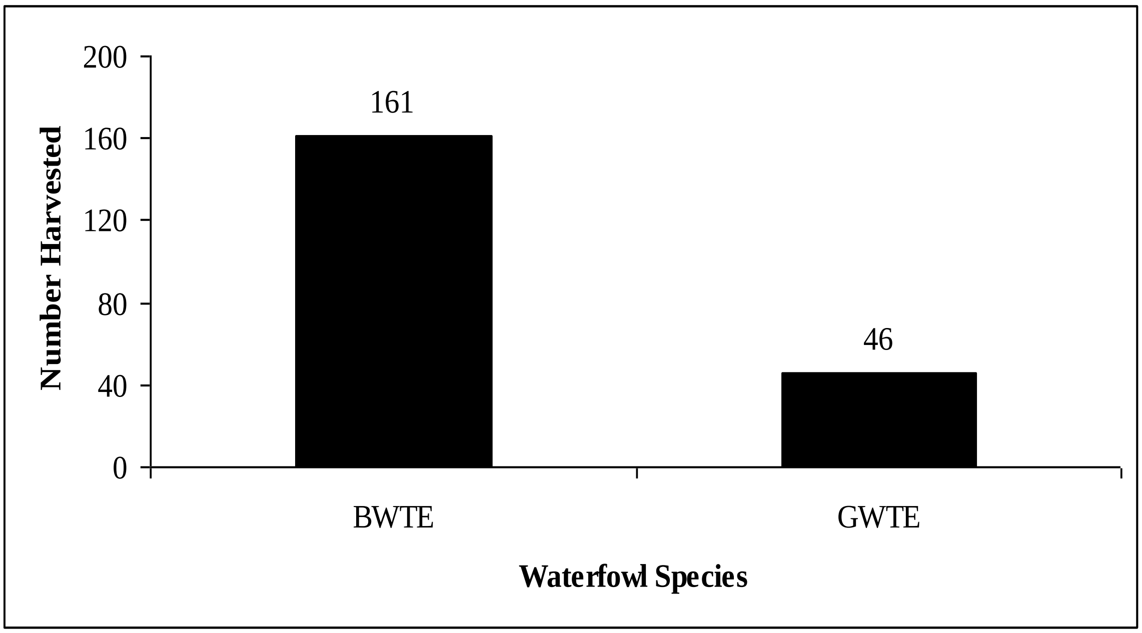


**Figure 2.2.** The average number of waterfowl harvested per hunter during the 2007 and 2008 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

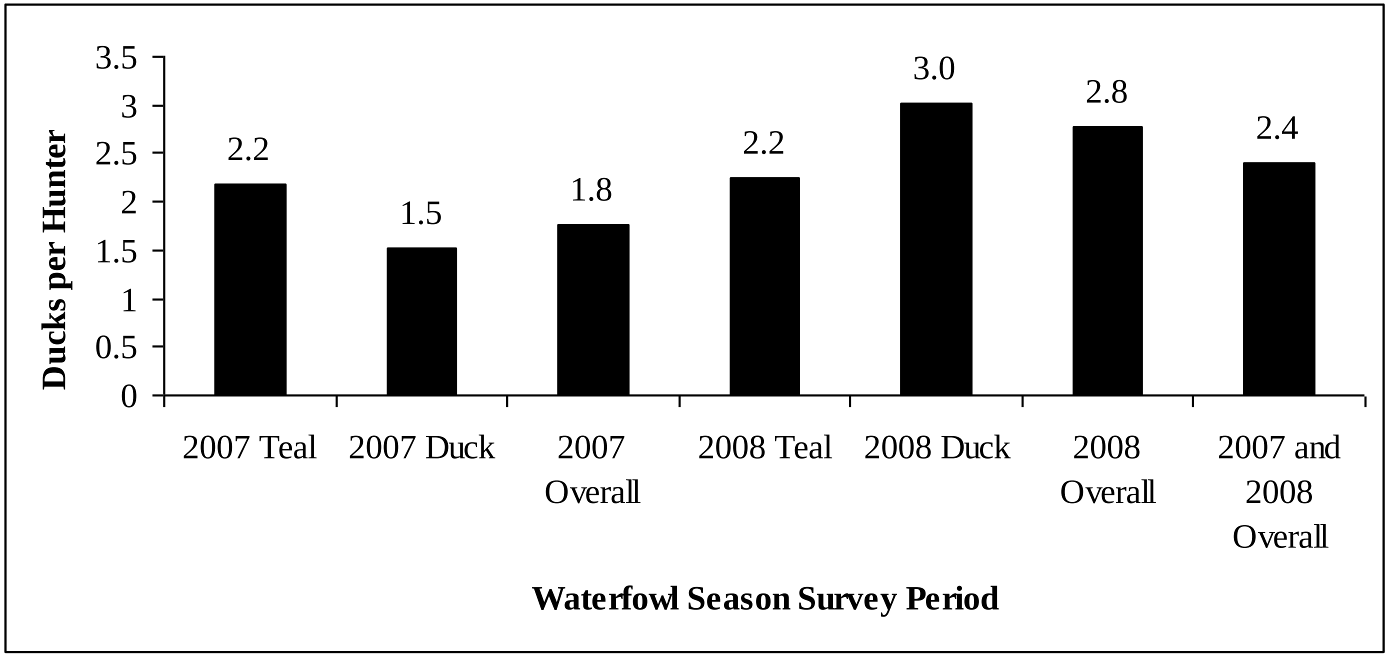


**Figure 2.3.** The species composition of 150 waterfowl hunter bag checks conducted during the 2007 duck season survey period at Cheyenne Bottoms Wildlife Area, which totaled 227 harvested ducks (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler,
NOPI = Northern pintail).

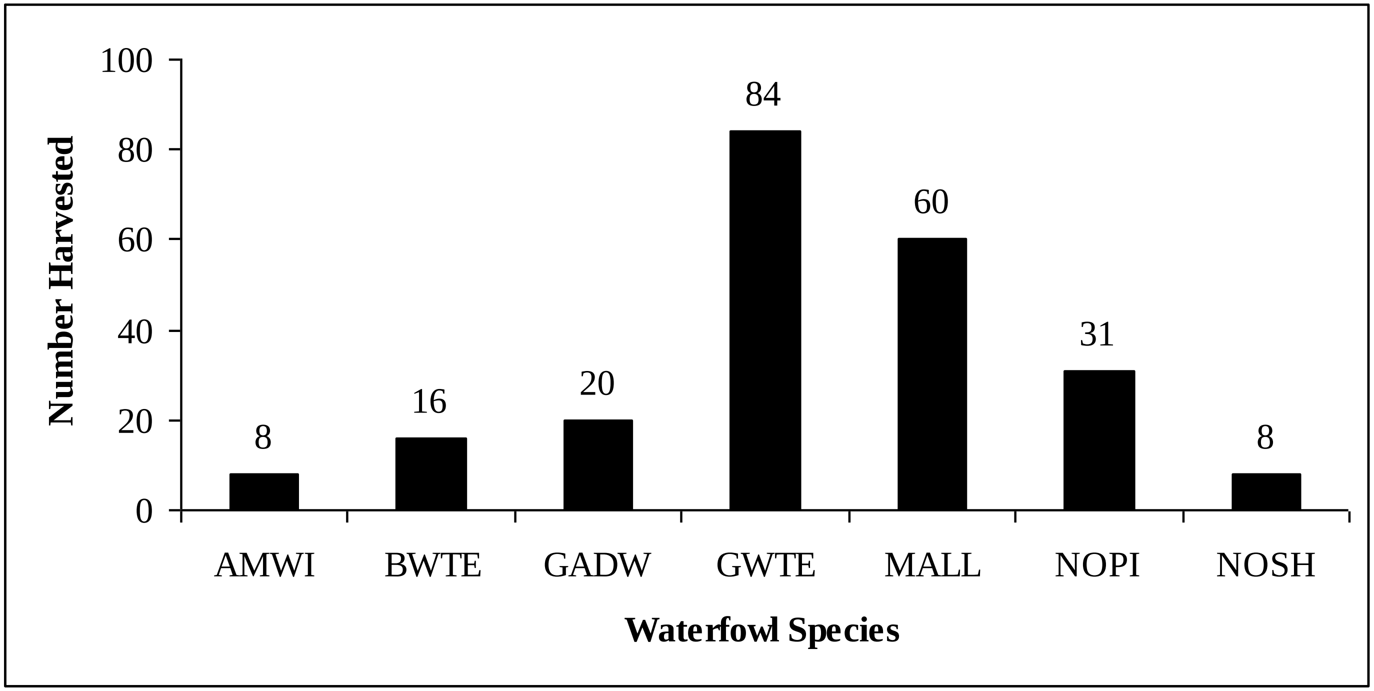


**Figure 2.4.** The species composition of 245 waterfowl hunter bag checks conducted during the 2007 teal and duck season survey periods at Cheyenne Bottoms Wildlife Area combined, which totaled 434 harvested ducks (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail).

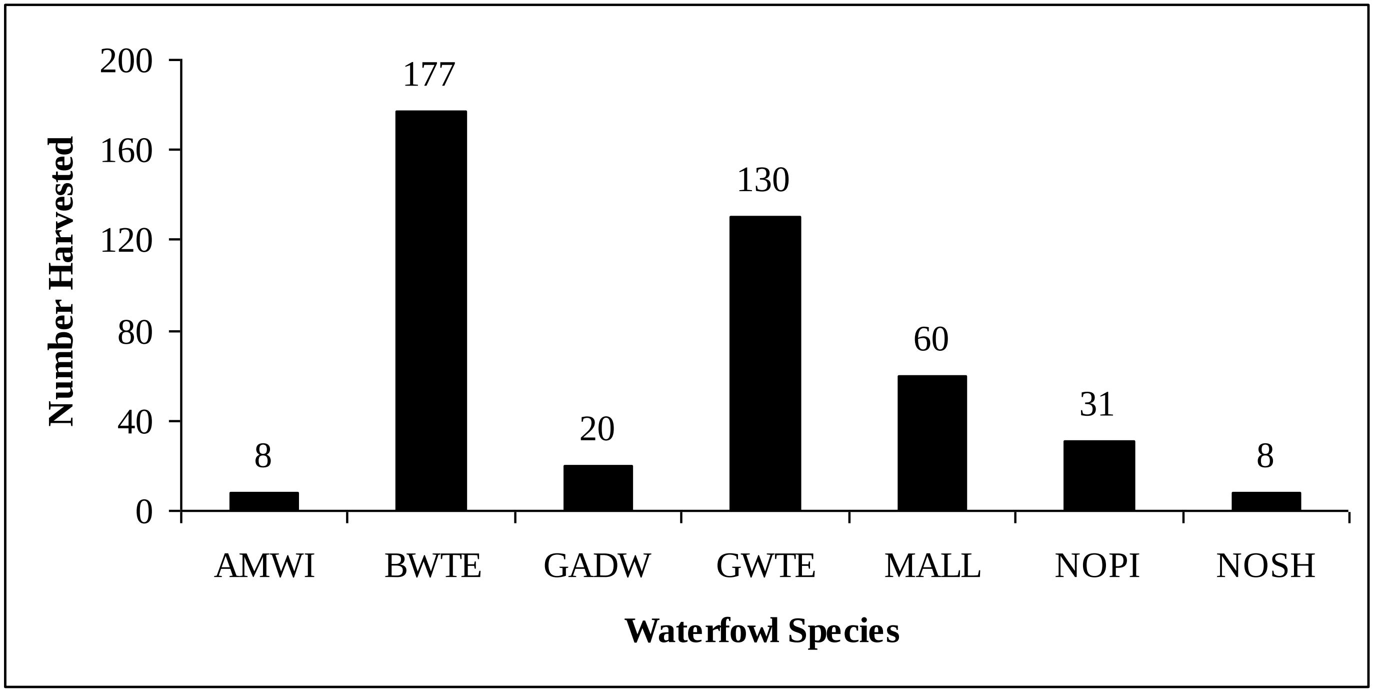


**Figure 2.5.** The species composition of 142 waterfowl hunter bag checks conducted during the 2008 teal season survey period at Cheyenne Bottoms Wildlife Area, which totaled 318 harvested ducks (BWTE = blue-winged teal,
GWTE = American green-winged teal).

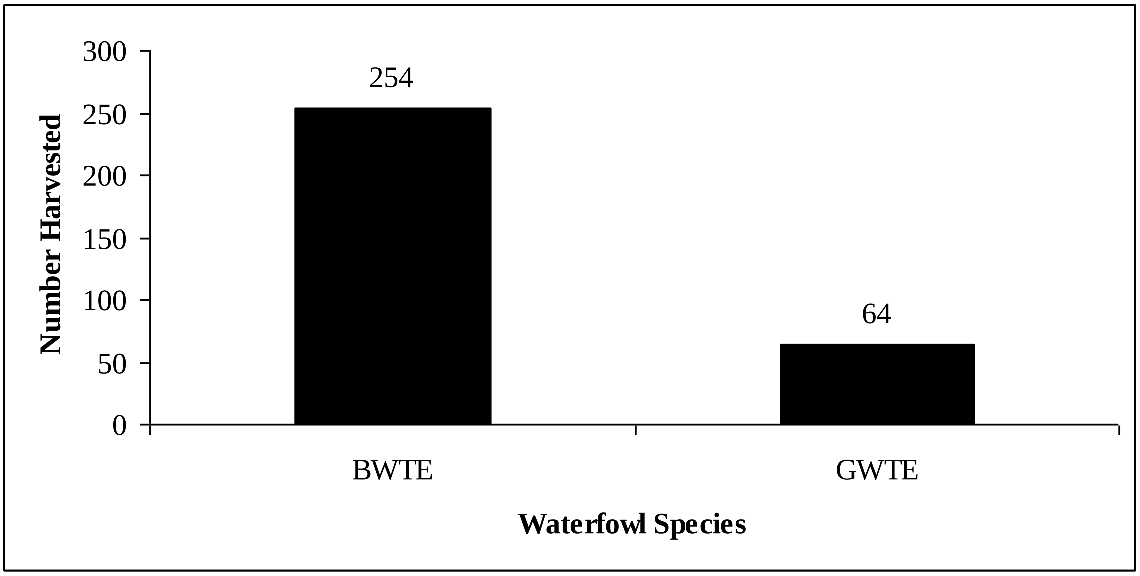


**Figure 2.6.** The species composition of 297 waterfowl hunter bag checks conducted during the 2008 duck season survey period at Cheyenne Bottoms Wildlife Area, which totaled 896 harvested ducks (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail, RING = ring-necked duck, REDH = redhead, LESC = lesser scaup, WOOD = wood duck, CANV = canvasback).

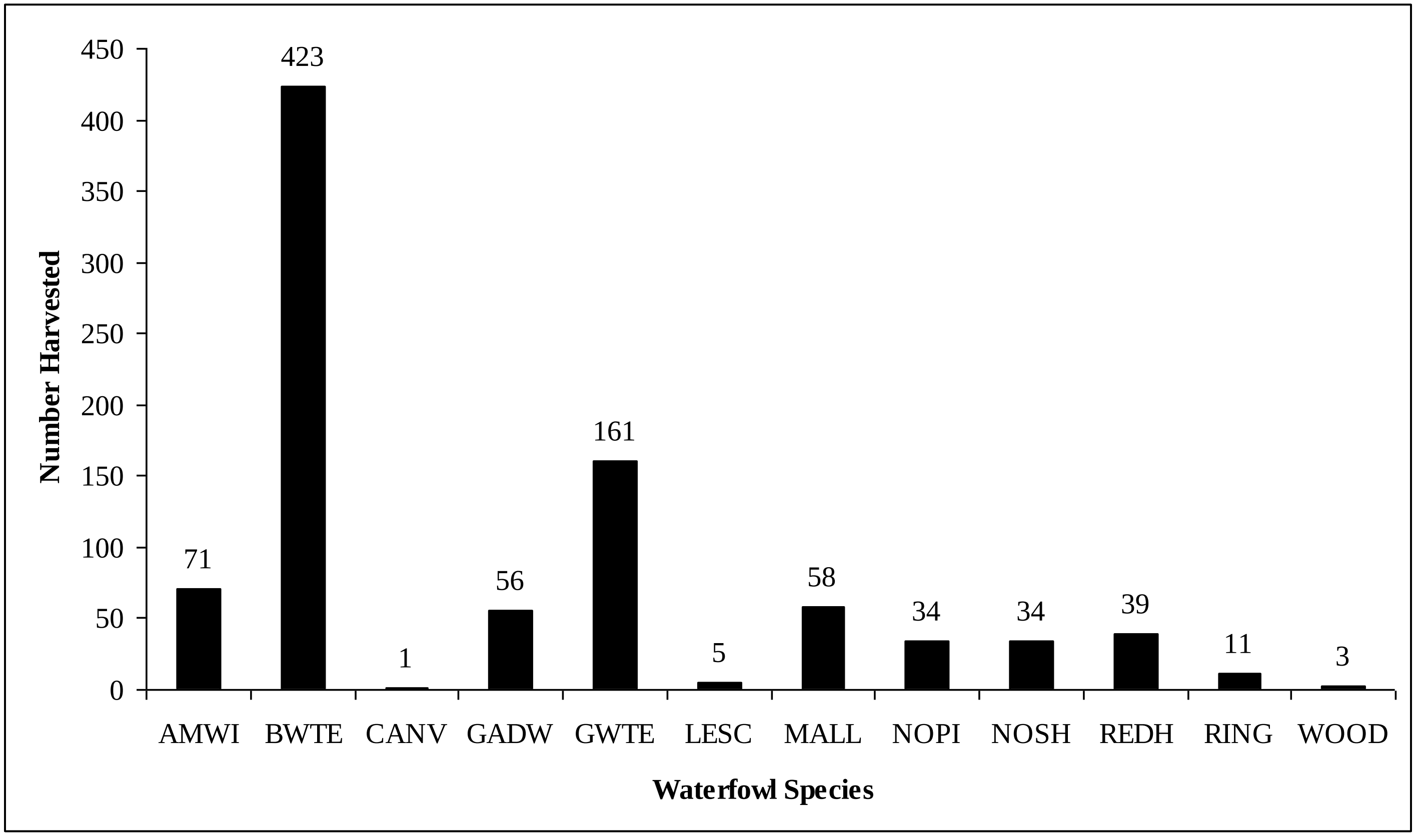


**Figure 2.7.** The species composition of 439 waterfowl hunter bag checks conducted during the 2008 teal and duck season survey periods at Cheyenne Bottoms Wildlife Area combined, which totaled 1,214 harvested ducks (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail, RING = ring-necked duck, REDH = redhead, LESC = lesser scaup, WOOD = wood duck, CANV = canvasback).

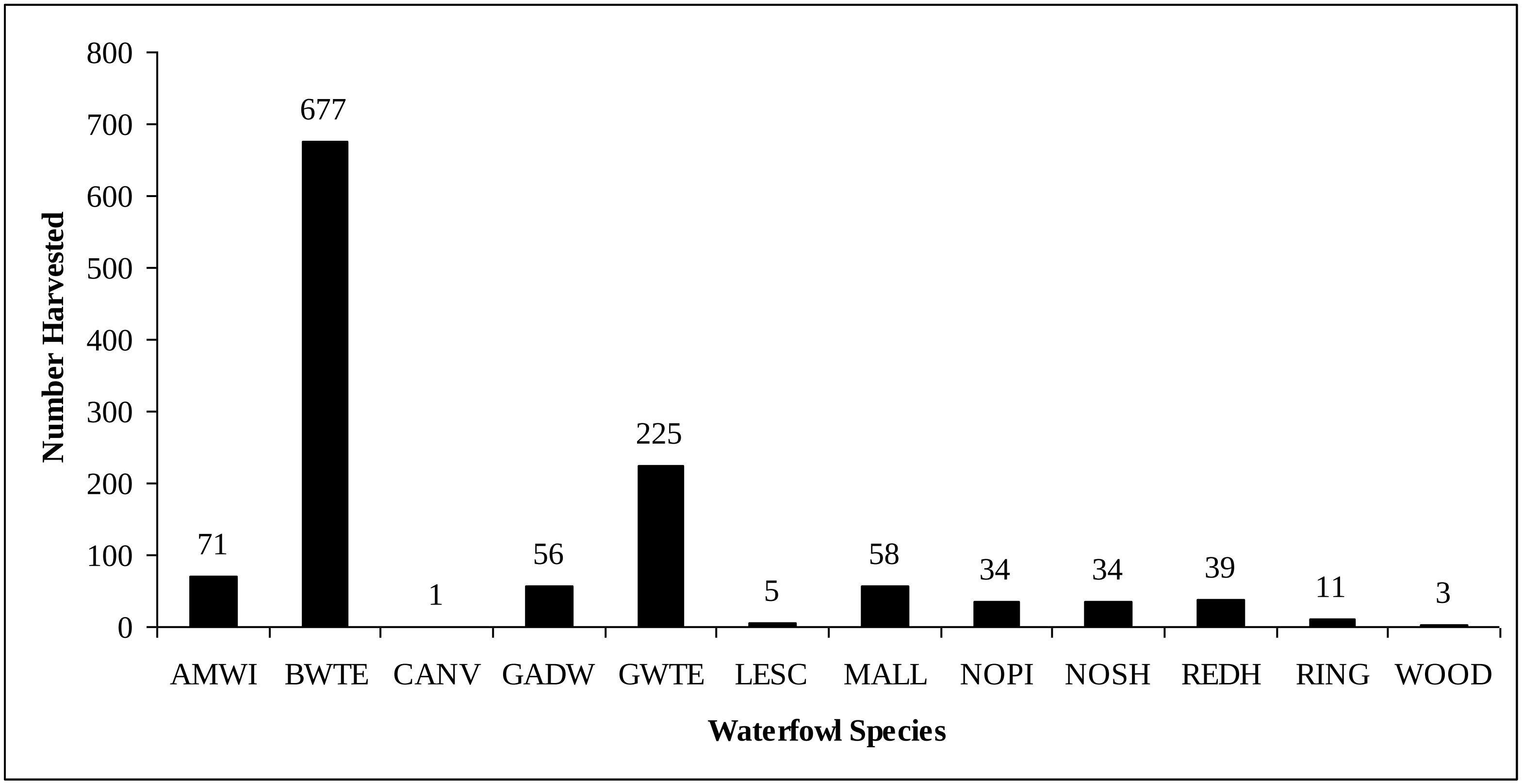


**Figure 2.8.** The species composition of 684 waterfowl hunter bag checks conducted during the 2007 and 2008 survey periods at Cheyenne Bottoms Wildlife Area combined, which totaled 1,648 harvested ducks (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail, RING = ring-necked duck, REDH = redhead, LESC = lesser scaup, WOOD = wood duck, CANV = canvasback).

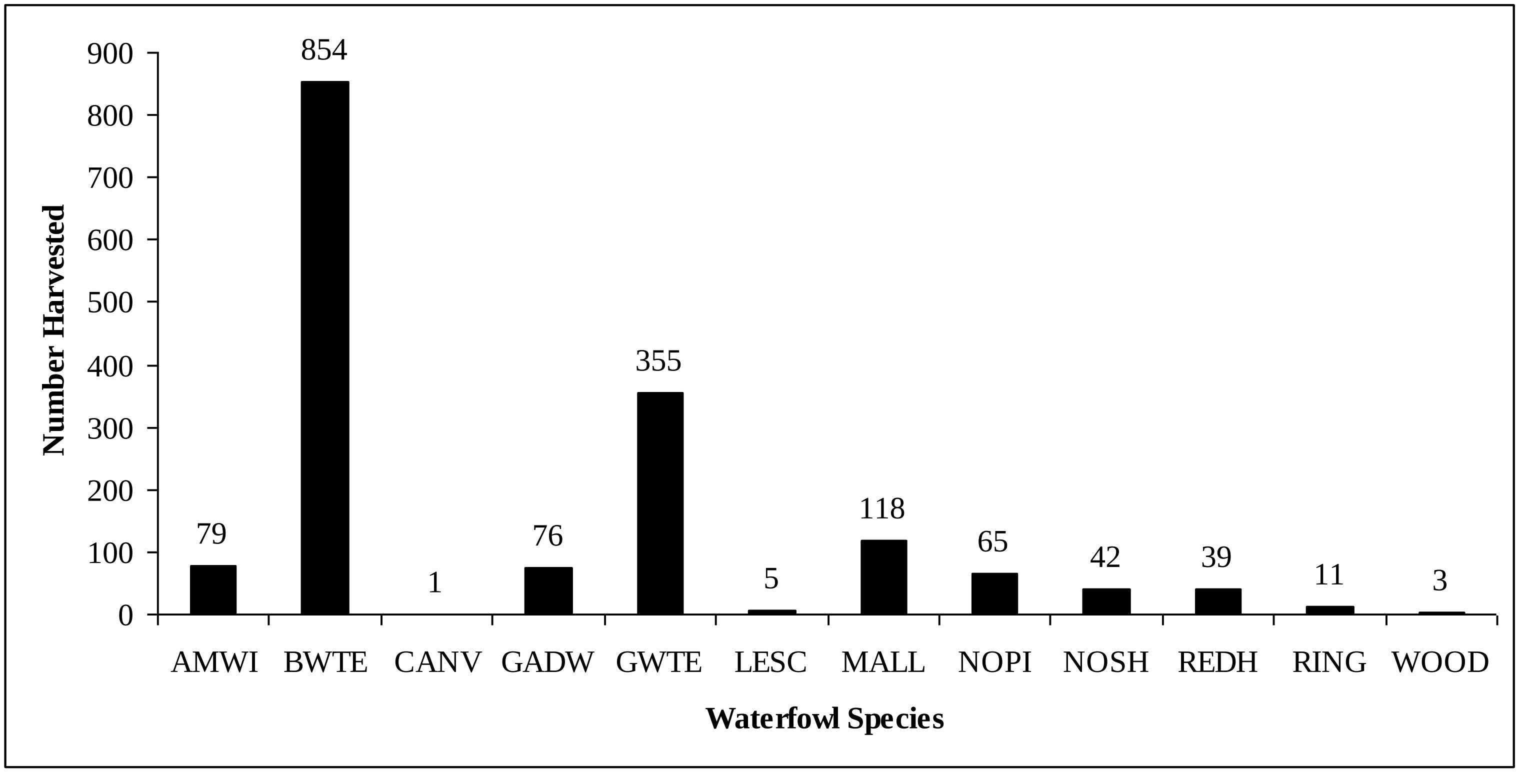


**Figure 2.9.** The Daily Hunt Permit (DHP) self-reporting rates of waterfowl species harvested during the 2007 teal season survey period at Cheyenne Bottoms Wildlife Area (BWTE = blue-winged teal, GWTE = American green-winged teal).

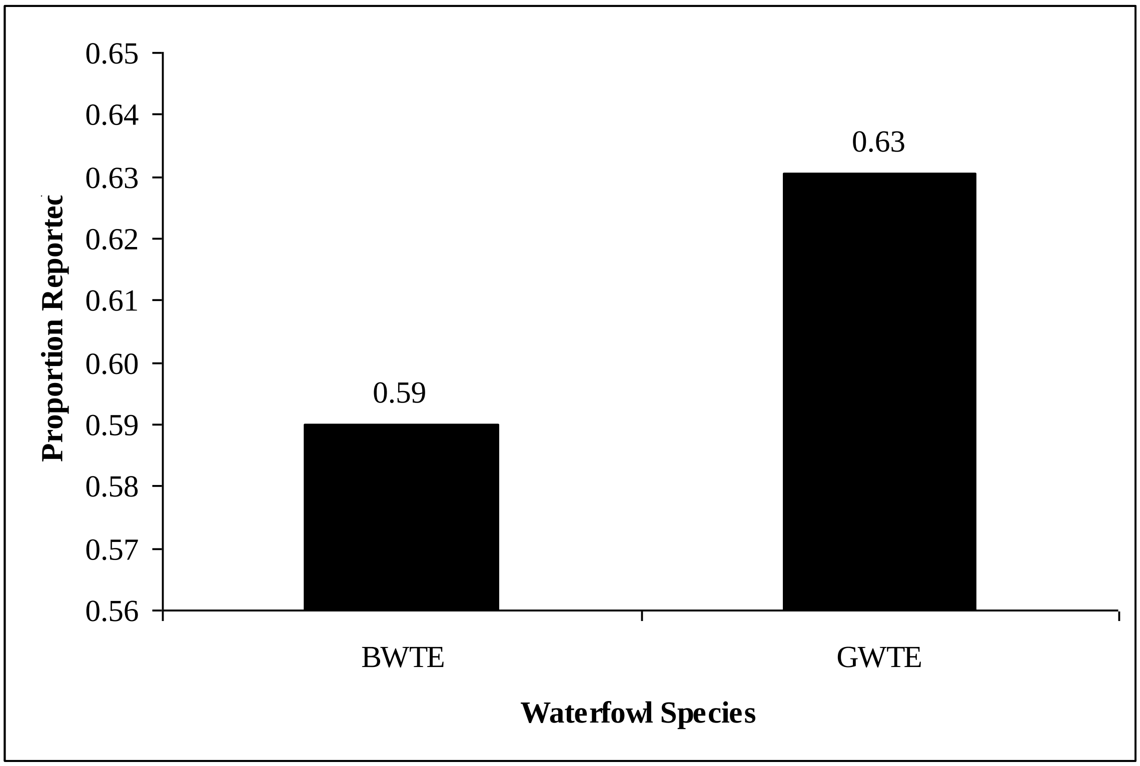


**Figure 2.10.** The Daily Hunt Permit (DHP) self-reporting rates of waterfowl species harvested during the 2007 duck season survey period at Cheyenne Bottoms Wildlife Area (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail, REDH = redhead).

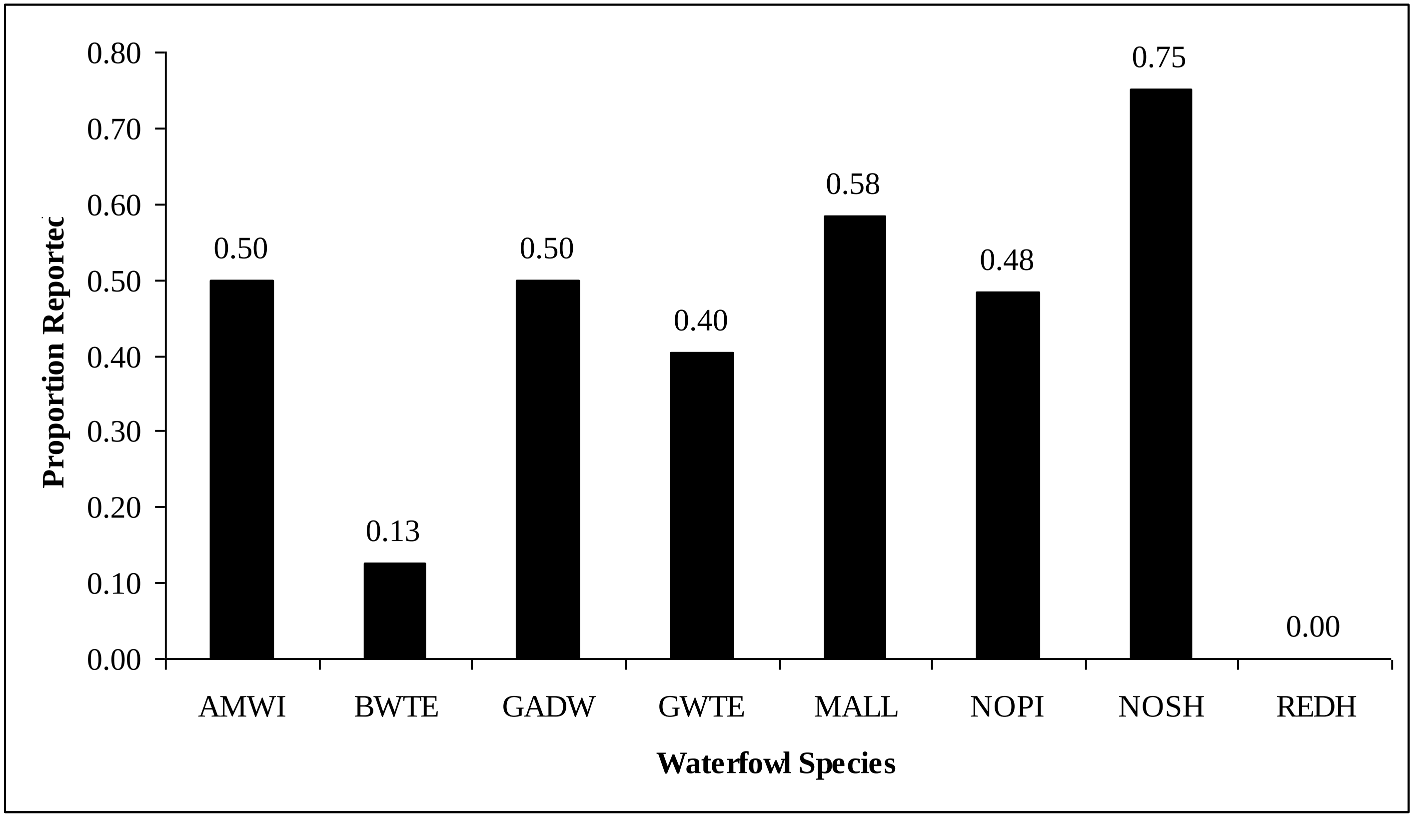


**Figure 2.11.** The Daily Hunt Permit (DHP) self-reporting rates of waterfowl species harvested during the 2008 teal season survey period at Cheyenne Bottoms Wildlife Area (BWTE = blue-winged teal, GWTE = American green-winged teal).

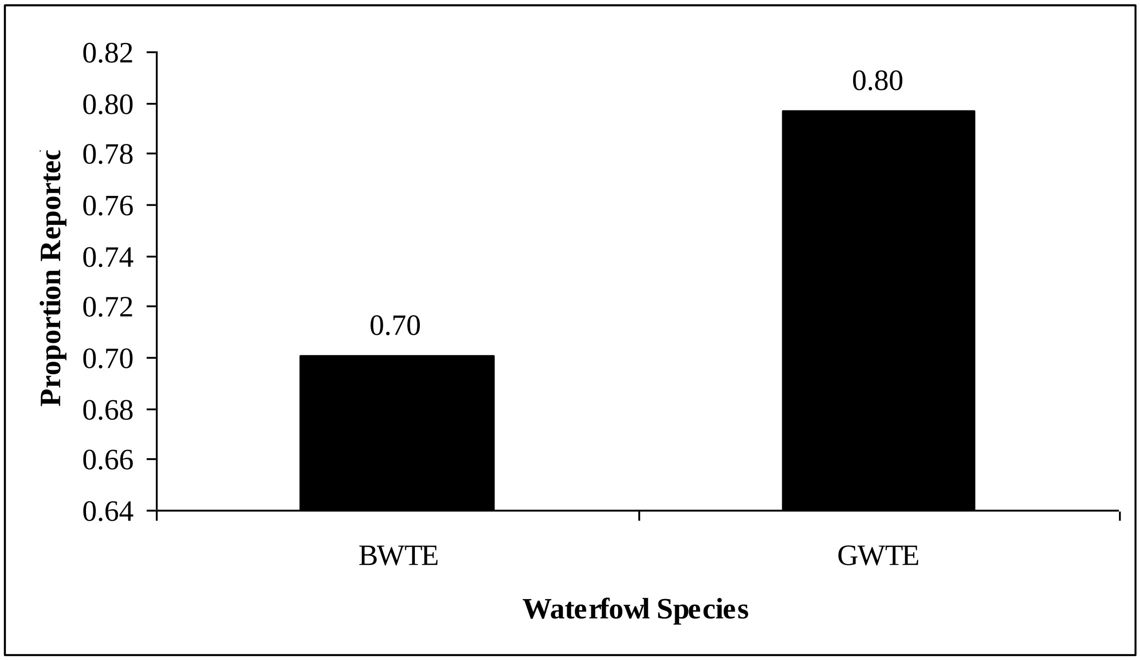


**Figure 2.12.** The Daily Hunt Permit (DHP) self-reporting rates of waterfowl species harvested during the 2008 duck season survey period at Cheyenne Bottoms Wildlife Area (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail, REDH = redhead).

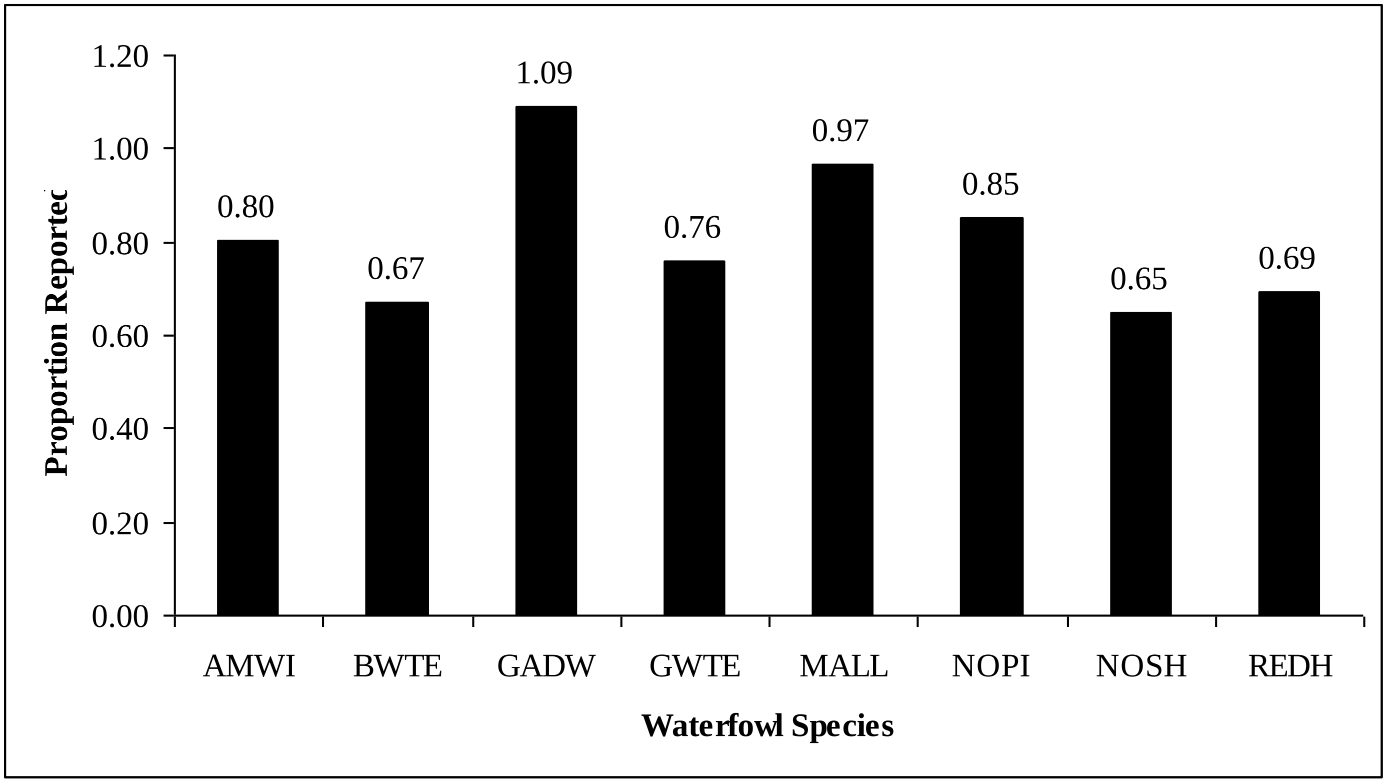


**Figure 2.13.** The overall Daily Hunt Permit (DHP) self-reporting rates of waterfowl species harvested during the 2007 and 2008 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area combined (BWTE = blue-winged teal, GWTE = American green-winged teal, MALL = mallard, GADW = gadwall, AMWI = American wigeon, NOSH = Northern shoveler, NOPI = Northern pintail, REDH = redhead).

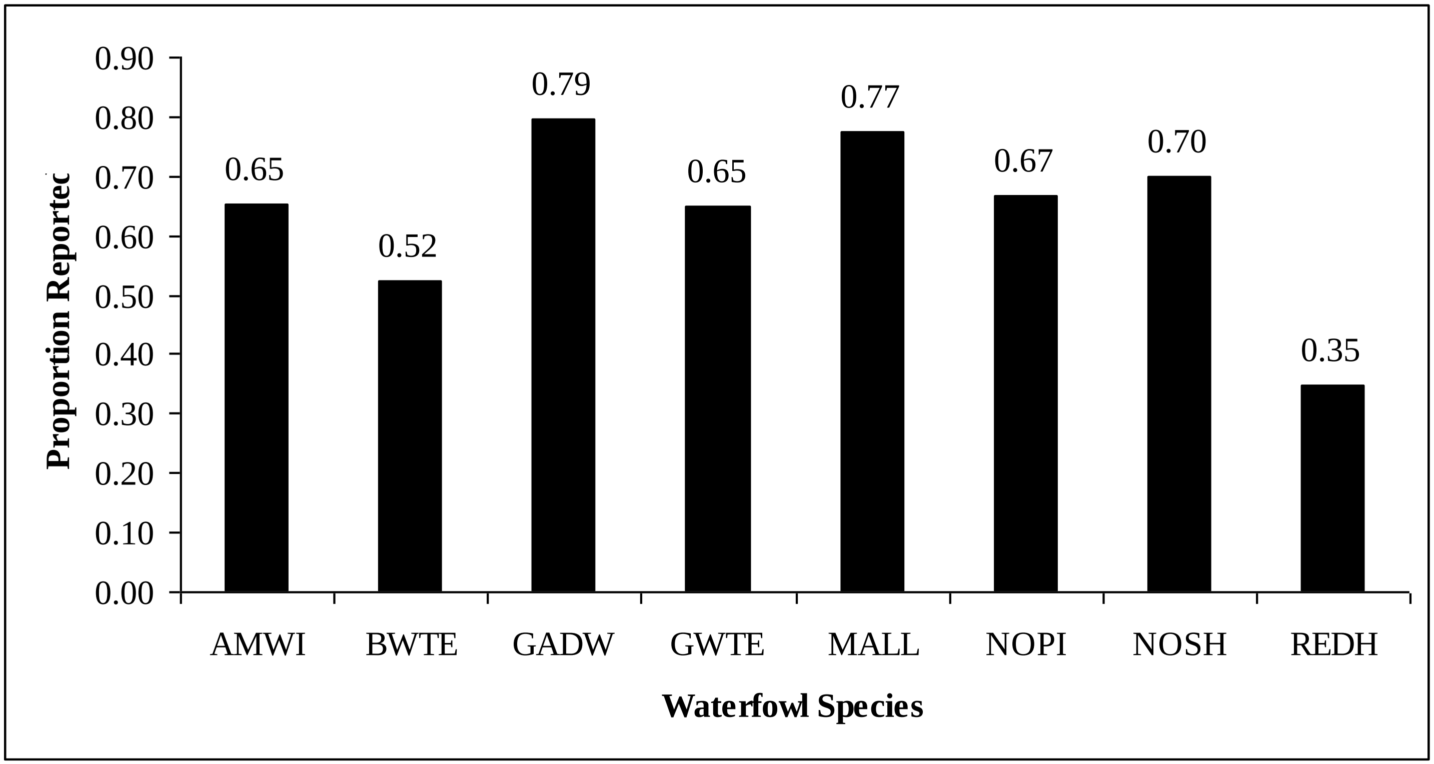


**Figure 2.14.** The reported proportion of the waterfowl harvested at Cheyenne Bottoms Wildlife Area as self-reported by hunters through the Daily Hunt Permit (DHP) system during the 2007 and 2008 waterfowl season survey periods.

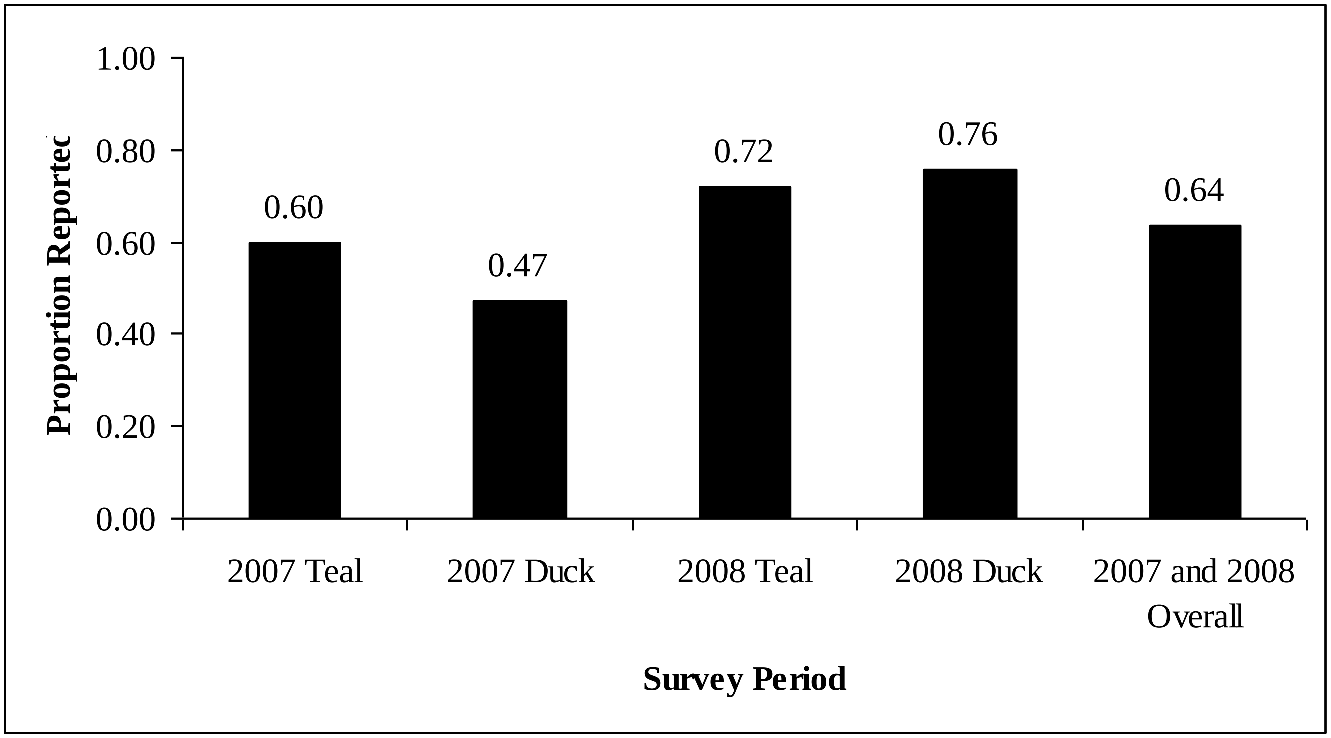


**Figure 2.15.** The number of observation hours per survey period during the 2007-2008 and 2008-2009 waterfowl seasons at Cheyenne Bottoms Wildlife Area.

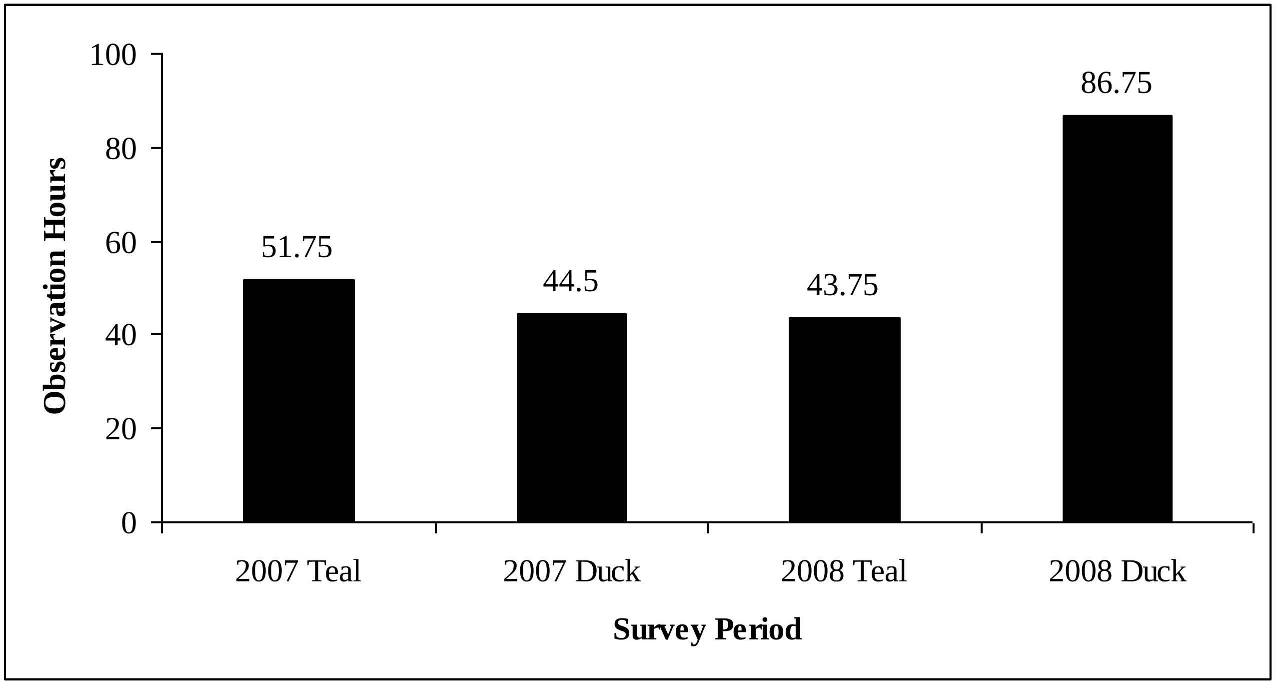


**Figure 2.16.** The number of waterfowl hunters observed and checked during each of the 2007-2008 and 2008-2009 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

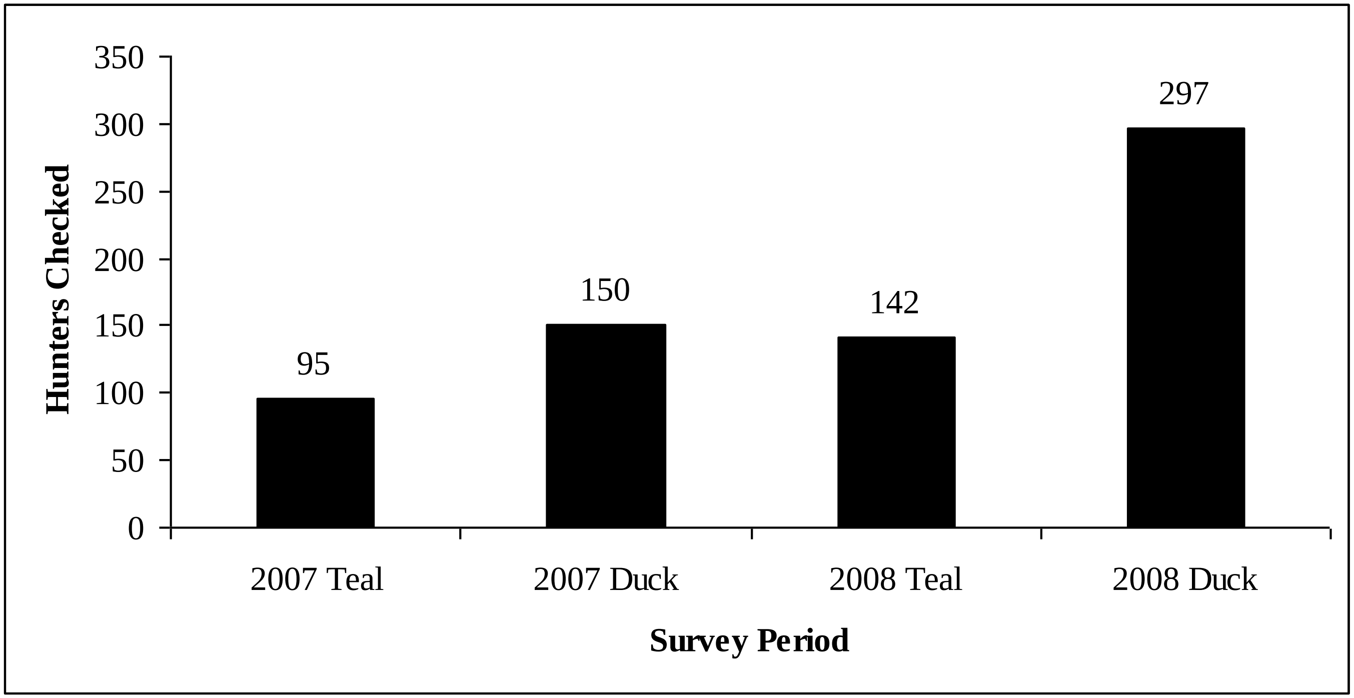


**Figure 2.17.** The Daily Hunt Permit (DHP) top compliance, bottom compliance, and complete compliance rates during the 2007-2008 and 2008-2009 waterfowl season survey periods at Cheyenne Bottoms Wildlife Area.

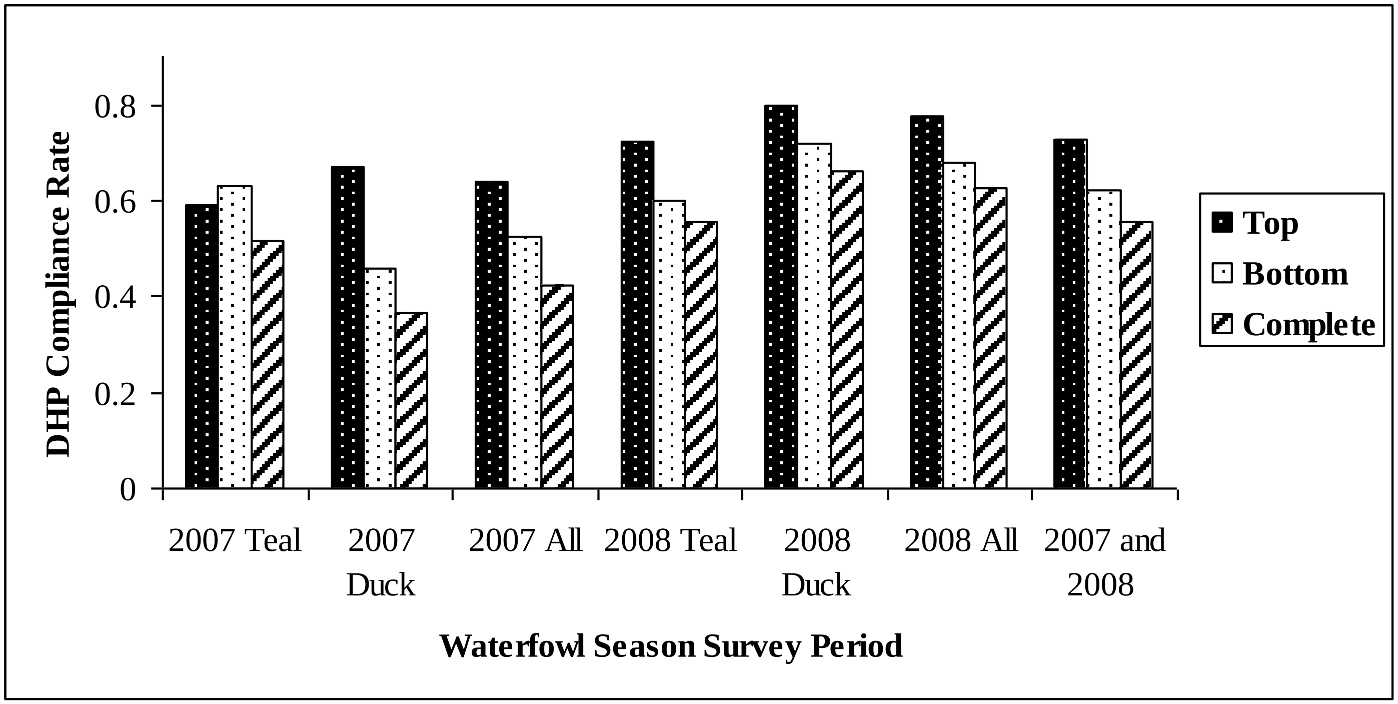


**Figure 3.1.** The percentage of total responses for each Likert Scale response category for Question One of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Did you hunt waterfowl during the 2005-2006 waterfowl season?" ($N$ = 387)

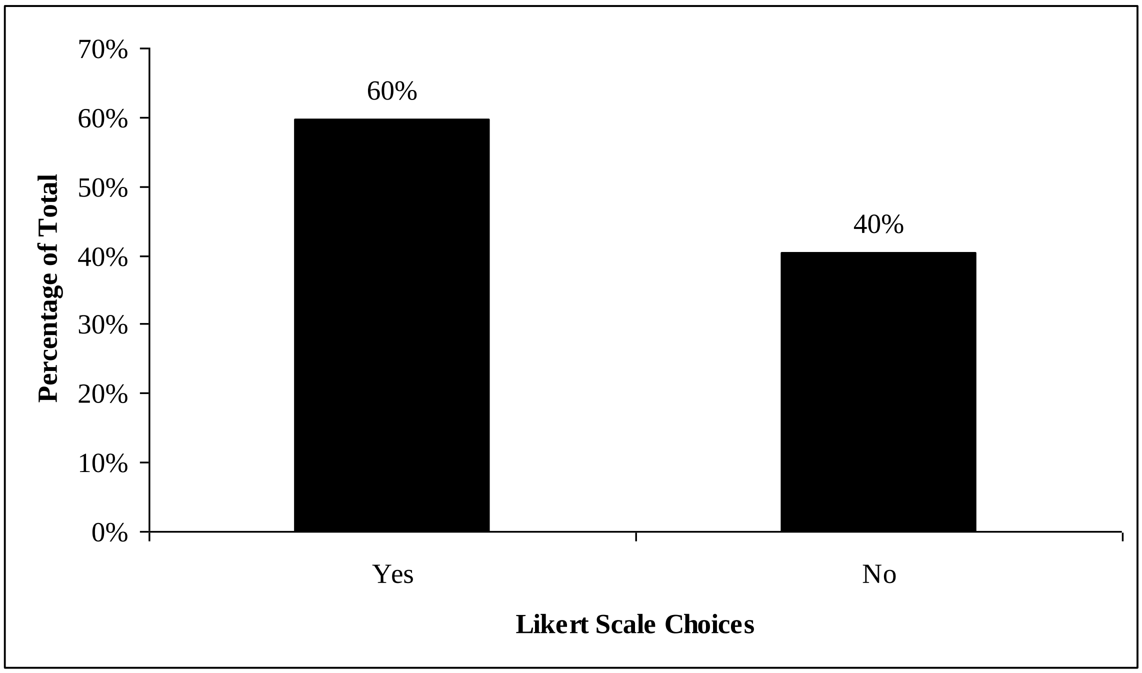


**Figure 3.2.** The percentage of total responses for each Likert Scale response category for Question Two of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Did you hunt waterfowl during the 2006-2007 waterfowl season?" (*N* = 388)

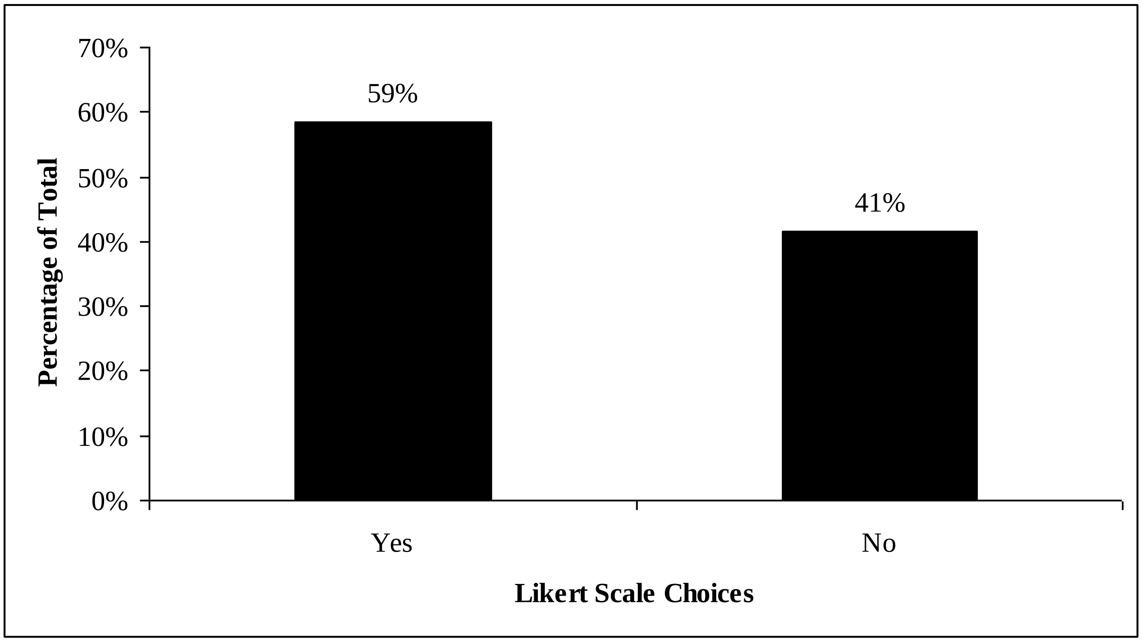


**Figure 3.3.** The percentage of total responses for each Likert Scale response category for Question Three of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Did the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) or other agency personnel swab the ducks you harvested for avian influenza (bird flu)?" (*N* = 363)

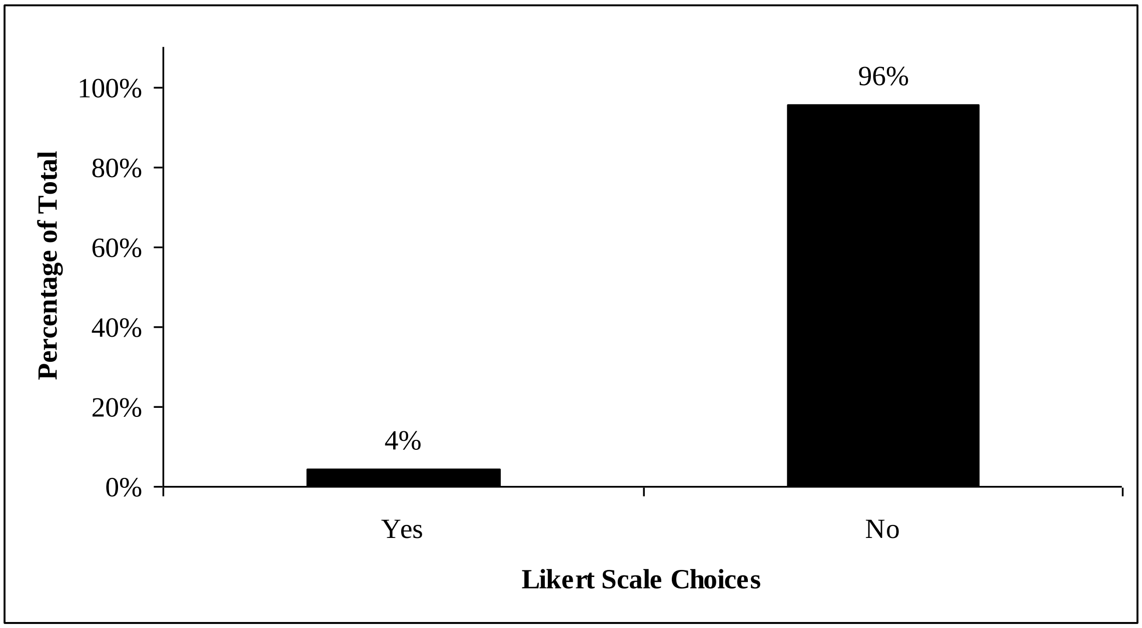


**Figure 3.4.** The percentage of total responses for each Likert Scale response category for Question Eight of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Do you think that the bird flu is a serious risk to the health of waterfowl hunters and their families?” (*N* = 377)

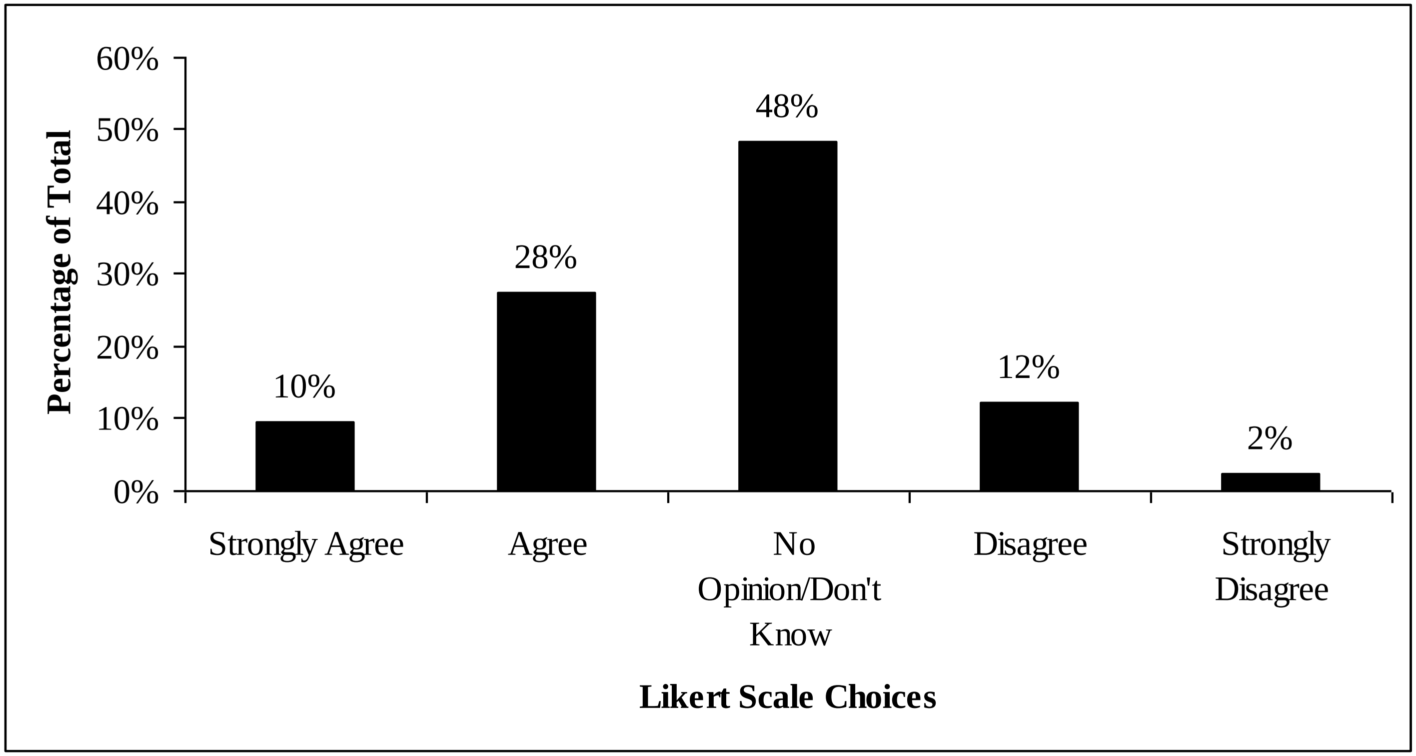


**Figure 3.5.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question Eight of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Do you think that the bird flu is a serious risk to the health of waterfowl hunters and their families?”

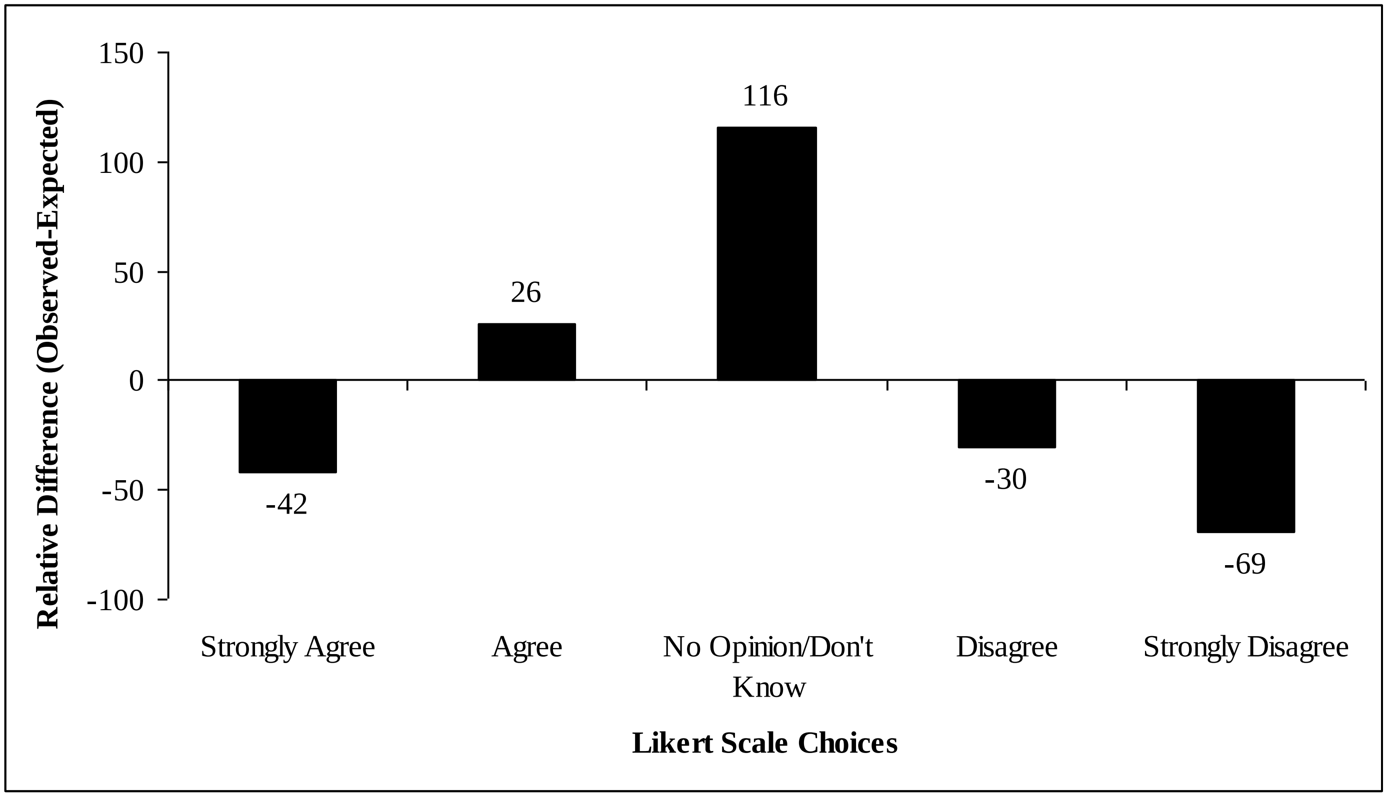


**Figure 3.6.** The percentage of total responses for each Likert Scale response category for Question Nine of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “How concerned is your family about getting bird flu from eating the waterfowl you bring home?” (*N* = 379)

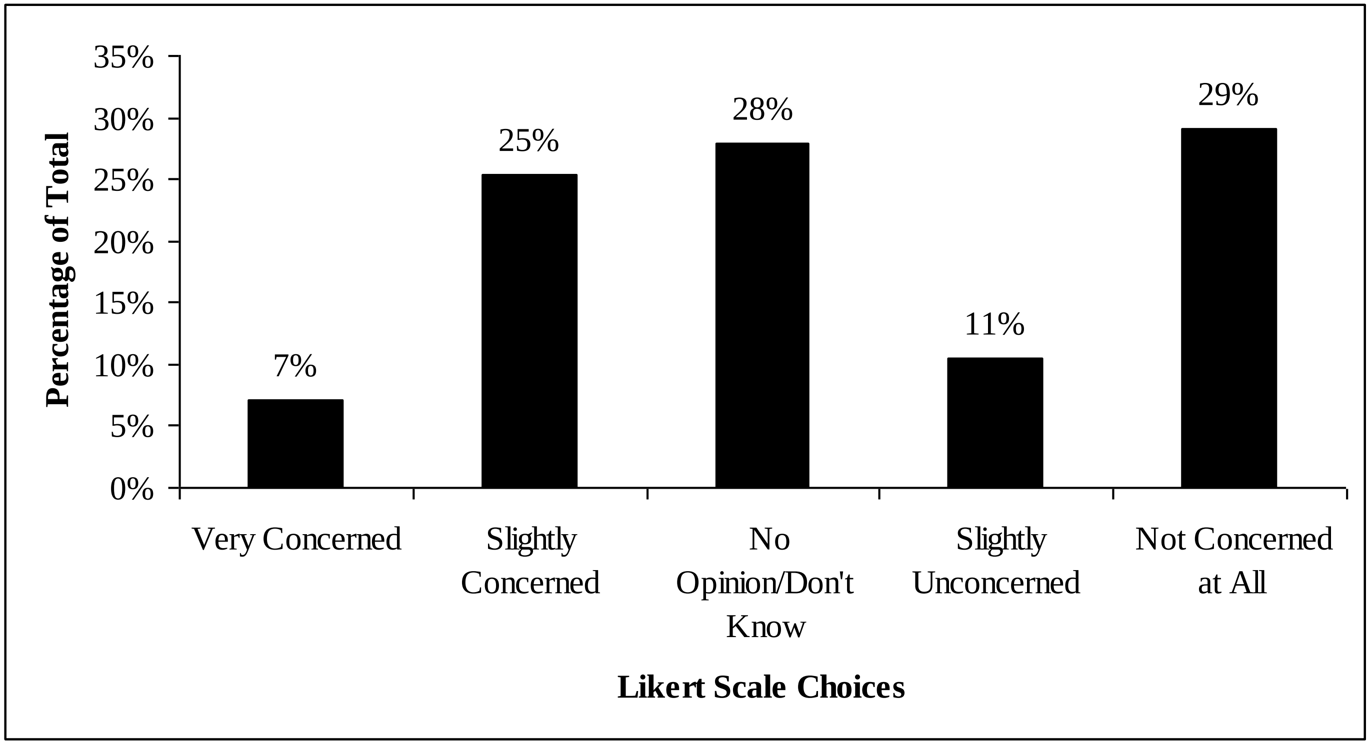


**Figure 3.7.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question Nine of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “How concerned is your family about getting bird flu from eating the waterfowl you bring home?”

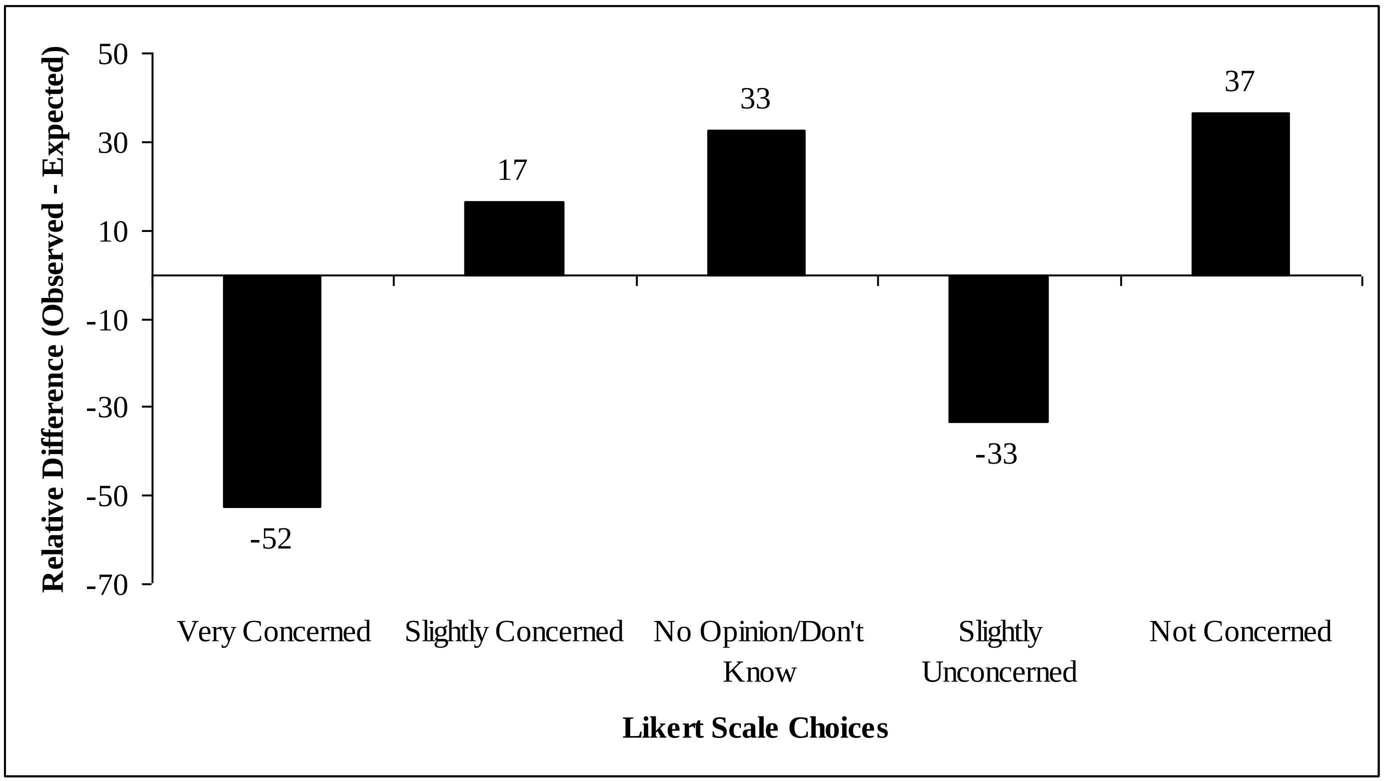


**Figure 3.8.** The percentage of total responses for each Likert Scale response category for Question 10 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "How concerned are you that your dog will get bird flu from retrieving ducks shot by waterfowl hunters?" ($N$ = 378)

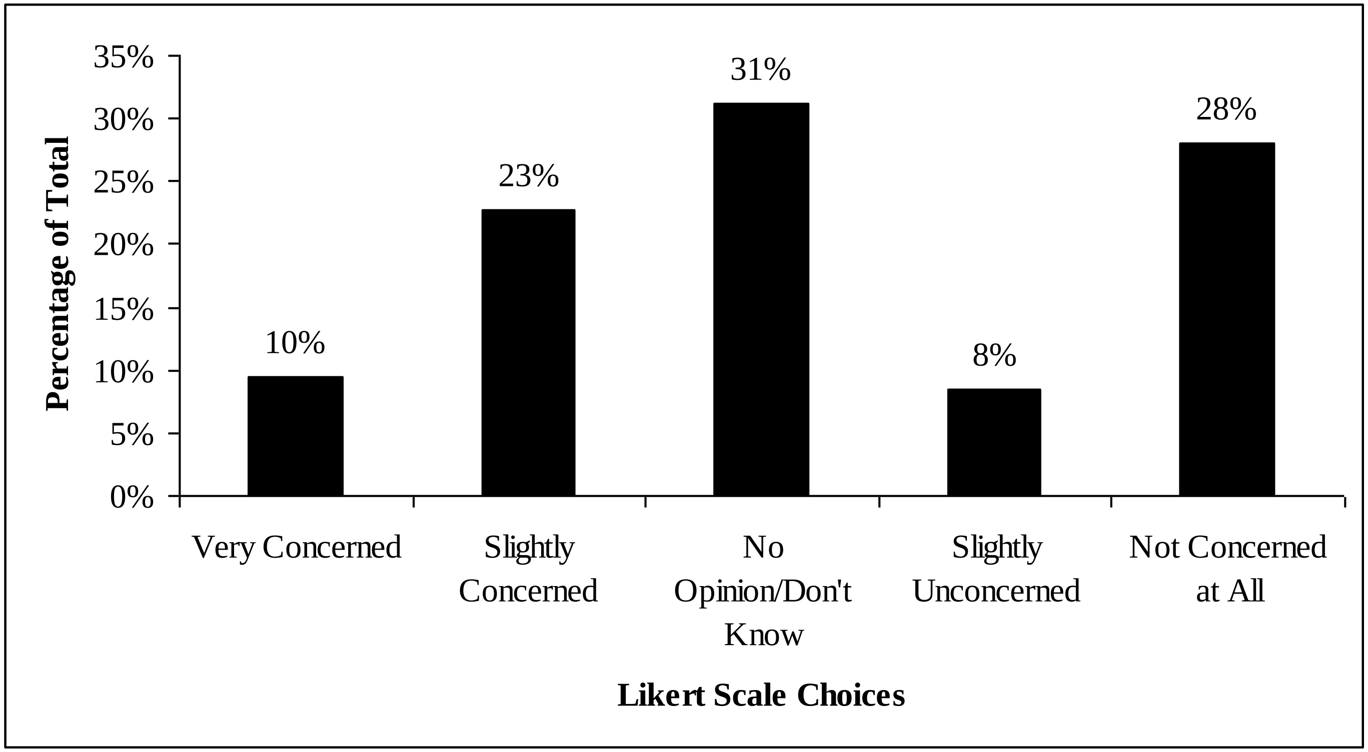


**Figure 3.9.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 10 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “How concerned are you that your dog will get bird flu from retrieving ducks shot by waterfowl hunters?”

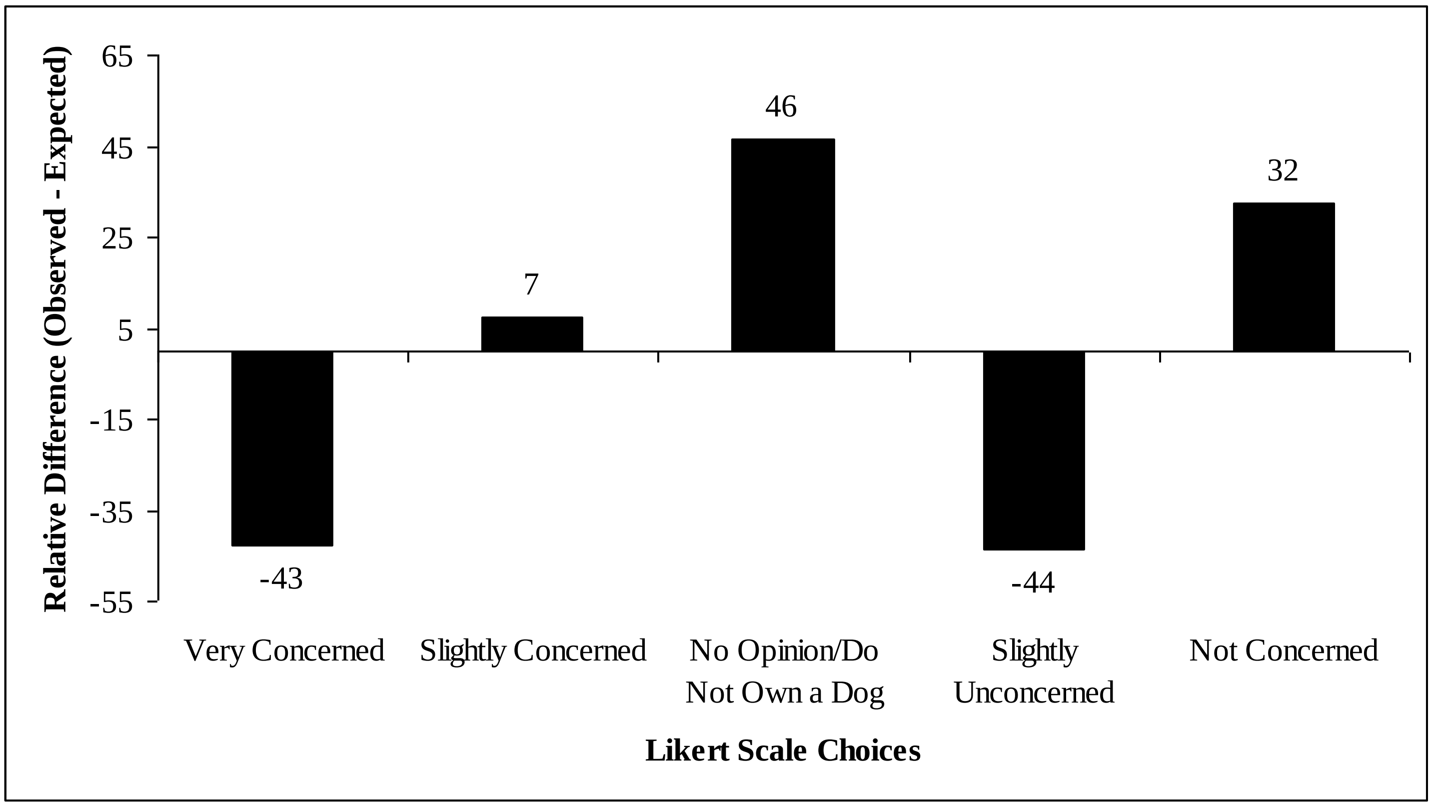


**Figure 3.10.** The percentage of total responses for each Likert Scale response category for Question Four of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “How many kinds of bird flu are there?” (*N* = 373)

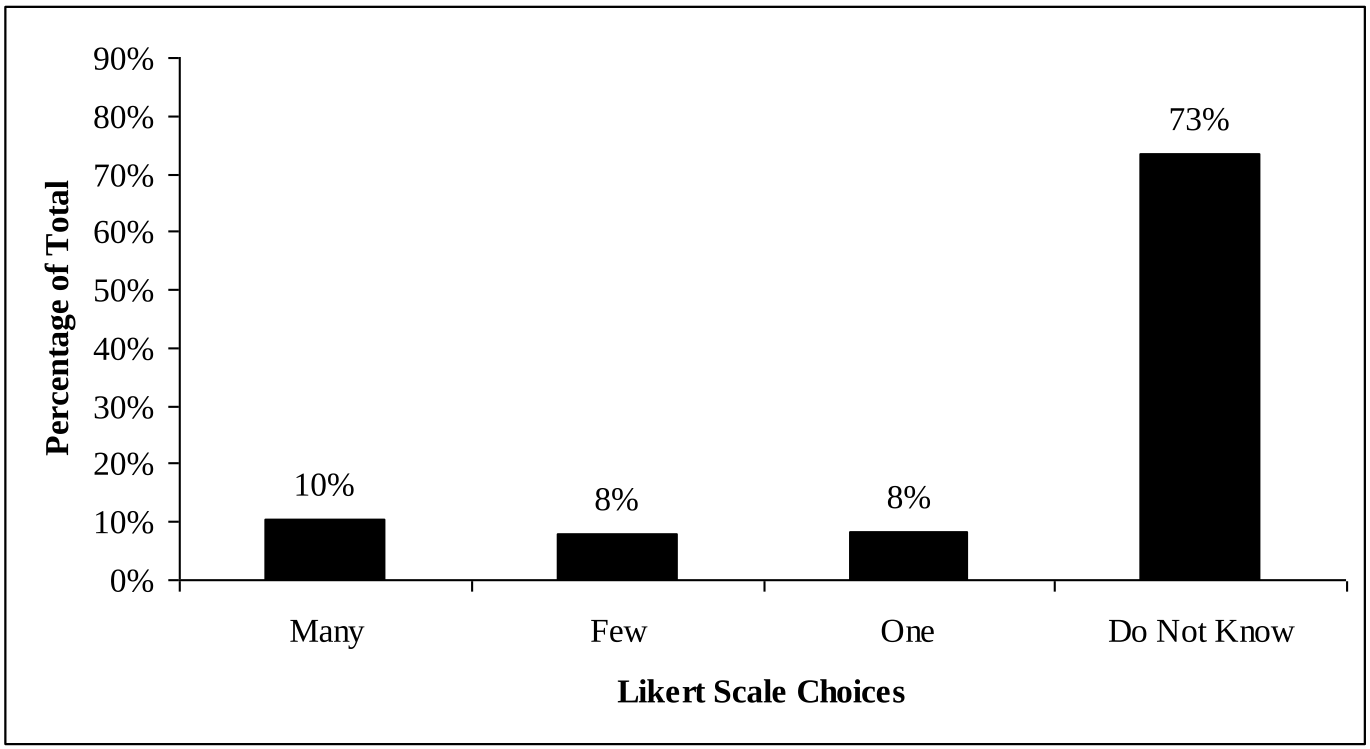


**Figure 3.11.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question Four of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "How many kinds of bird flu are there?"

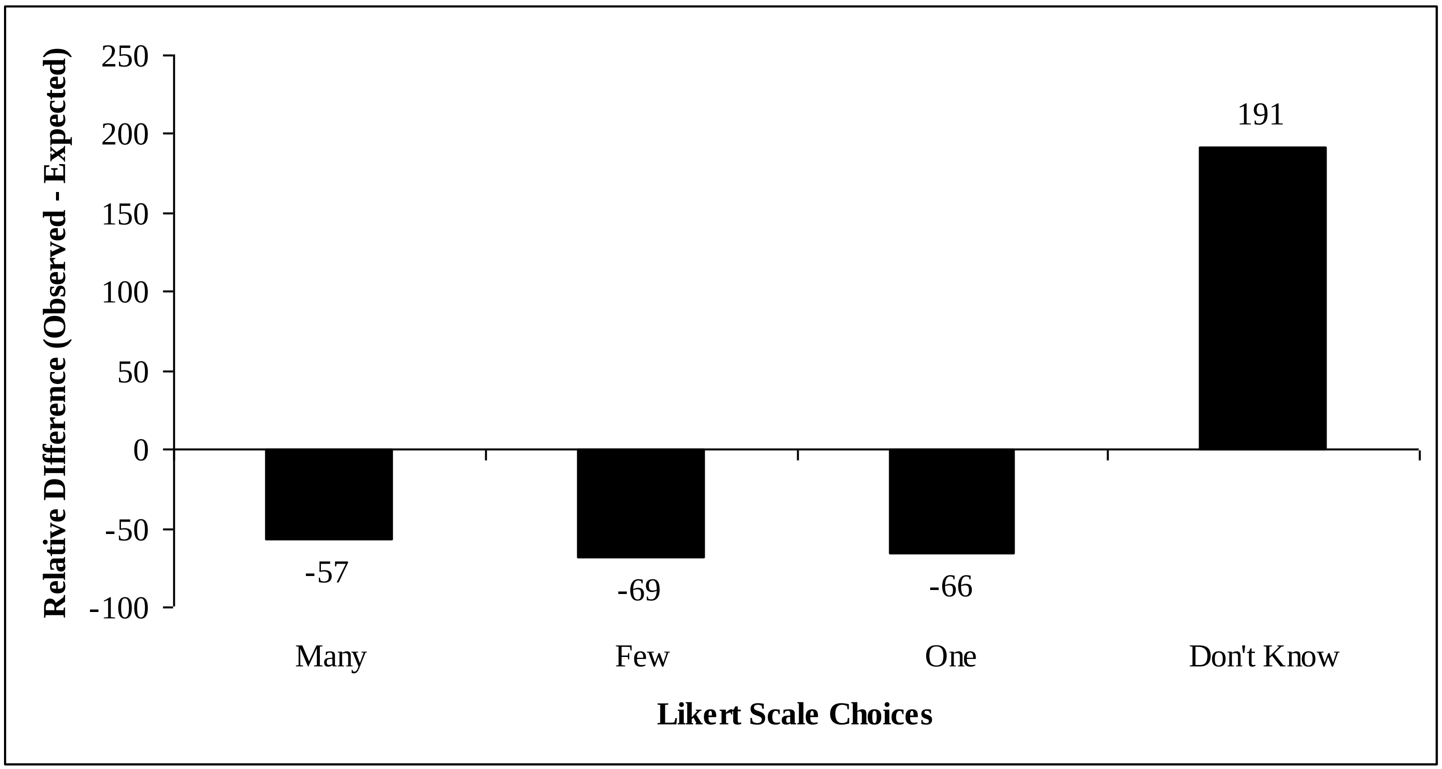


**Figure 3.12.** The percentage of total responses for each Likert Scale response category for Question Five of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Are all types of bird flu equally dangerous to waterfowl?” ($N$ = 374)

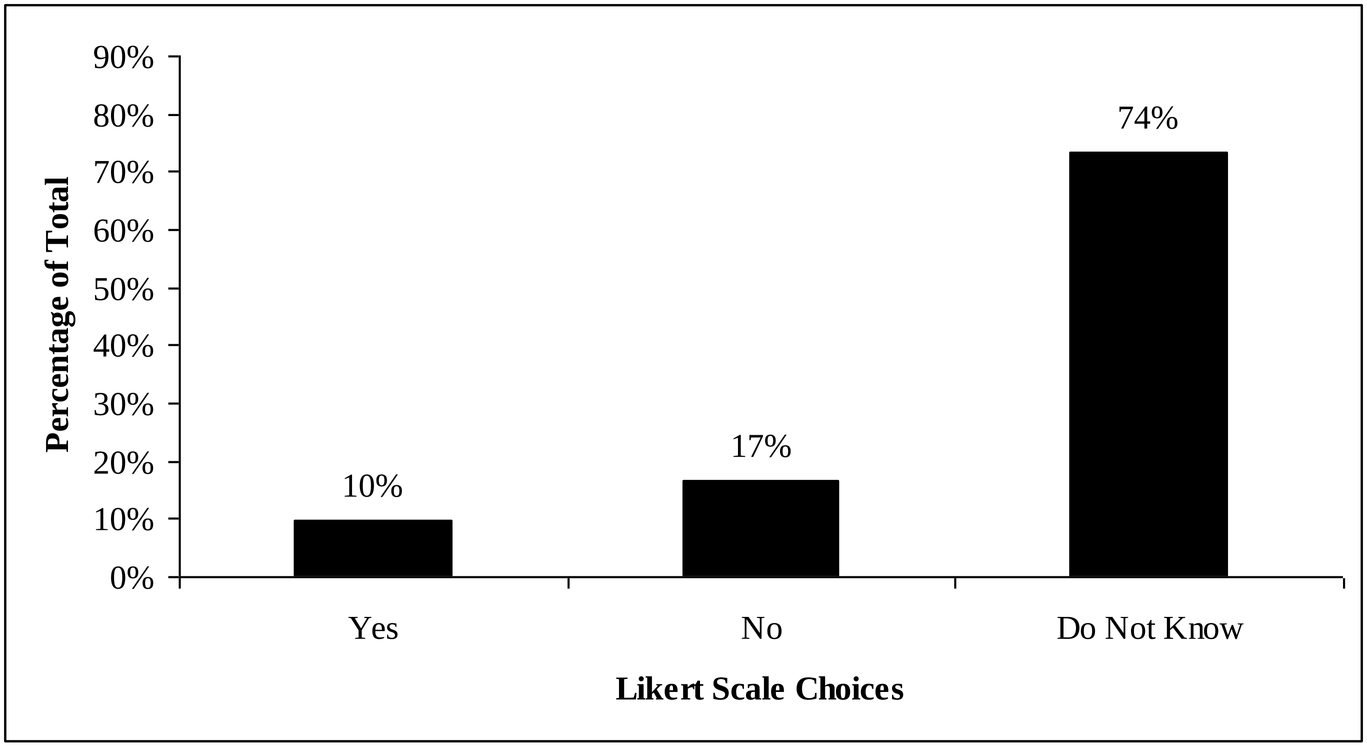


**Figure 3.13.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question Five of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Are all types of bird flu equally dangerous to waterfowl?”

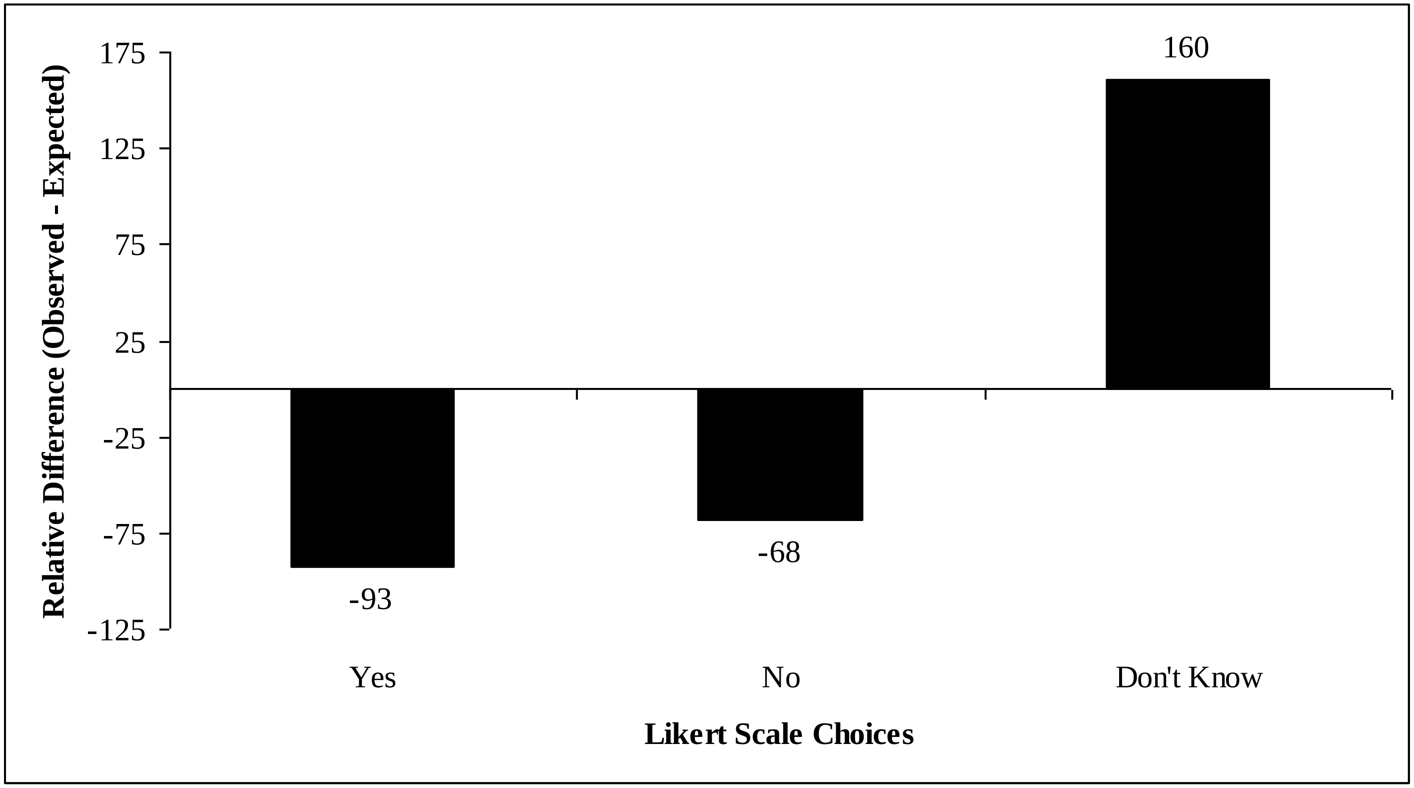


**Figure 3.14.** The percentage of total responses for each Likert Scale response category for Question Six of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Are all types of bird flu equally dangerous to people?” (*N* = 376)

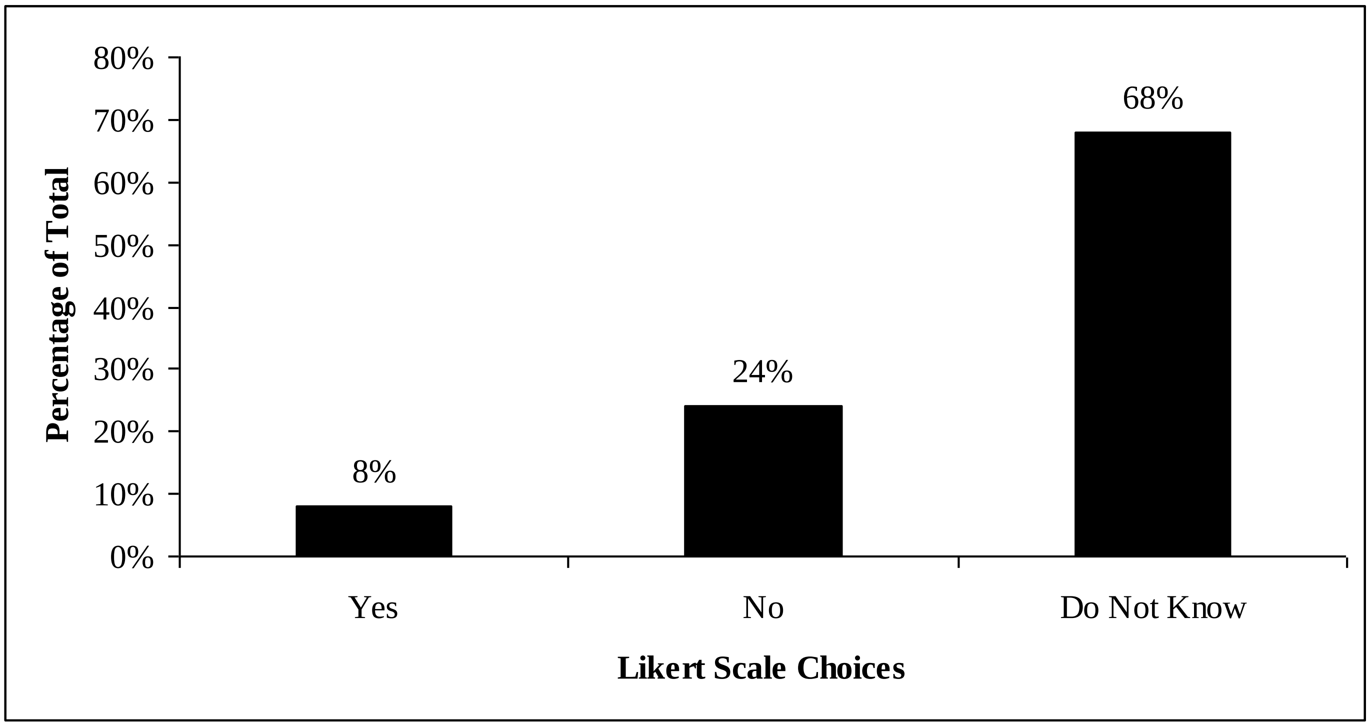


**Figure 3.15.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question Six of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are all types of bird flu equally dangerous to people?"

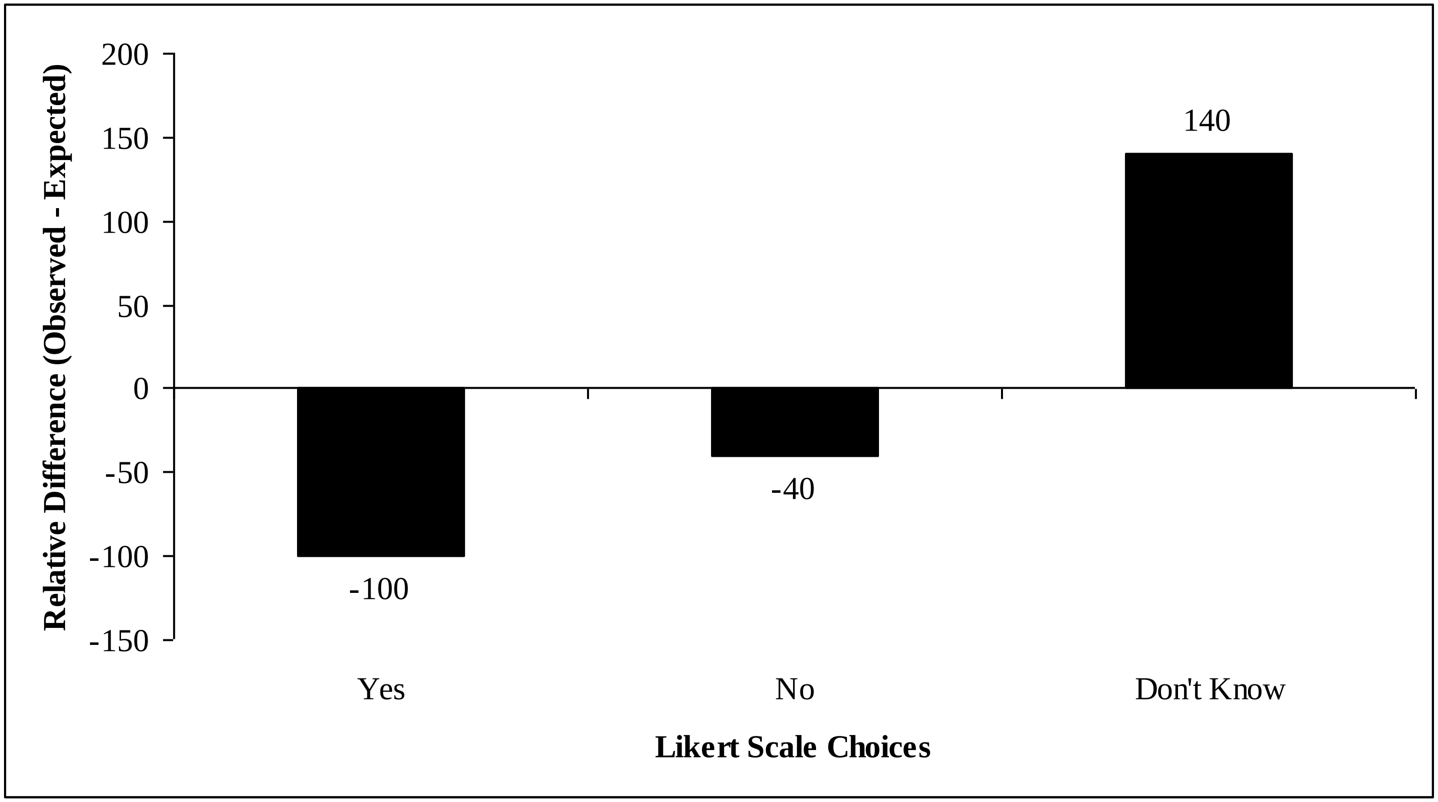


**Figure 3.16.** The percentage of total responses for each Likert Scale response category for Question Seven of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "How much do you need or want to know about bird flu?" (*N* = 378)

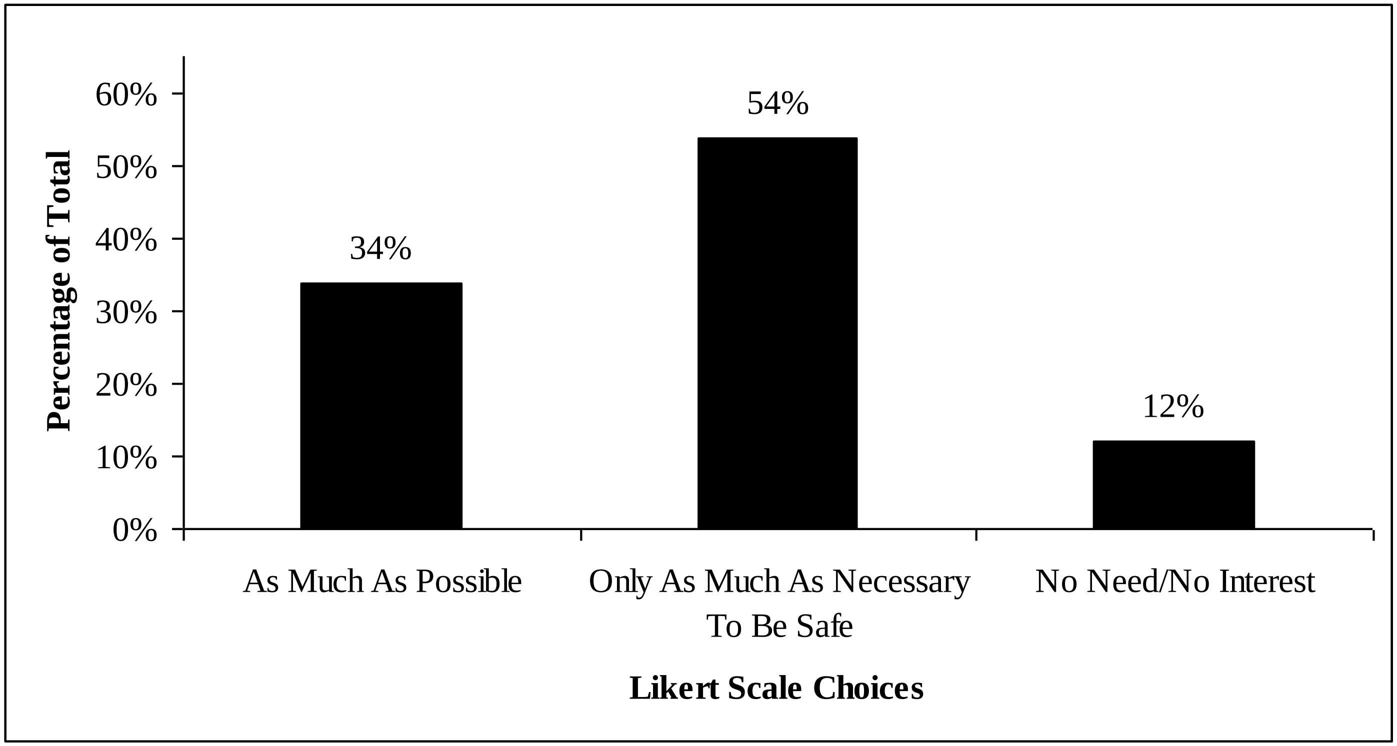


**Figure 3.17.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question Seven of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "How much do you need or want to know about bird flu?"

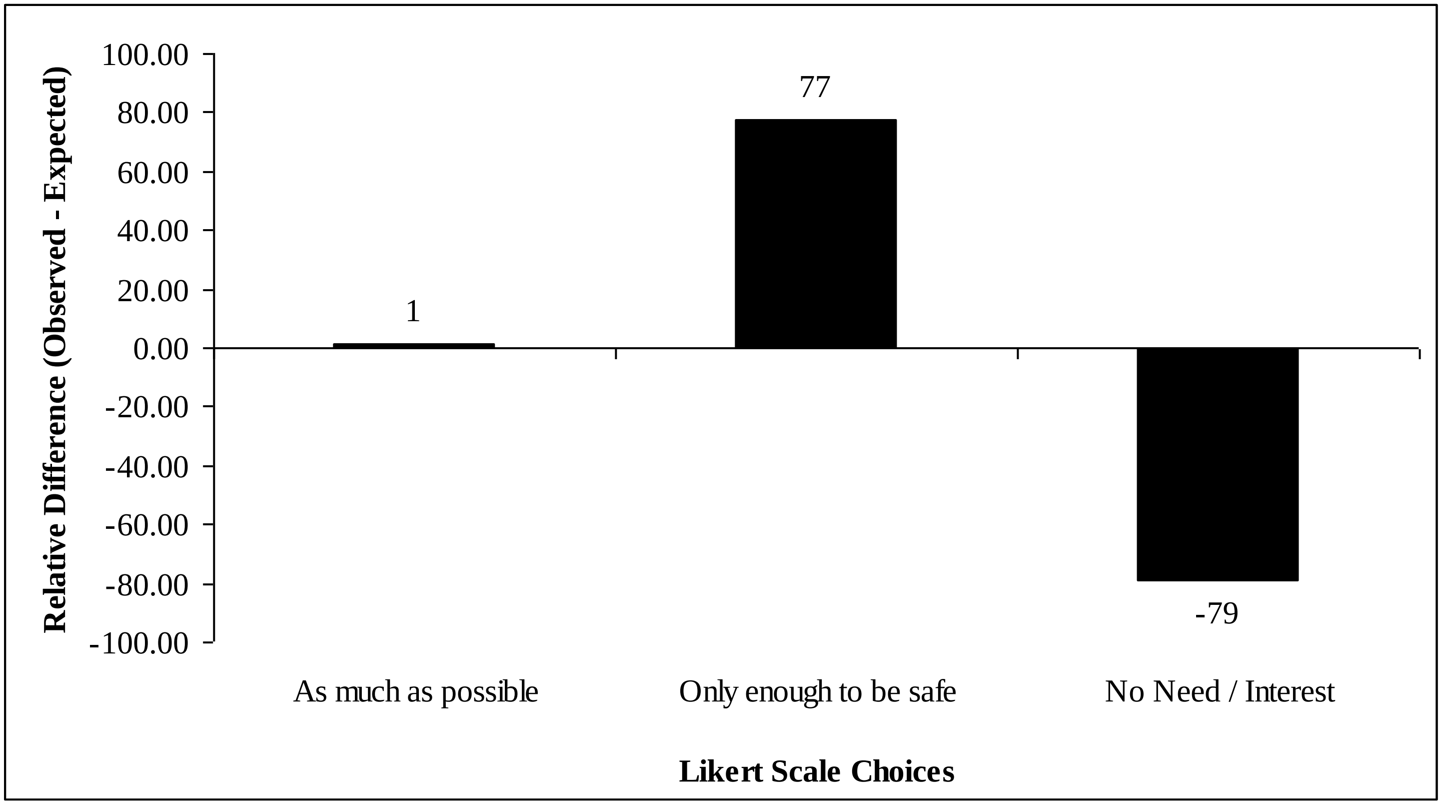


**Figure 3.18.** The percentage of each current source of bird flu information ranked as High, Medium, or Low in Question 17 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Please rate the importance of these choices in how you currently obtain your bird flu information." (*N* = 303)

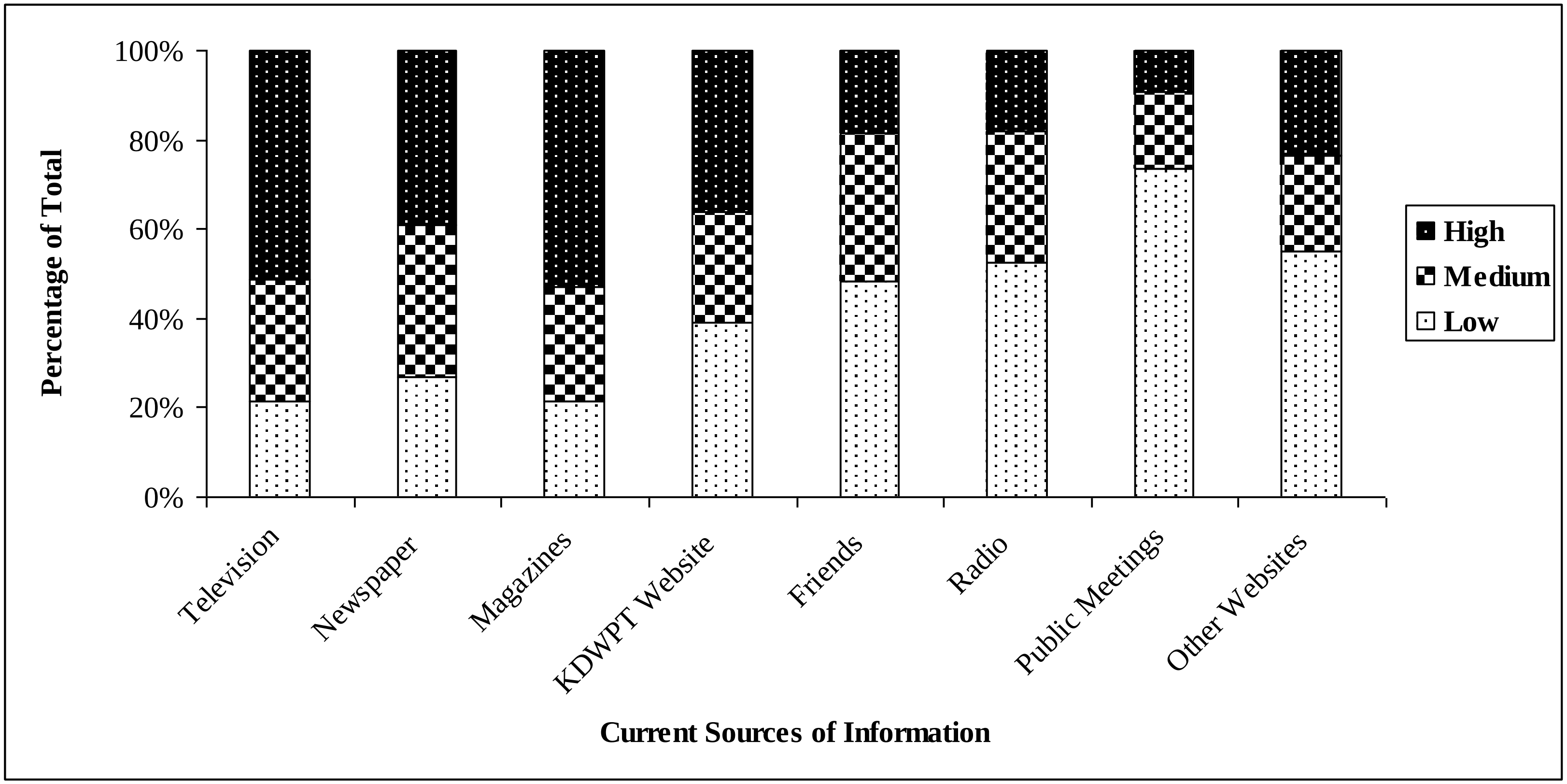


**Figure 3.19.** The percentage of most preferred sources of bird flu information ranked as High, Medium, or Low in Question 19 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Please rate the importance of these choices in how you would most prefer to obtain your bird flu information." (*N* = 298)

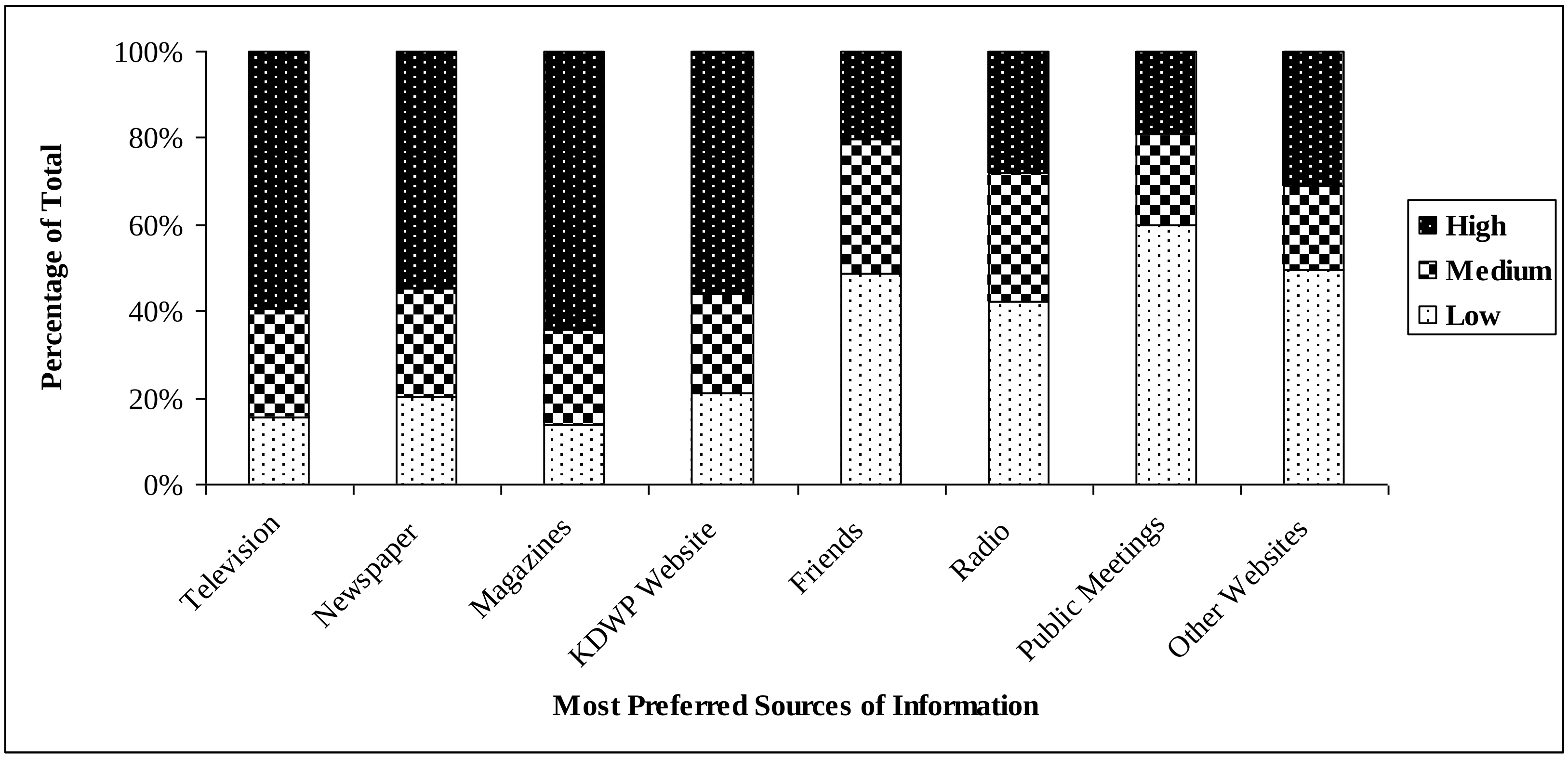


**Figure 3.20.** The percentage of total responses for each Likert Scale response category for Question 21 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Do you wish to be informed about bird flu news by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT)?” (*N* = 364)

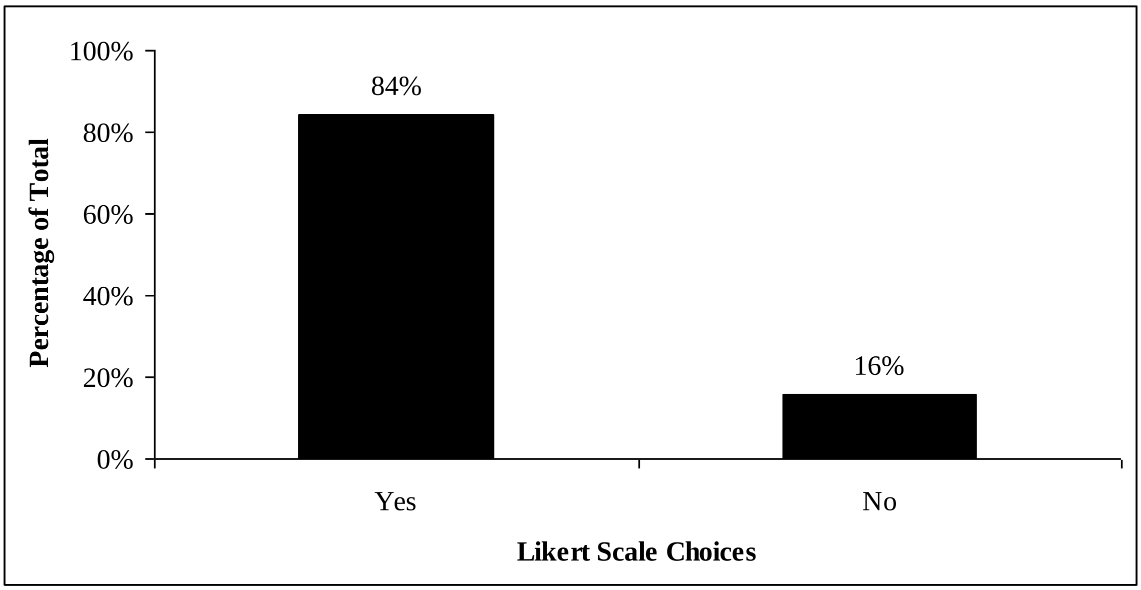


**Figure 3.21.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 21 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Do you wish to be informed about bird flu news by the Kansas Department of Wildlife, Parks, and Tourism (KDWPT)?”

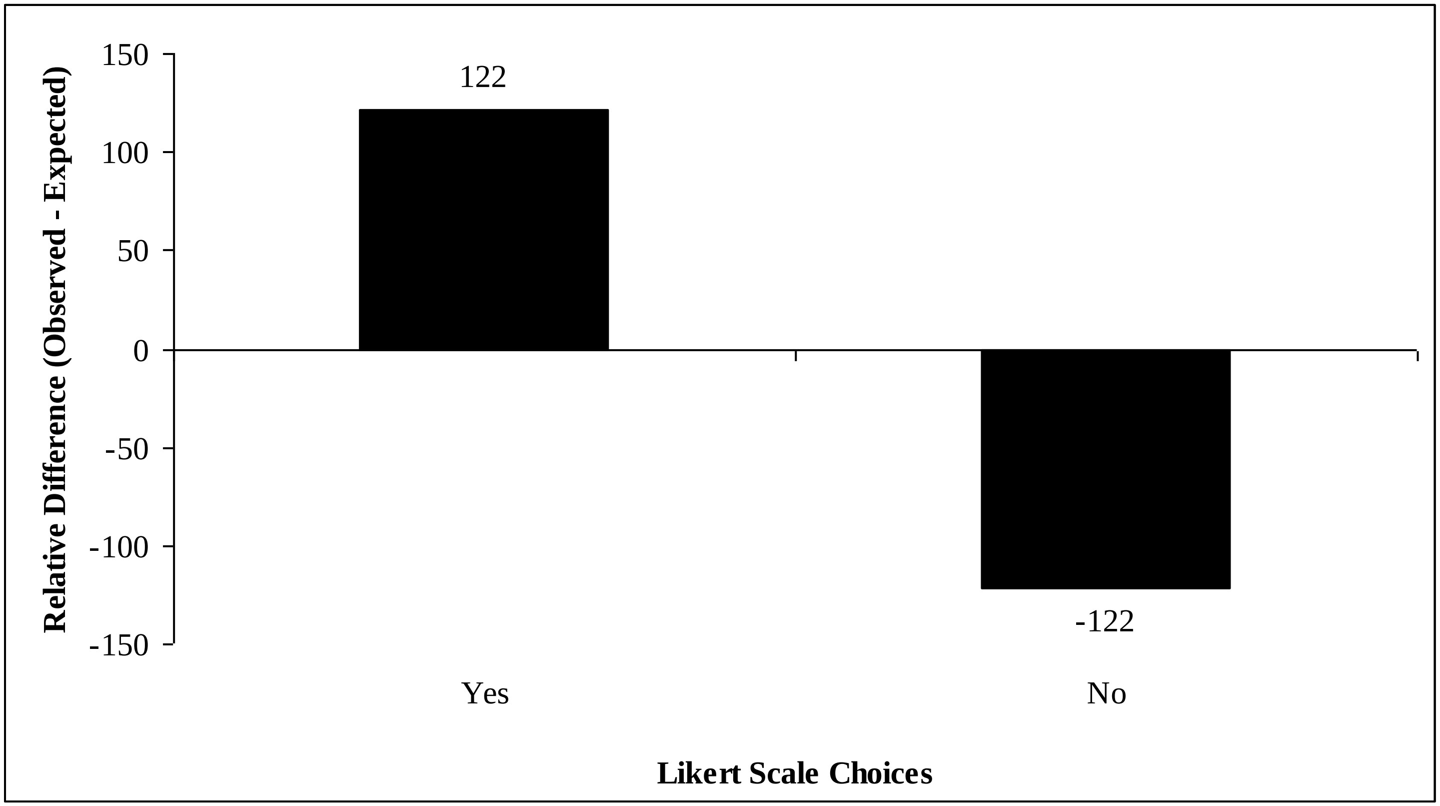


**Figure 3.22.** The percentage of total responses for each Likert Scale response category for Question 22 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) bird flu surveillance and monitoring efforts sufficient for detecting bird flu in Kansas?" (*N* = 365)

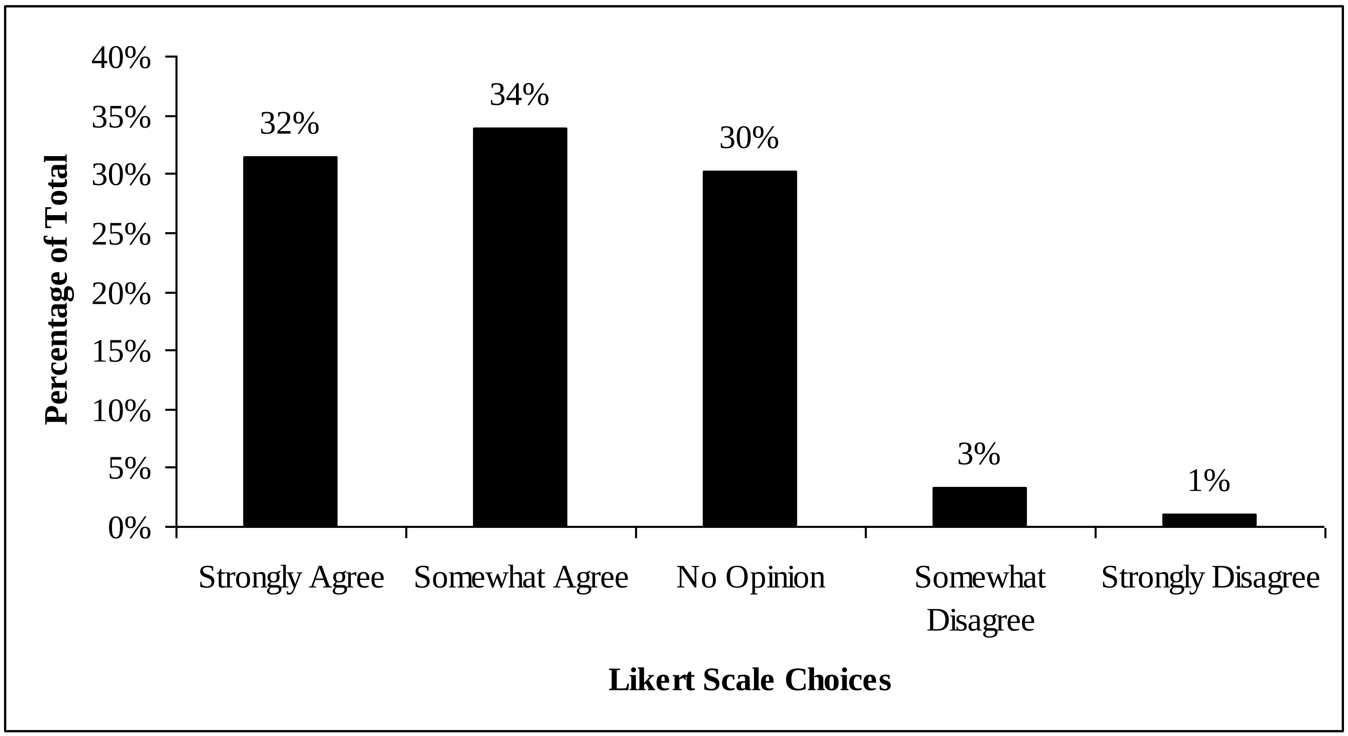


**Figure 3.23.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 22 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) bird flu surveillance and monitoring efforts sufficient for detecting bird flu in Kansas?"

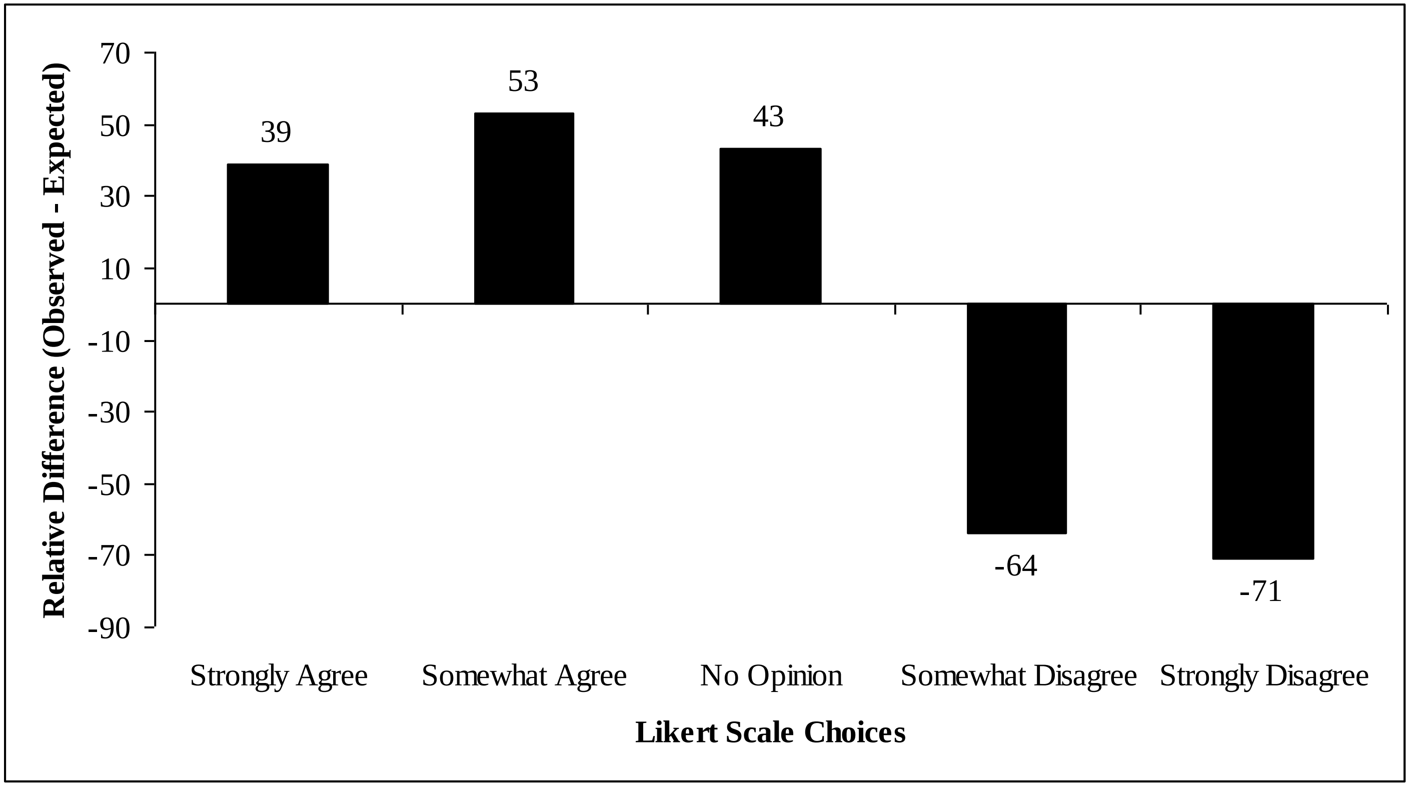


**Figure 3.24.** The percentage of total responses for each Likert Scale response category for Question 23 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Are waterfowl the correct group of birds to be monitoring for the presence of bird flu?” (*N* = 368)

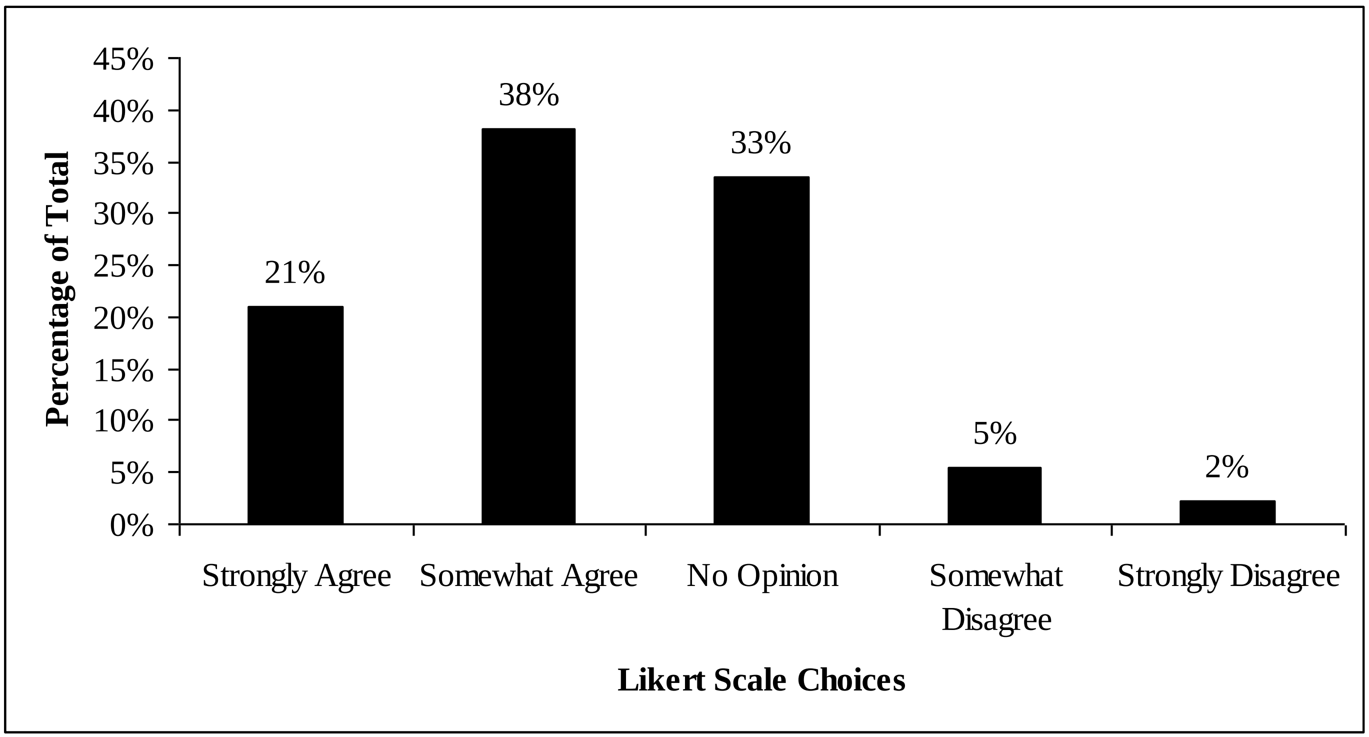


**Figure 3.25.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 23 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are waterfowl the correct group of birds to be monitoring for the presence of bird flu?"

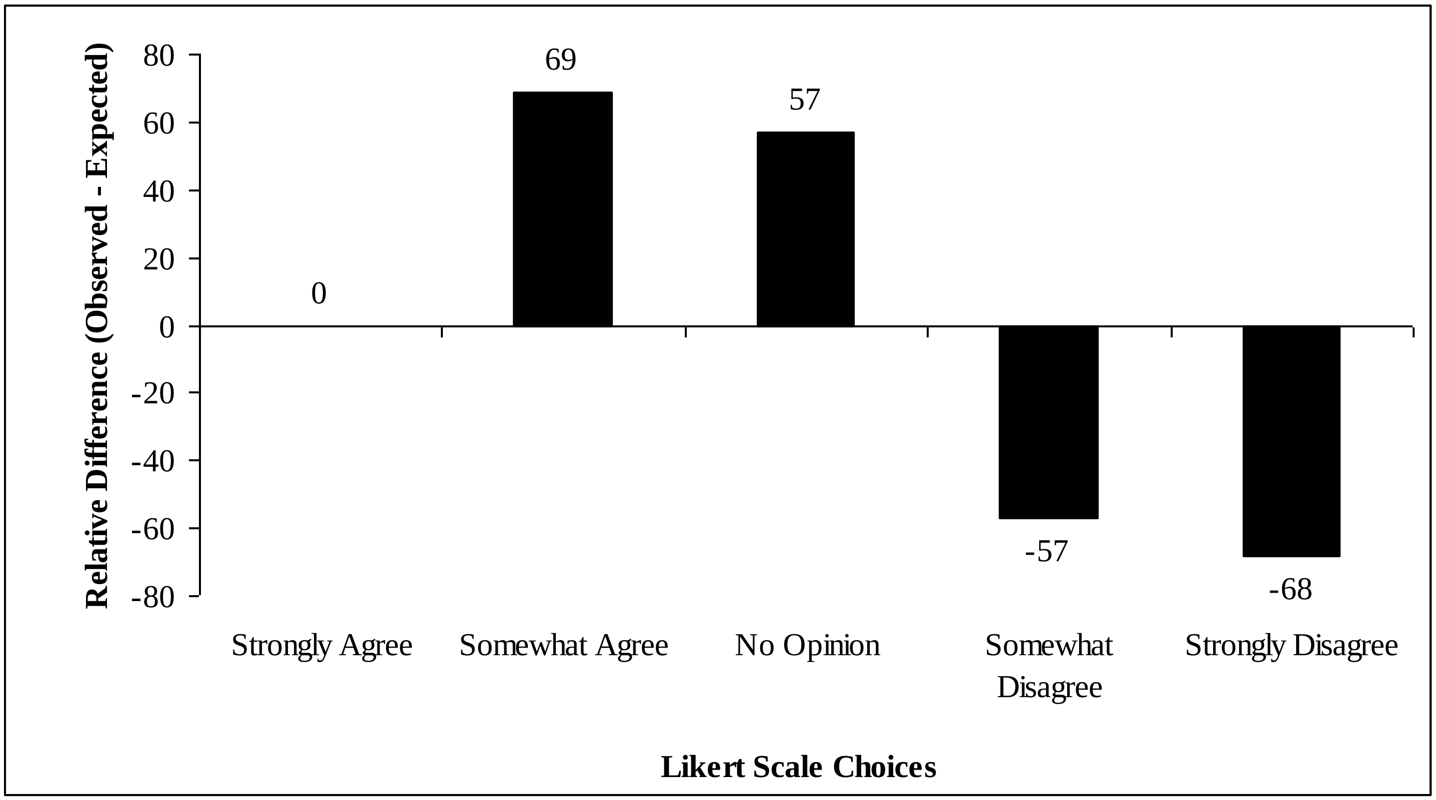


**Figure 3.26.** The percentage of total responses for each Likert Scale response category for Question 24 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Should the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) be monitoring wild waterfowl for the presence of bird flu?” (*N* = 367)

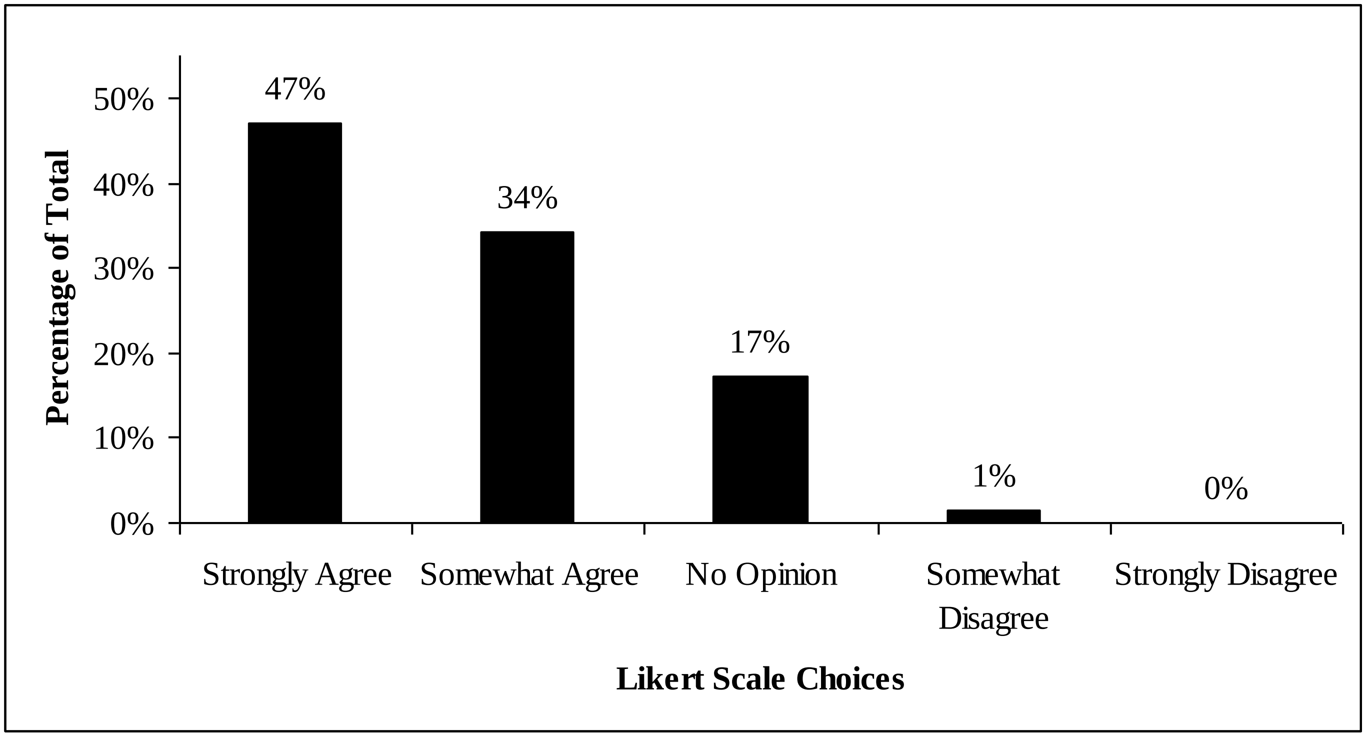


**Figure 3.27.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 24 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Should the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) be monitoring wild waterfowl for the presence of bird flu?"

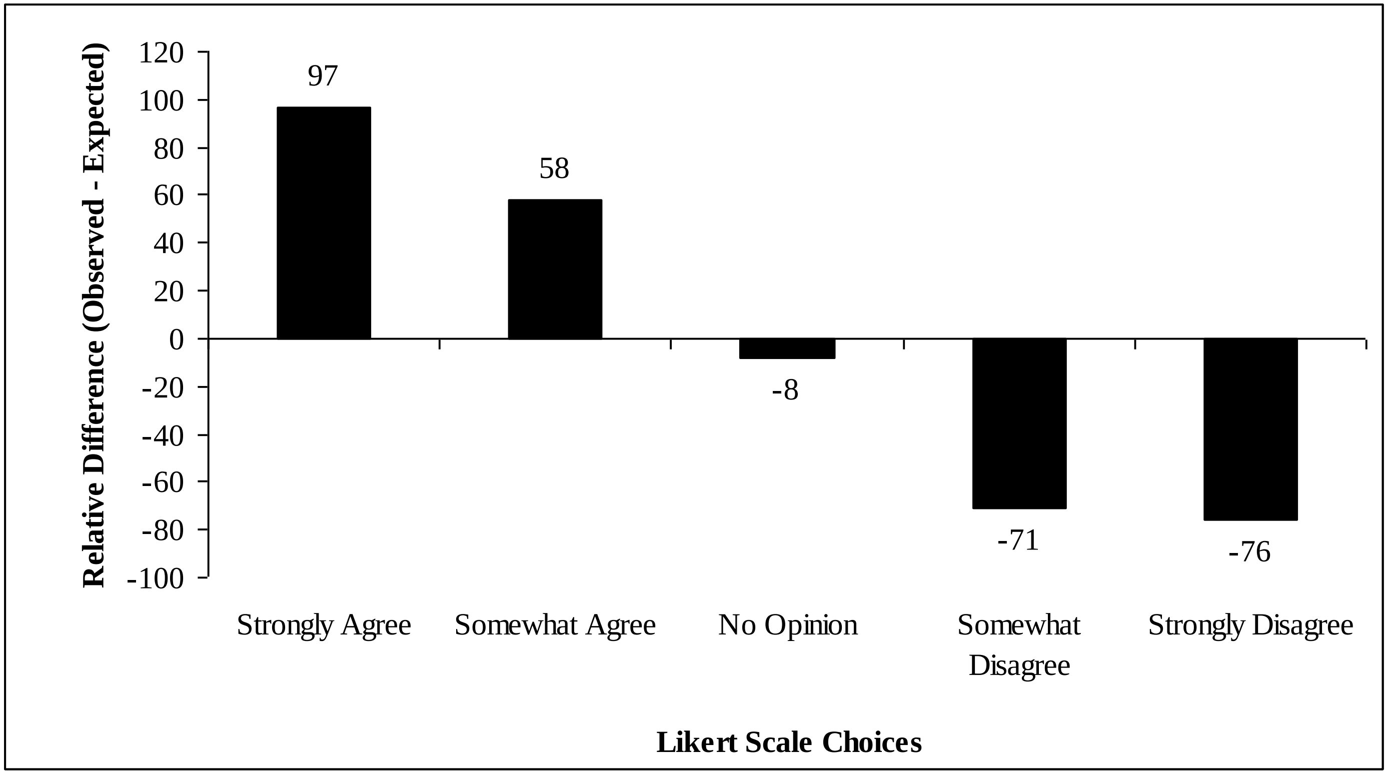


**Figure 3.28.** The percentage of total responses for each Likert Scale response category for Question 25 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Should the Kansas Department of Agriculture (KDA) monitor domestic fowl for bird flu?" (*N* = 366)

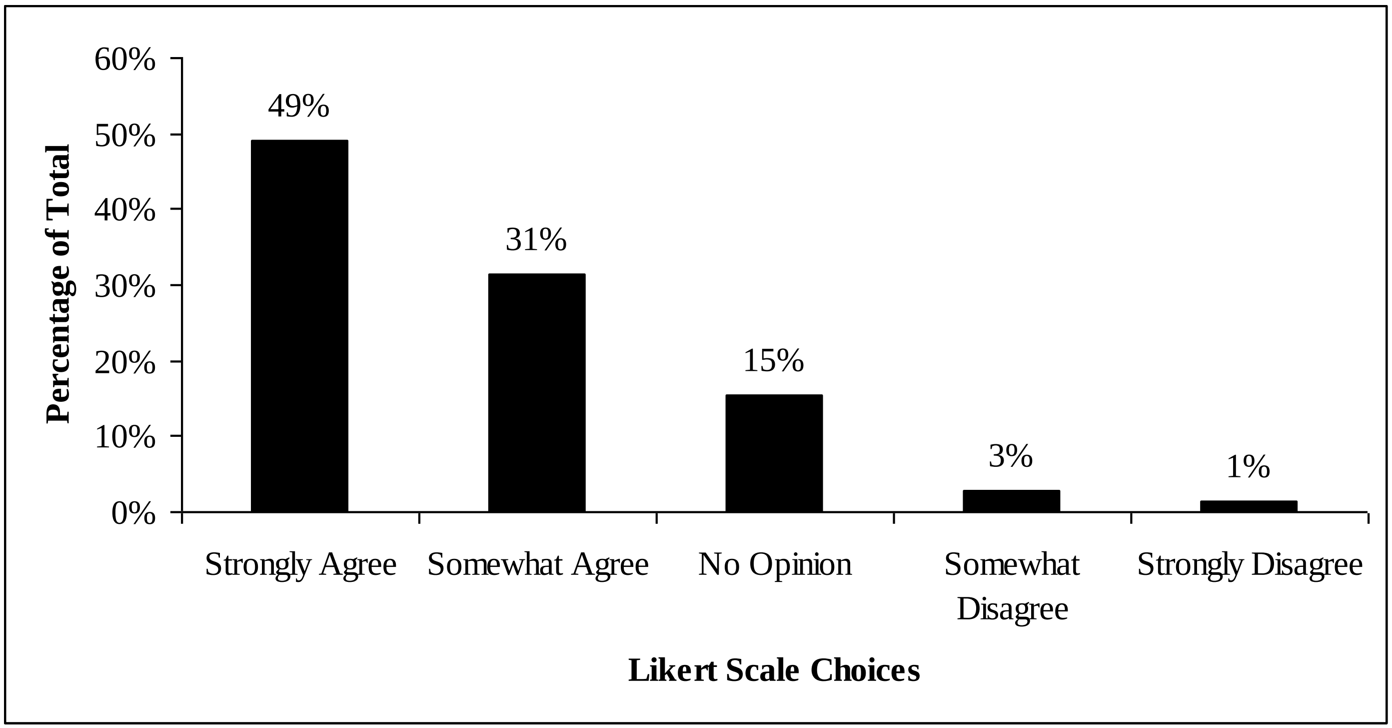


**Figure 3.29.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 25 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Should the Kansas Department of Agriculture (KDA) be monitoring domestic fowl for bird flu?”

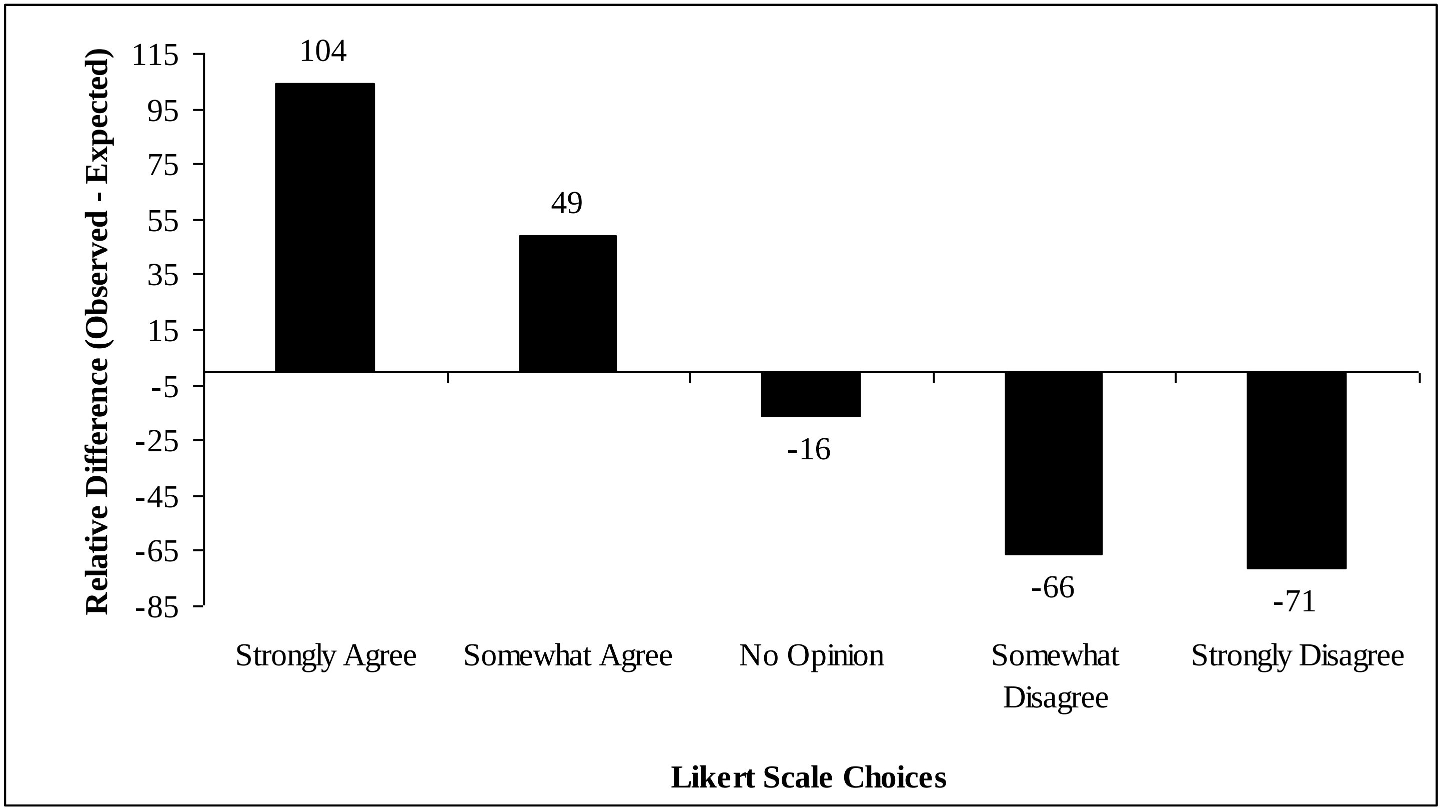


**Figure 3.30.** The percentage of total responses for each Likert Scale response category for Question 11 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Do you think that bird flu could be a significant factor affecting the health of North American waterfowl populations?" ($N$ = 378)

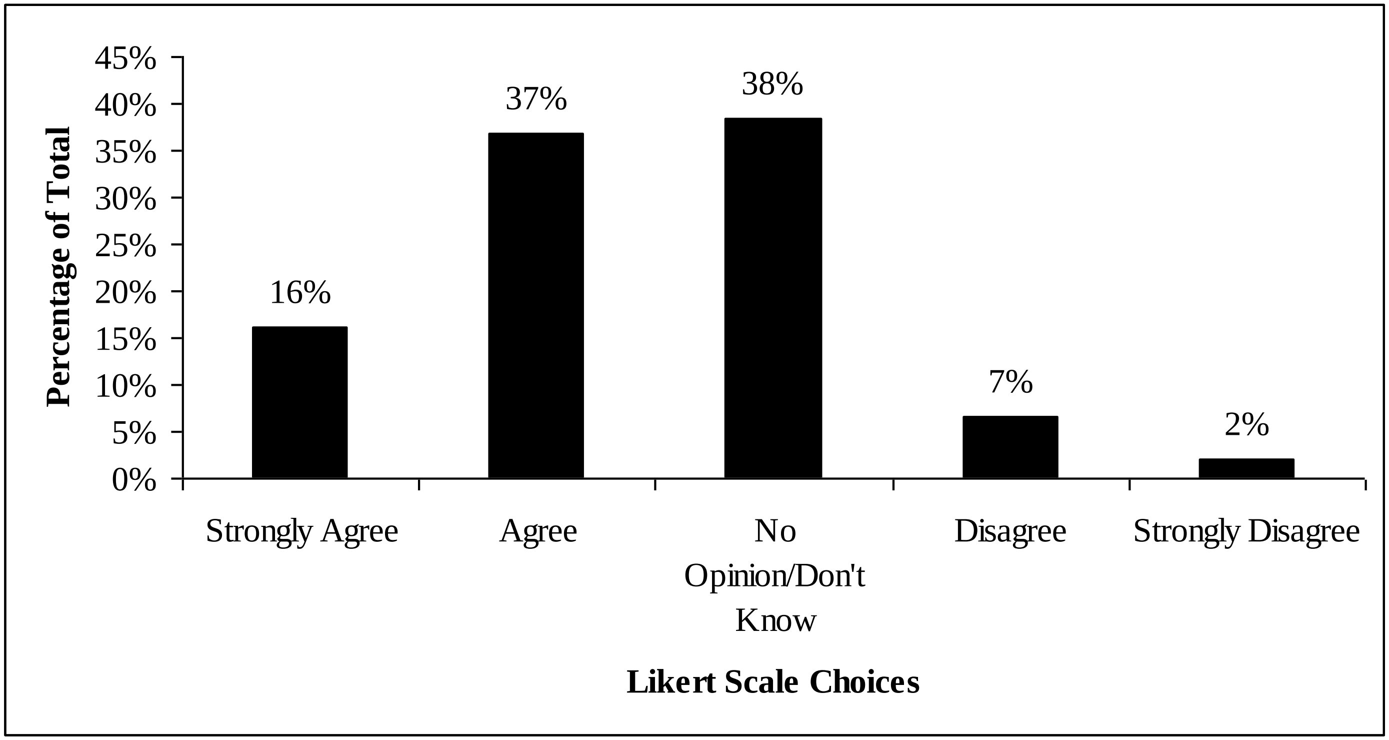


**Figure 3.31.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 11 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “Do you think that bird flu could be a significant factor affecting the health of North American waterfowl populations?”

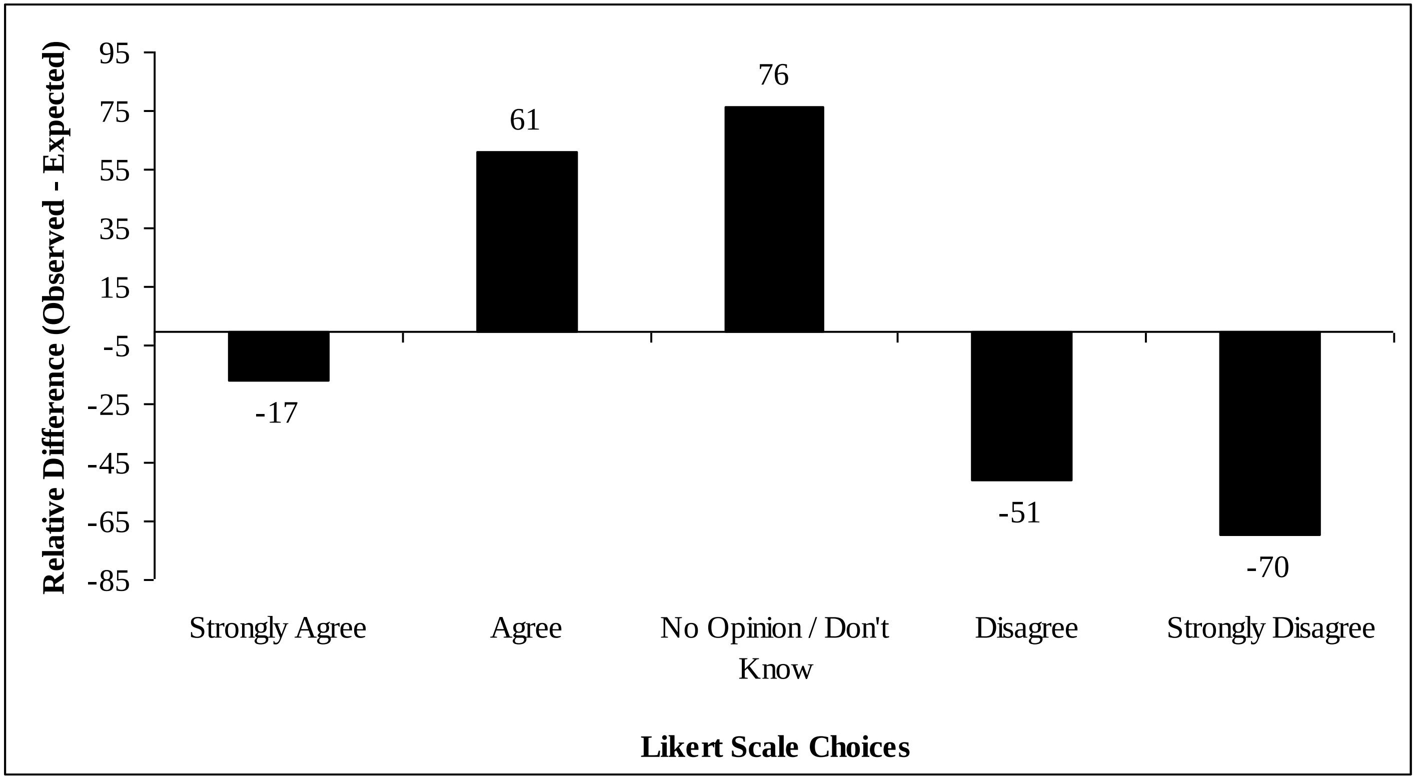


**Figure 3.32.** The percentage of total responses for each Likert Scale response category for Question 12 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are you concerned that the United States Fish and Wildlife Service (USFWS) will close waterfowl seasons due to bird flu?" (*N* = 378)

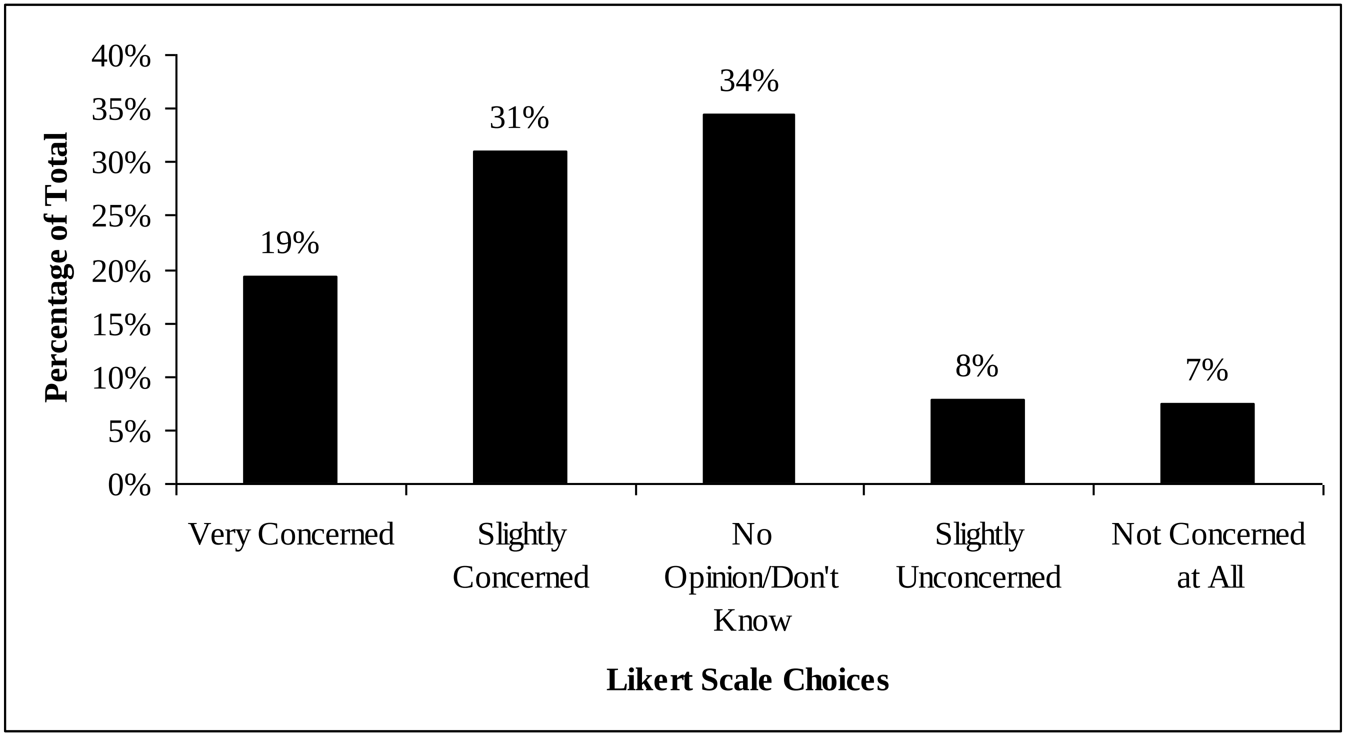


**Figure 3.33.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 12 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are you concerned that the United States Fish and Wildlife Service (USFWS) will close waterfowl seasons due to bird flu?"

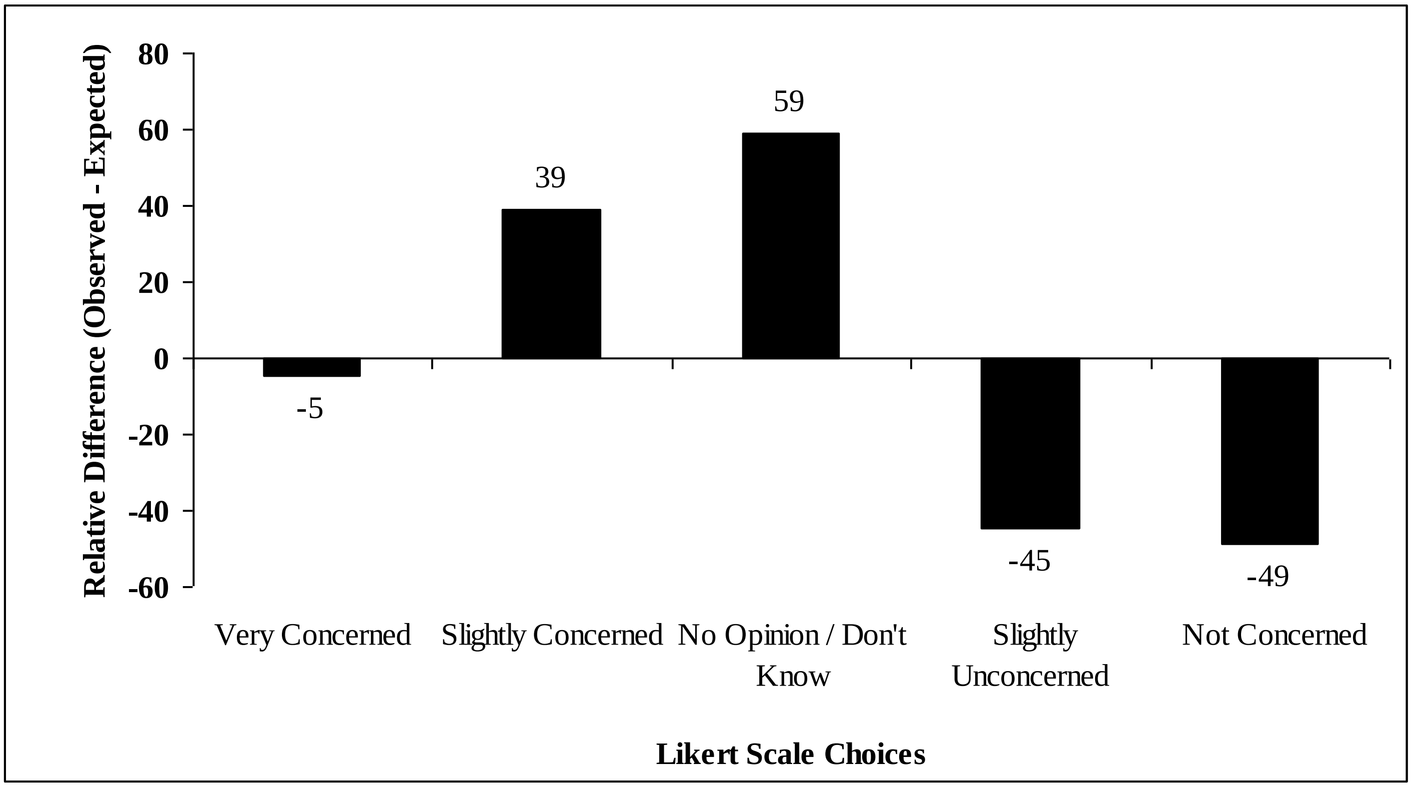


**Figure 3.34.** The percentage of total responses for each Likert Scale response category for Question 13 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are you concerned that the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) will close waterfowl seasons due to bird flu?" ($N$ = 379)

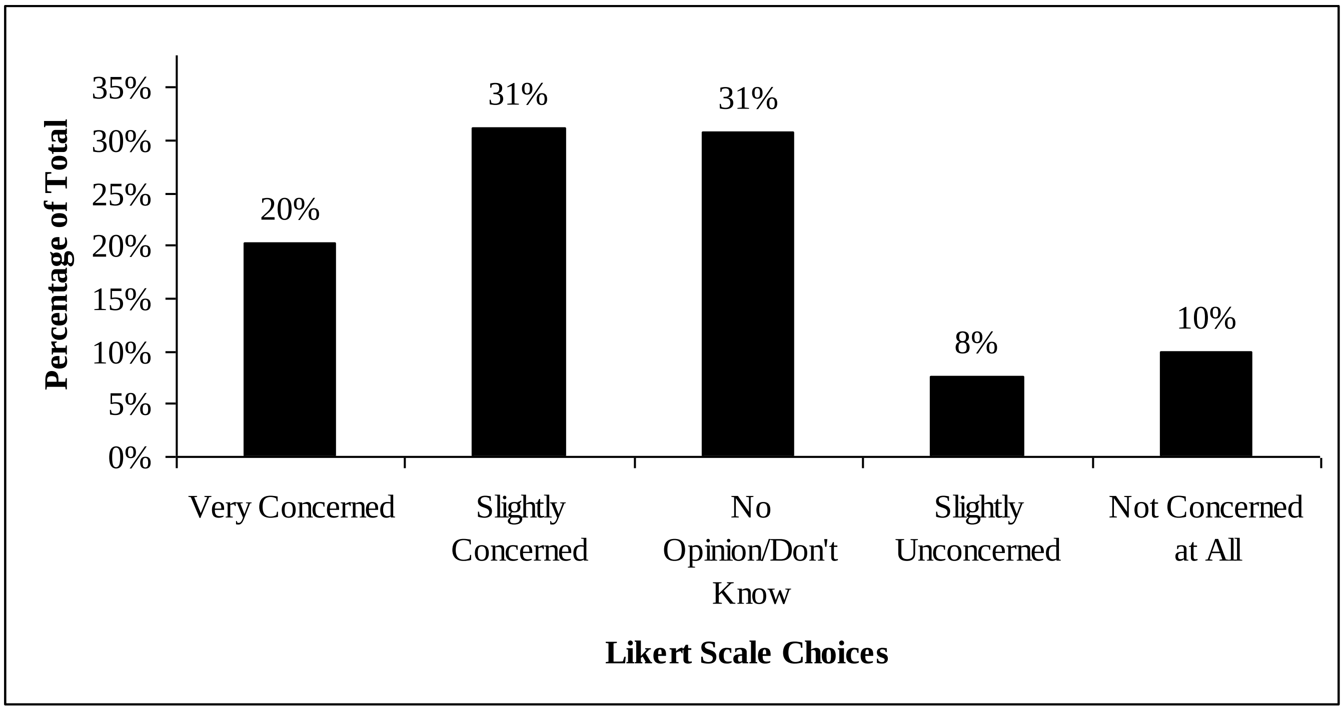


**Figure 3.35.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 13 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "Are you concerned that the Kansas Department of Wildlife, Parks, and Tourism (KDWPT) will close waterfowl seasons due to bird flu?"

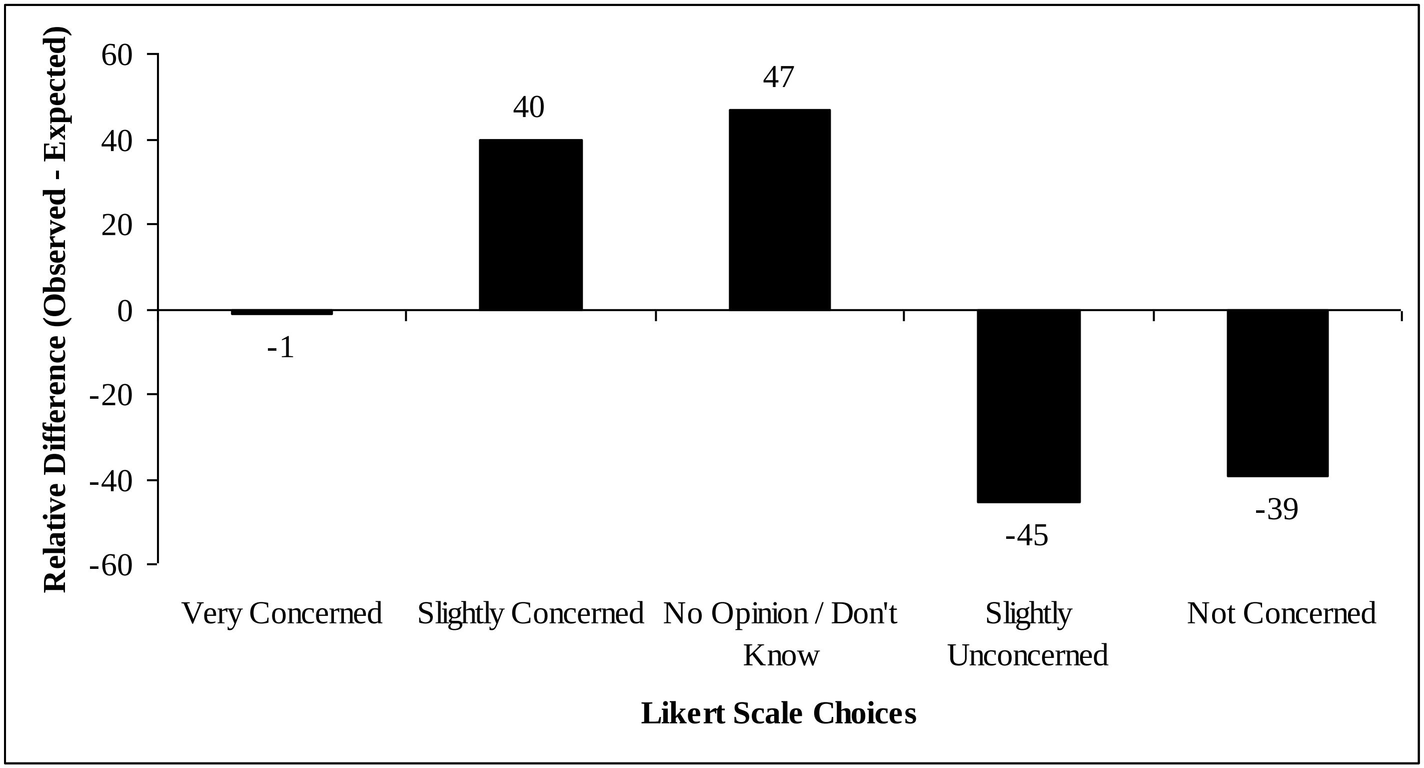


**Figure 3.36.** The percentage of total responses for each Likert Scale response category for Question 14 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "If you did not hunt waterfowl at all during the 2006 – 2007 or 2007 – 2008 waterfowl season, did bird flu have anything to do with your decision?" (*N* = 170)

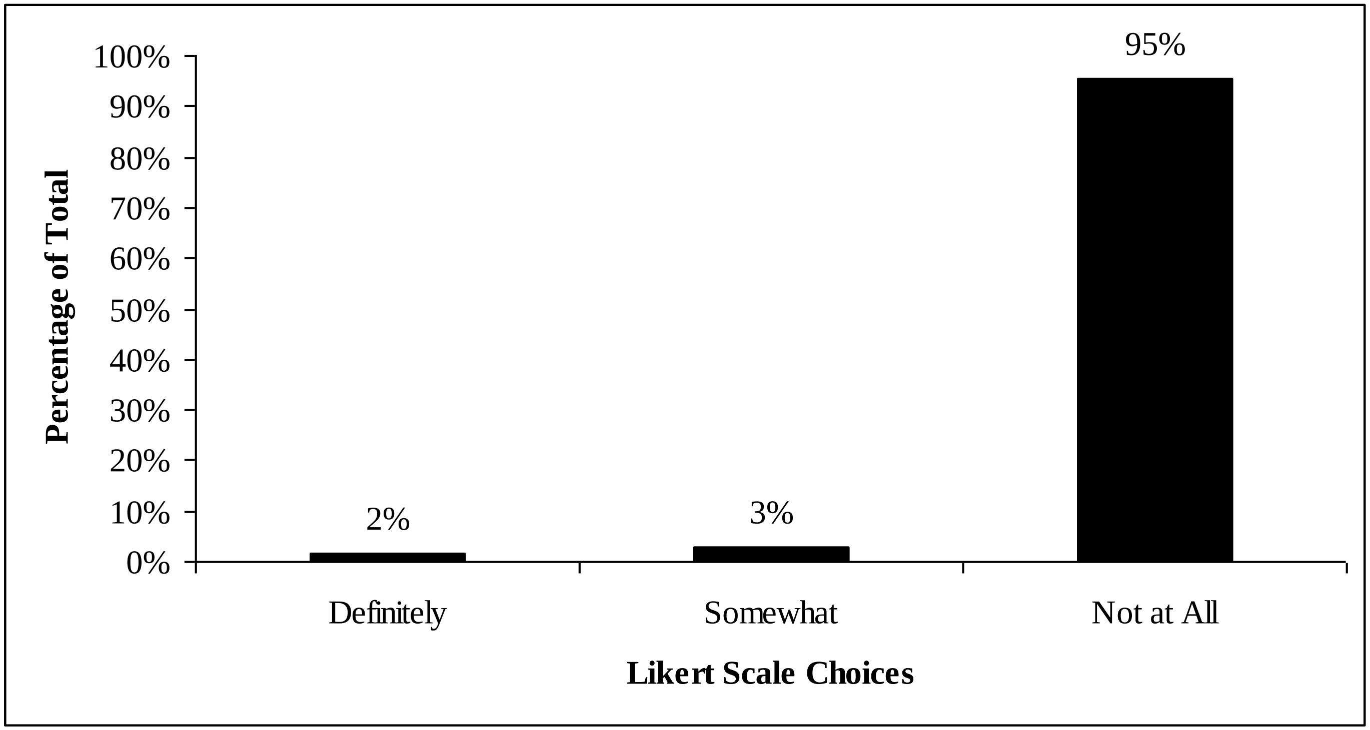


**Figure 3.37.** The relative difference from the expected values of the Likert Scale choices for the Chi-square goodness-of-fit analysis of Question 14 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: “If you did not hunt waterfowl at all during the 2006-2007 or 2007-2008 waterfowl season, did bird flu have anything to do with your decision?”

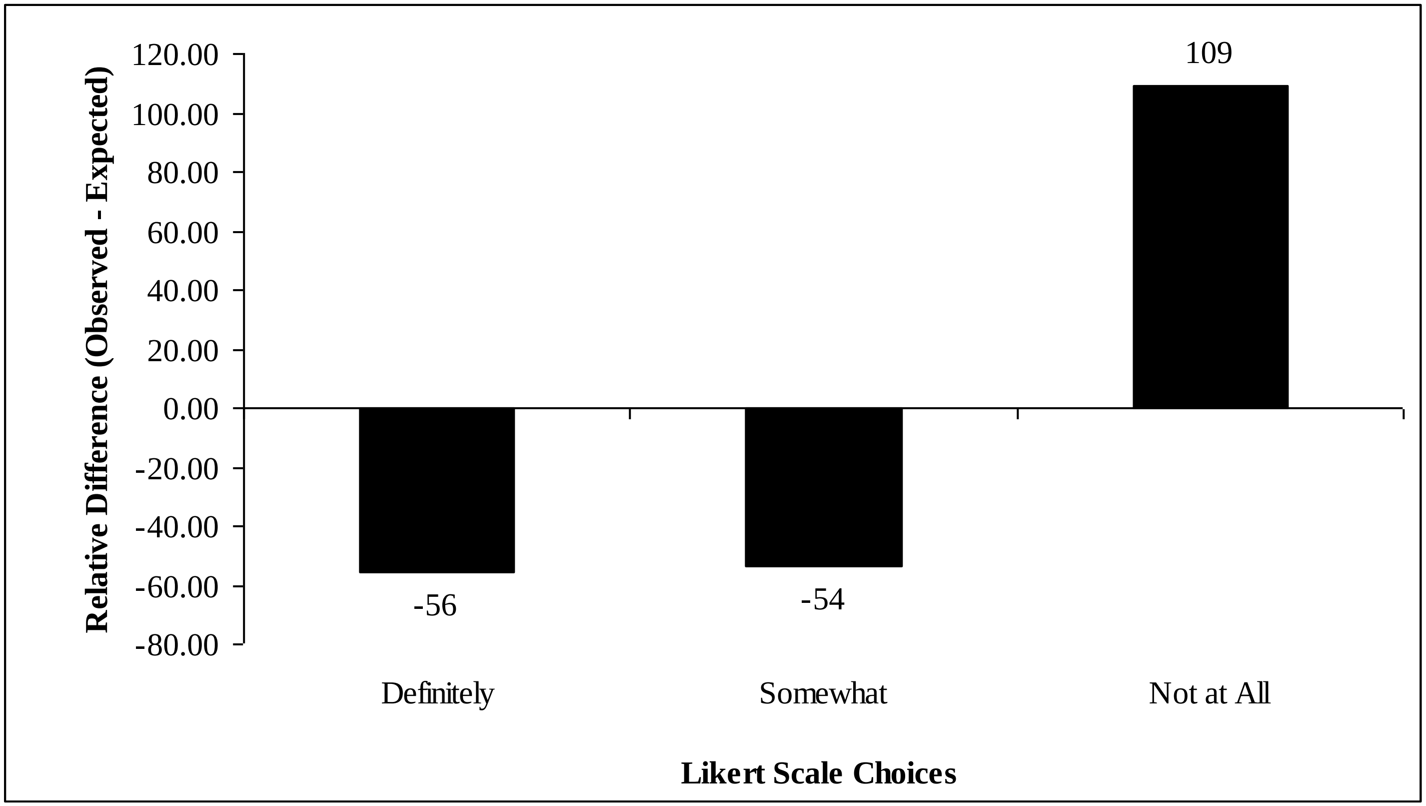


**Figure 3.38.** The percentage of total responses for each reason people chose not to hunt in Question 15 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "If you chose not to hunt waterfowl at all during the 2006-2007 or 2007-2008 waterfowl seasons, please select the one reason that contributed most to your decision not to hunt." (*N* = 122)

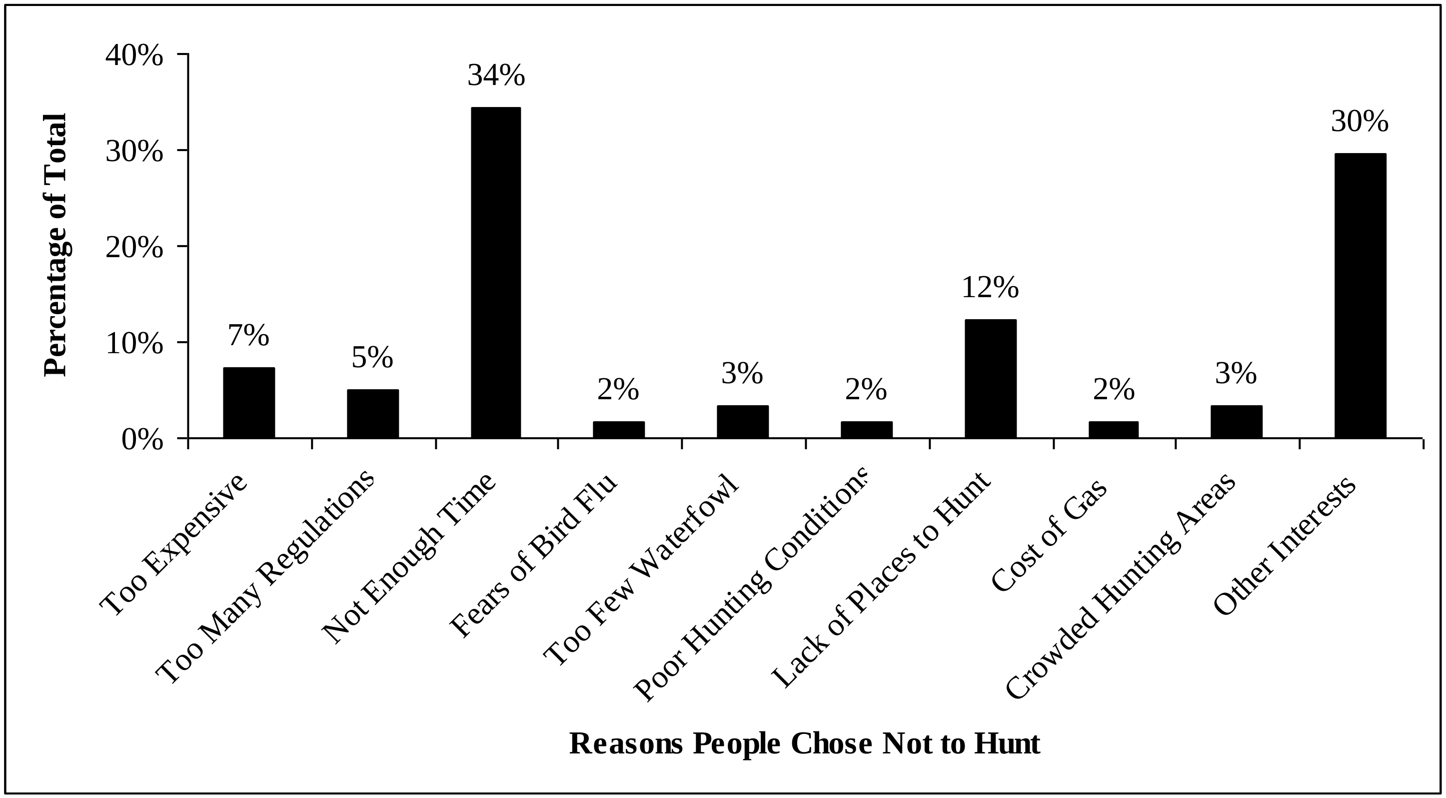


**Figure 3.39.** The percentage each reason people chose not to hunt ranked as High, Medium, or Low in Question 16 of the survey assessing waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation: "If you chose not to hunt waterfowl at all during the 2006-2007 or 2007-2008 waterfowl seasons, please rate the importance of the reasons why you did not hunt." (*N* = 111)

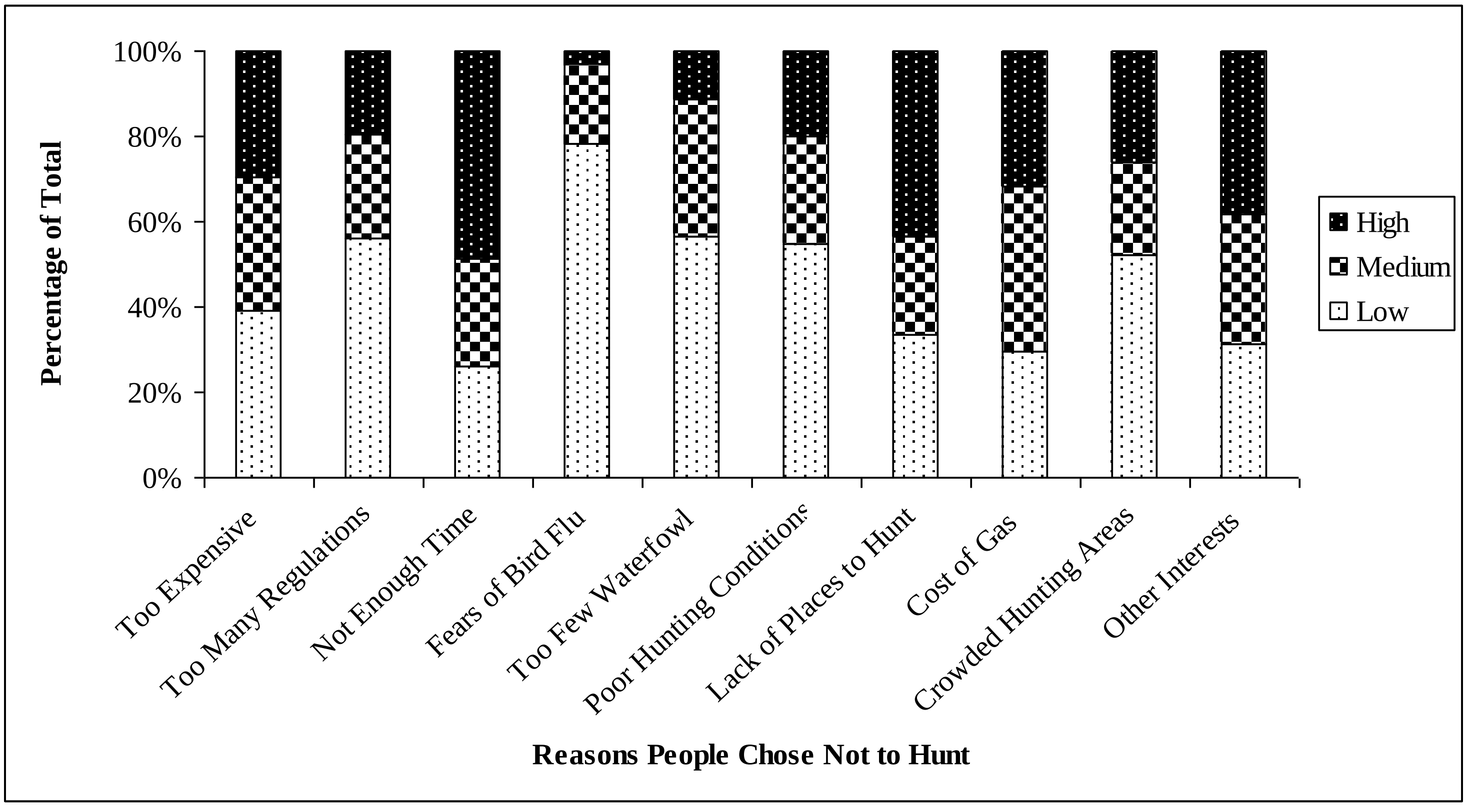


**Figure 4.1.** Percent occurrence (the number of gizzards with seed type "x" divided by the total number of gizzards with food, multiplied by 100) by category for all species (BUFF = bufflehead, GADW = gadwall, NOPI = Northern pintail, NOSH = Northern shoveler, REDH = redhead) of waterfowl gizzard contents collected during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area (*N* = 103).

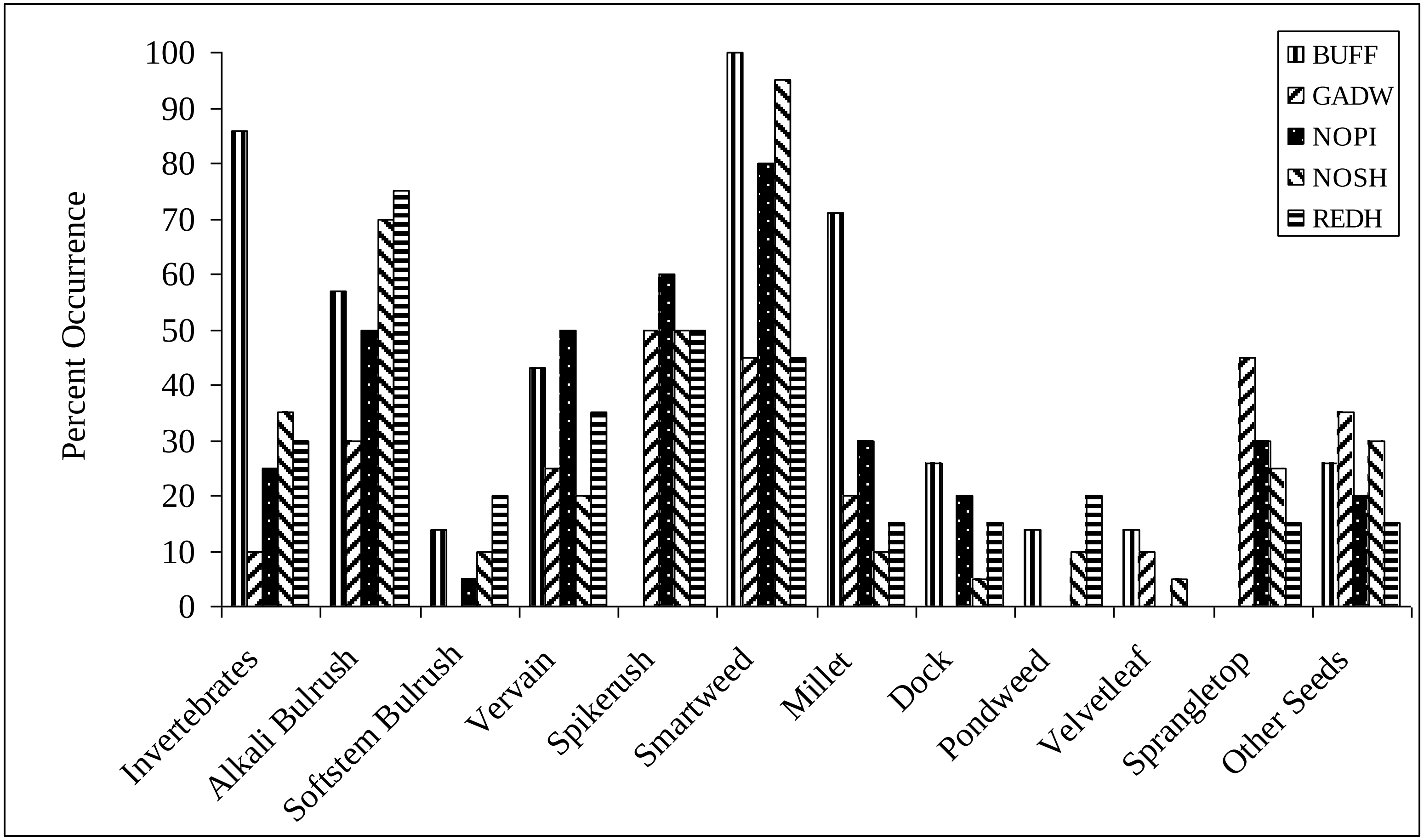


**Figure 4.2.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among American wigeon (AMWI), blue-winged teal (BWTE), American green-winged teal (GWTE), and Northern shoveler (NOSH) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

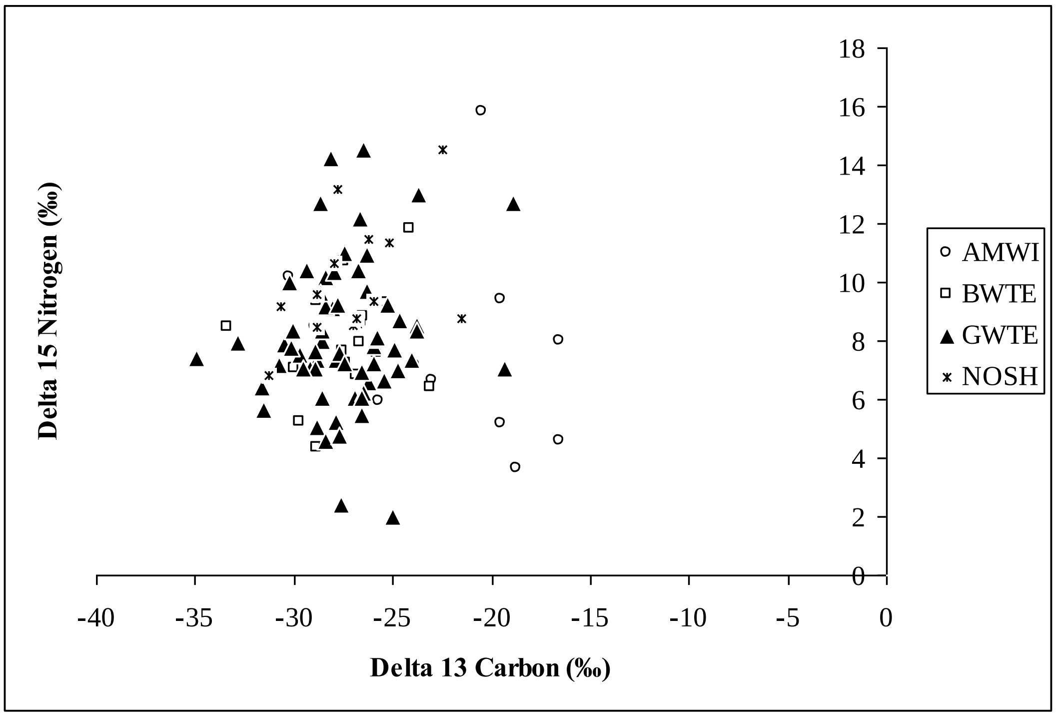


**Figure 4.3.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among blue-winged teal (BWTE), gadwall (GADW), mallard (MALL), and redhead (REDH) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

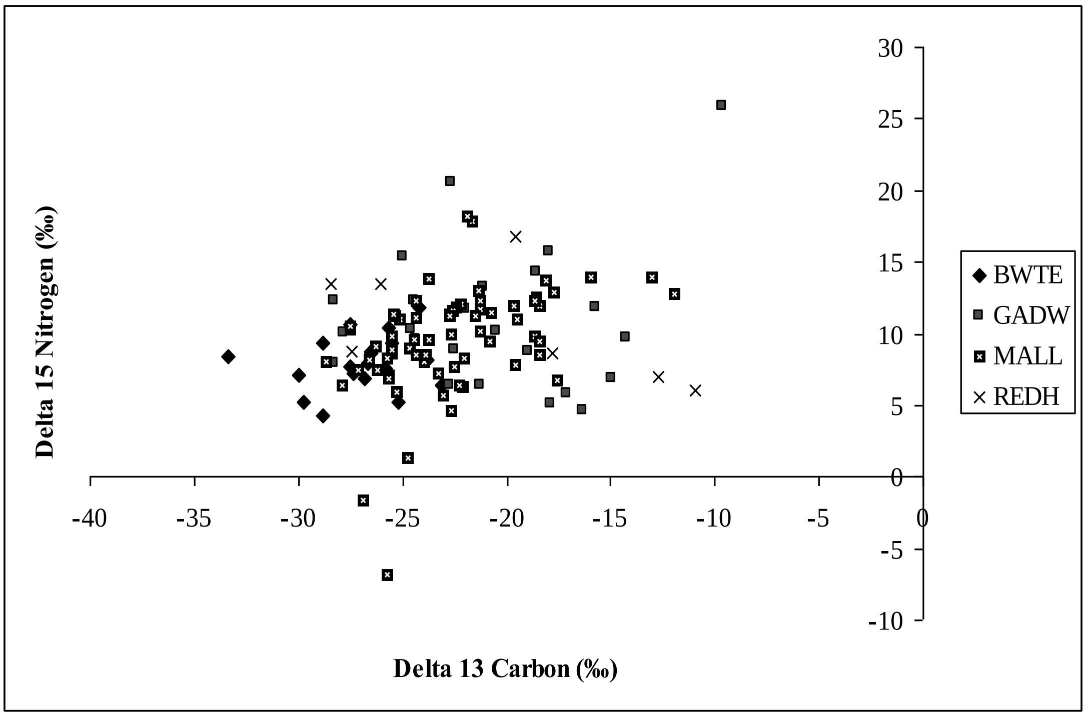


**Figure 4.4.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among gadwall (GADW), American green-winged teal (GWTE), and Northern shoveler (NOSH) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

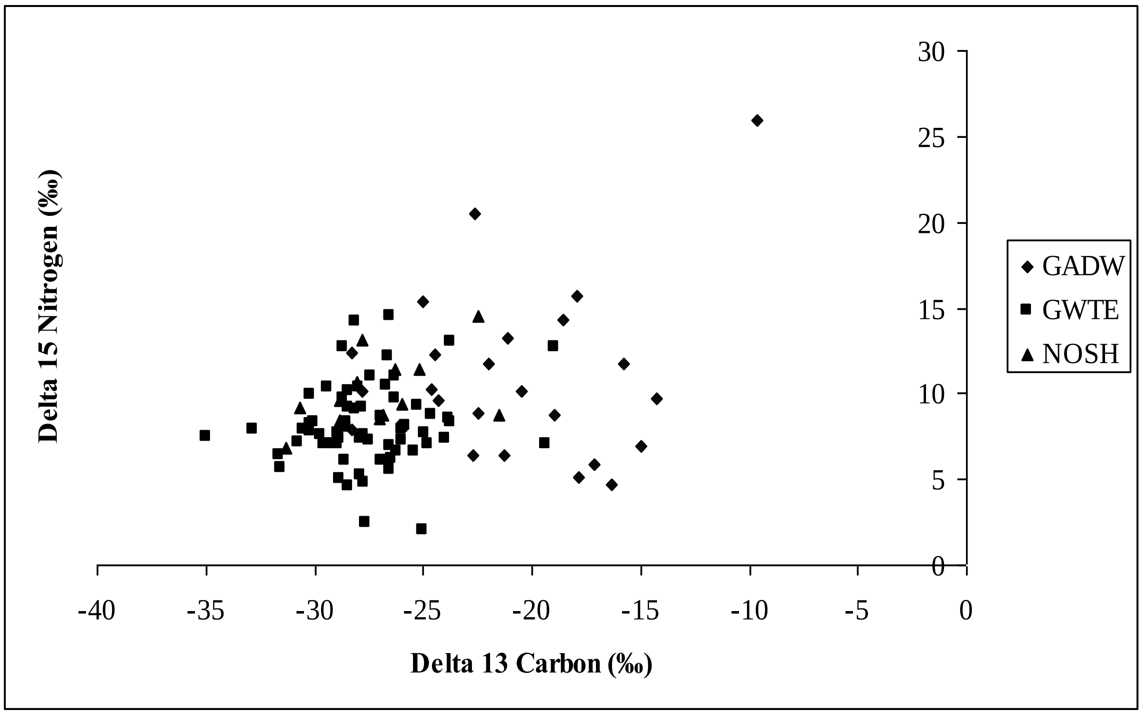


**Figure 4.5.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among American green-winged teal (GWTE), mallard (MALL), Northern pintail (NOPI), and redhead (REDH) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

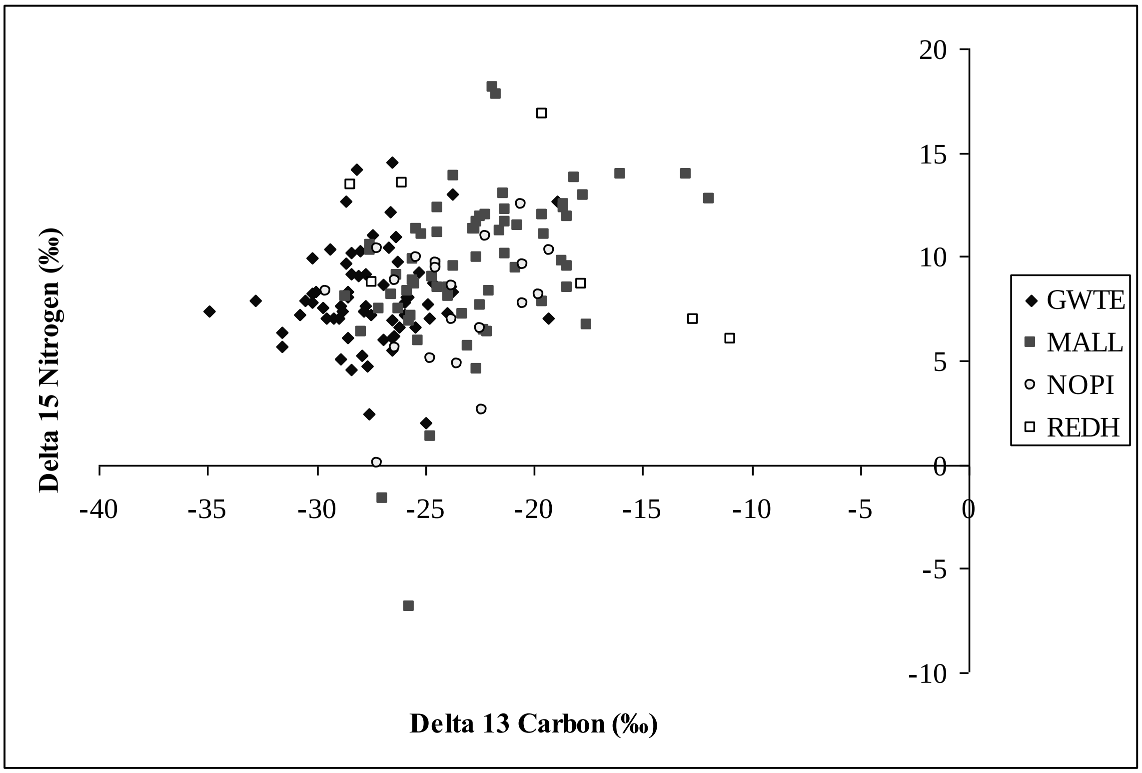


**Figure 4.6.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), between mallard (MALL) and Northern shoveler (NOSH) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

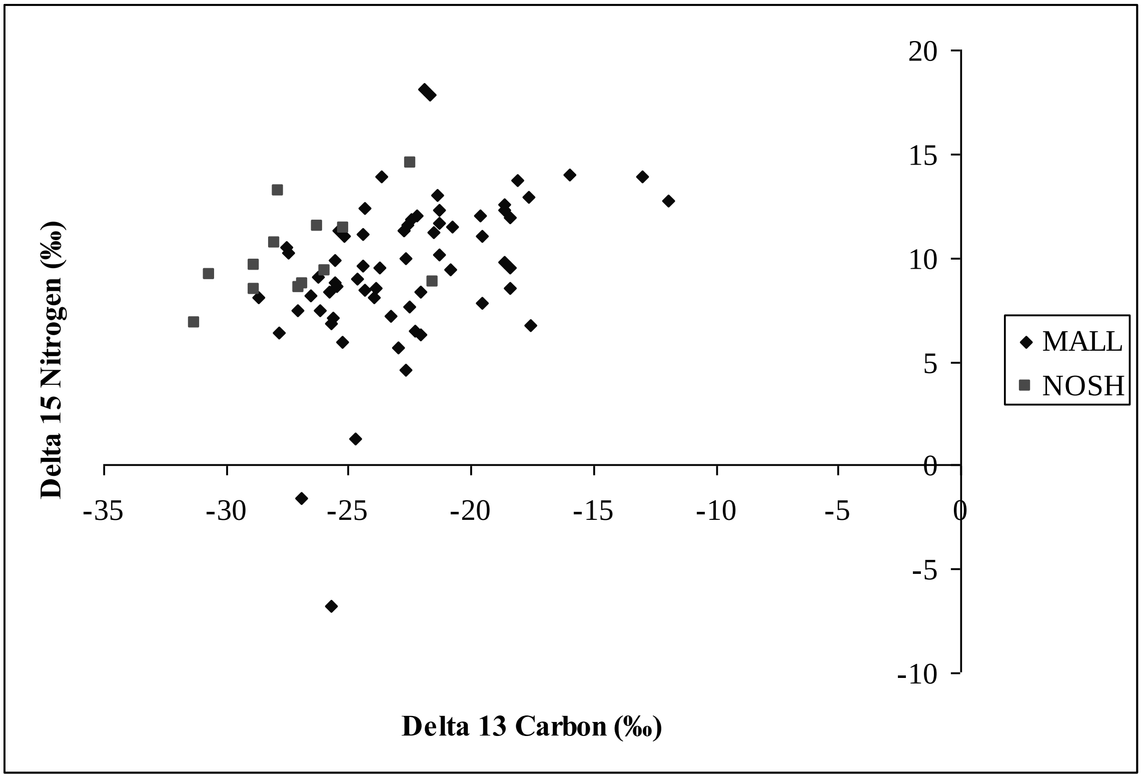


**Figure 4.7.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), between Northern shoveler (NOSH) and redhead (REDH) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

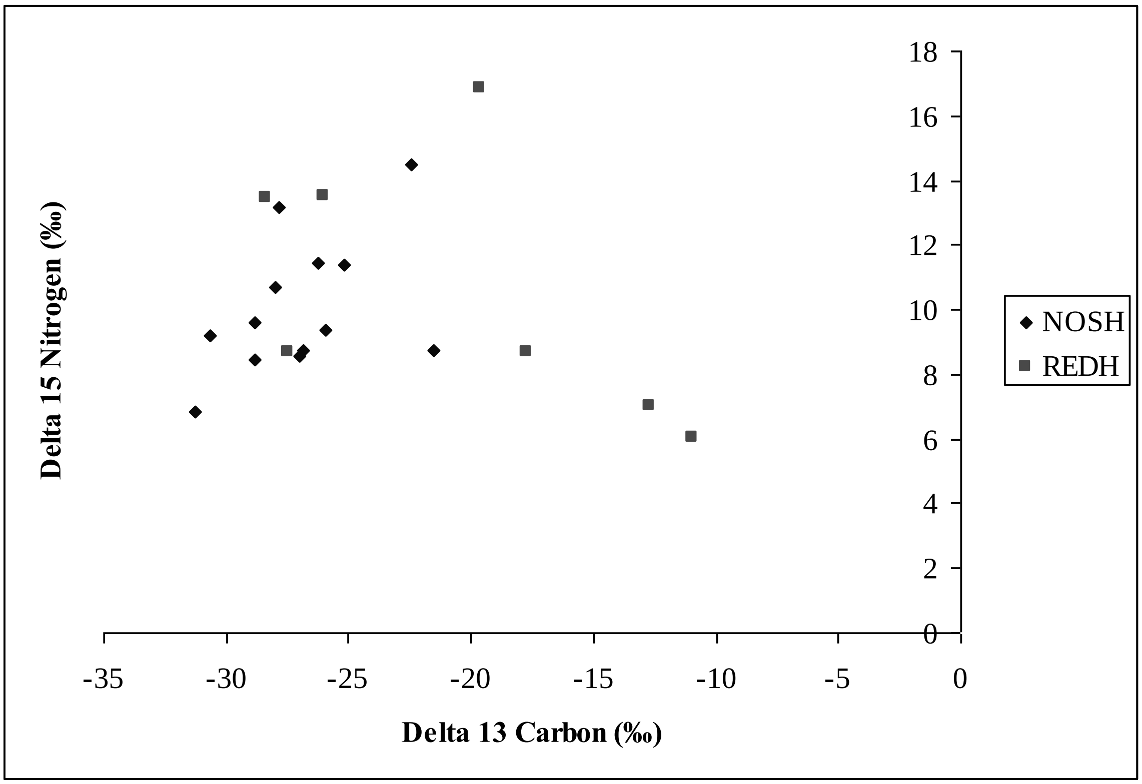


**Figure 4.8.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among American wigeon (AMWI), American green-winged teal (GWTE), and Northern shoveler (NOSH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

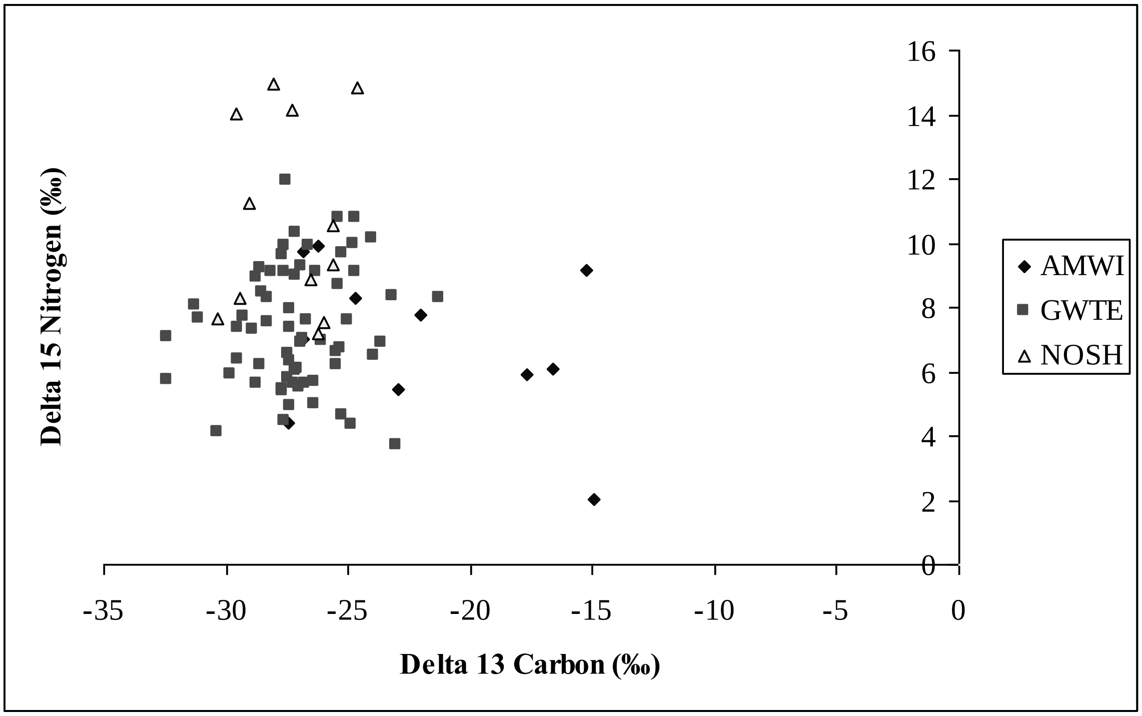


**Figure 4.9.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among bufflehead (BUFF), gadwall (GADW), and redhead (REDH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

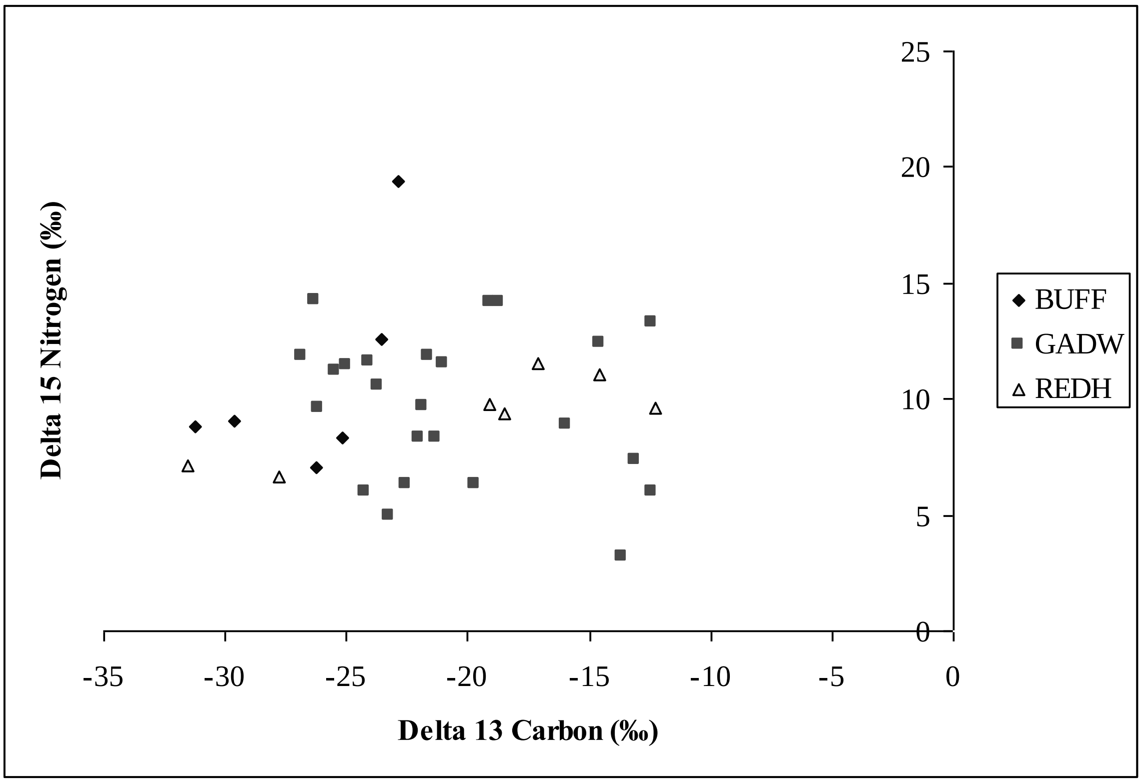


**Figure 4.10.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among blue-winged teal (BWTE), gadwall (GADW), and redhead (REDH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

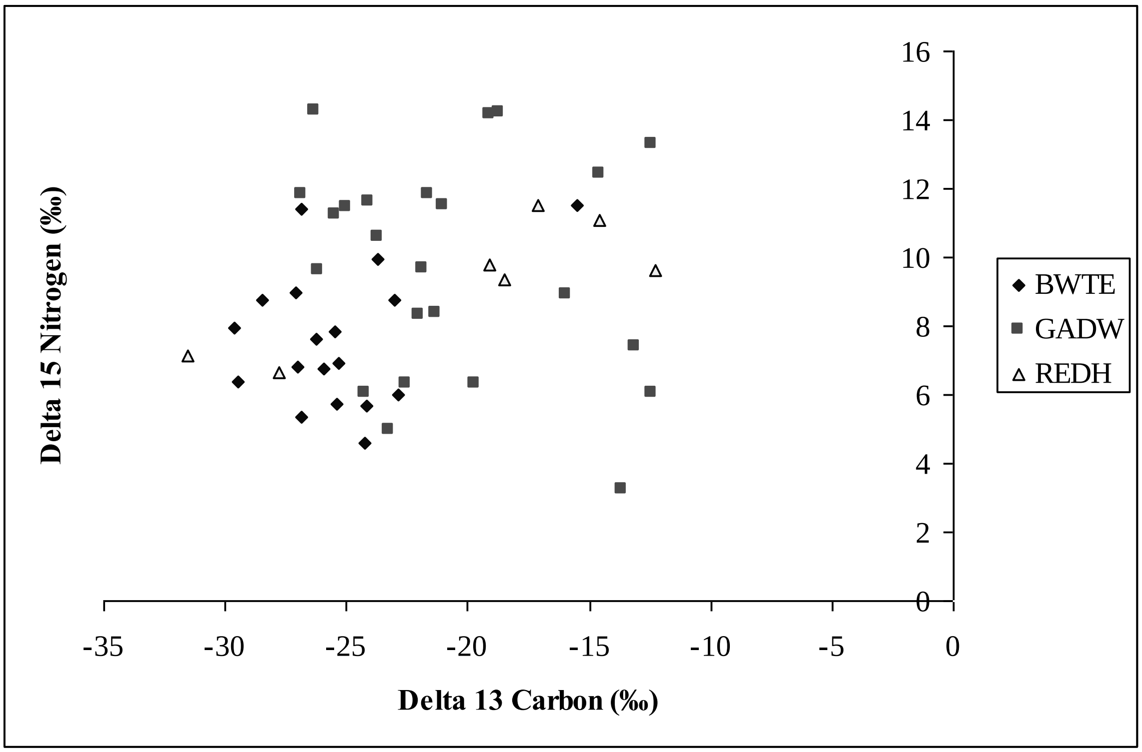


**Figure 4.11.** The relationship of δ[13]C and δ[15]N isotope feather values, in parts per mil (‰), among gadwall (GADW), American green-winged teal (GWTE), Northern pintail (NOPI), and Northern shoveler (NOSH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

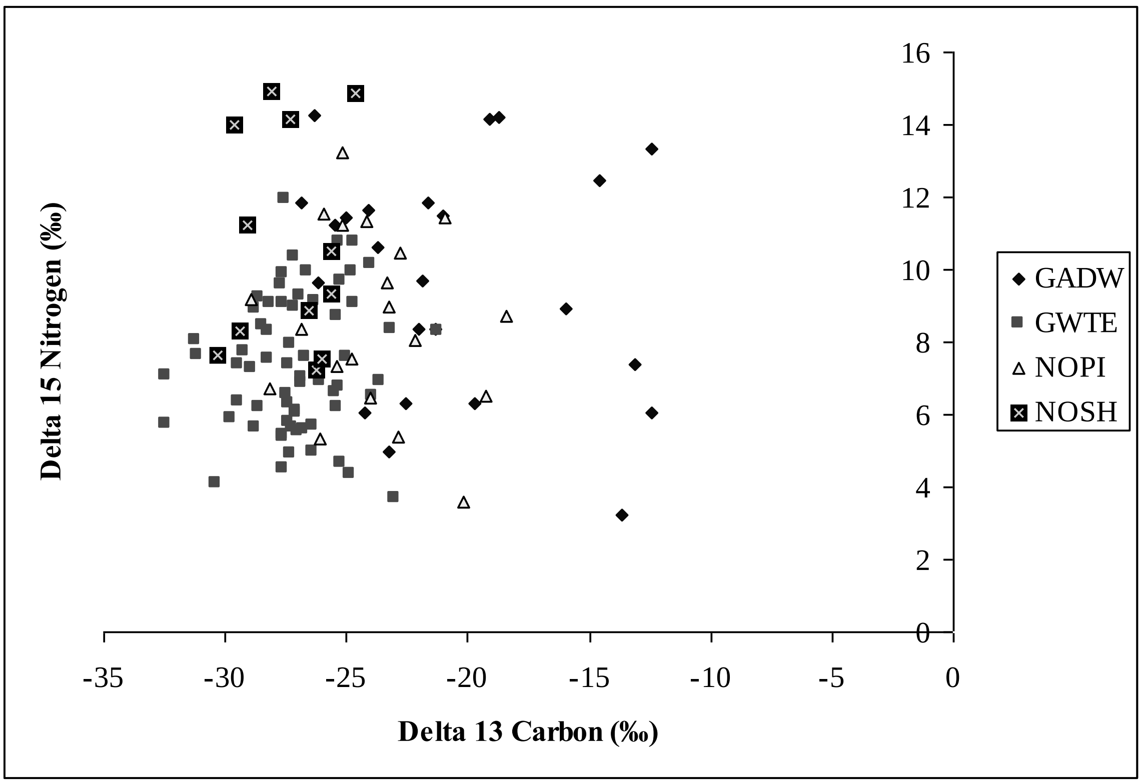


**Figure 4.12.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among American green-winged teal (GWTE), Northern pintail (NOPI), and redhead (REDH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

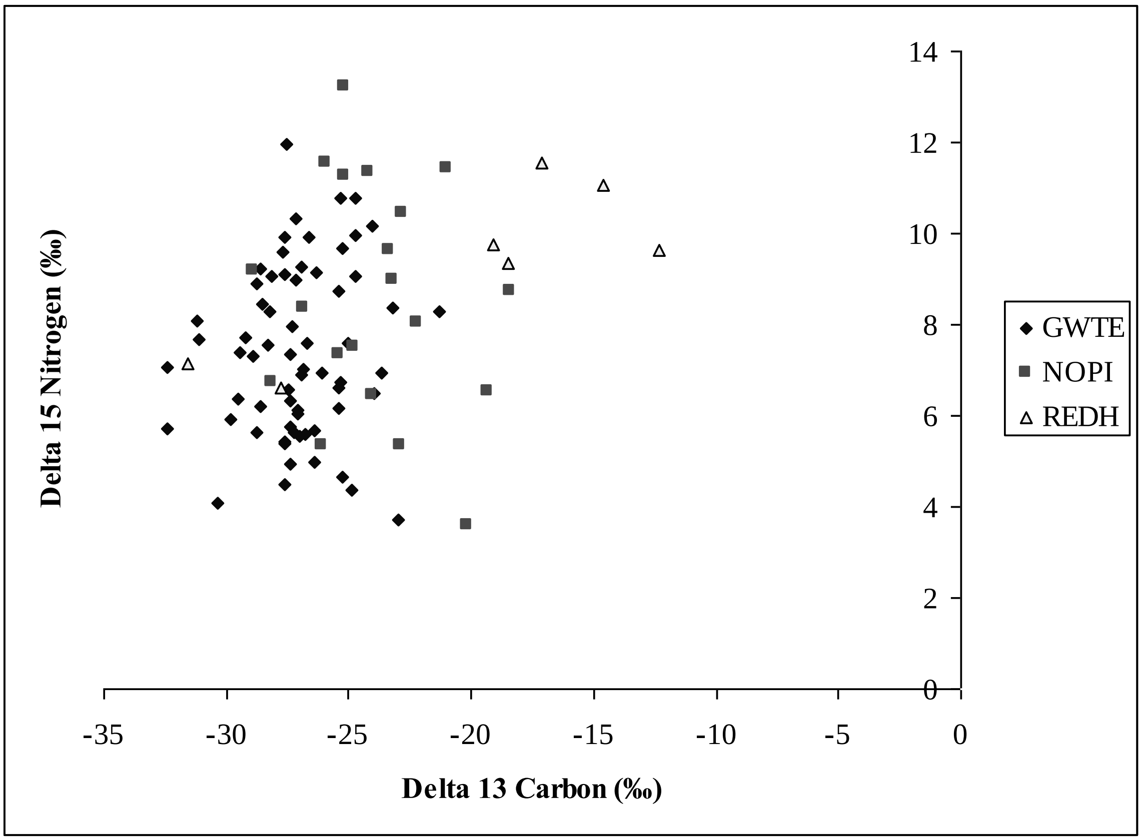


**Figure 4.13.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), between Northern shoveler (NOSH) and redhead (REDH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

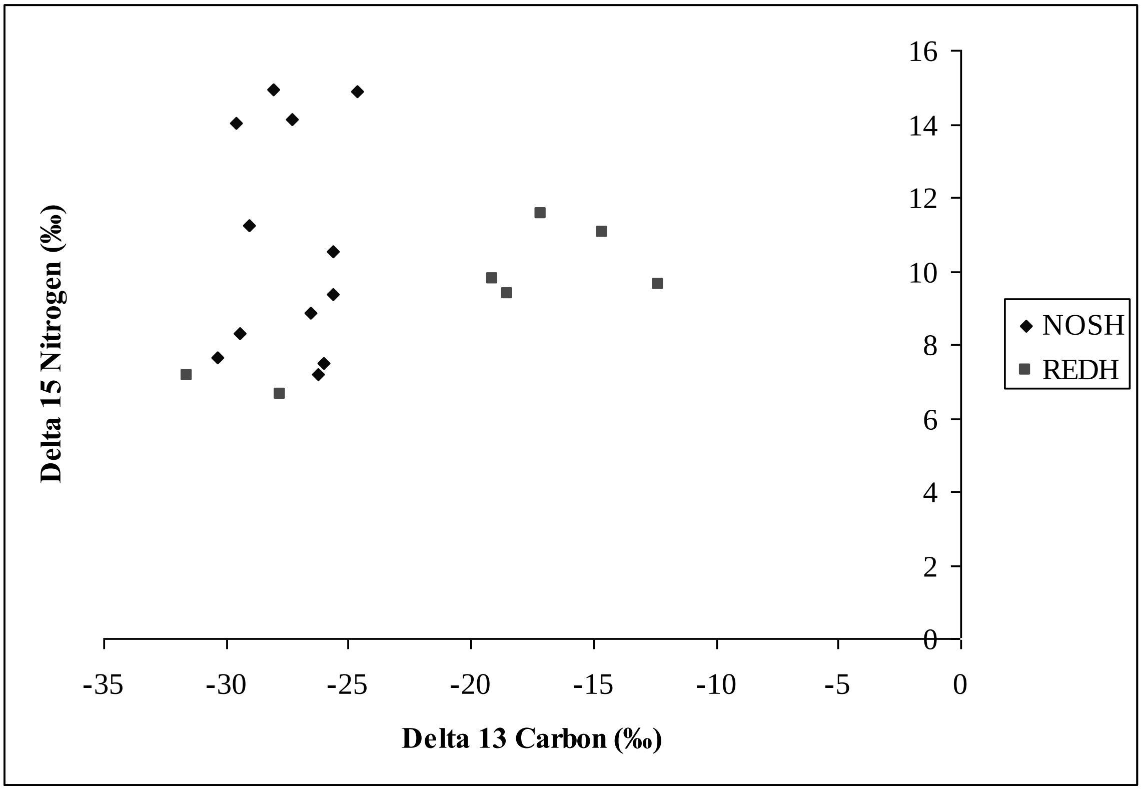


**Figure 4.14.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among gadwall (GADW), American green-winged teal (GWTE), and Northern pintail (NOPI) sampled during the 2007 waterfowl season at Cheyenne Bottoms Wildlife Area.

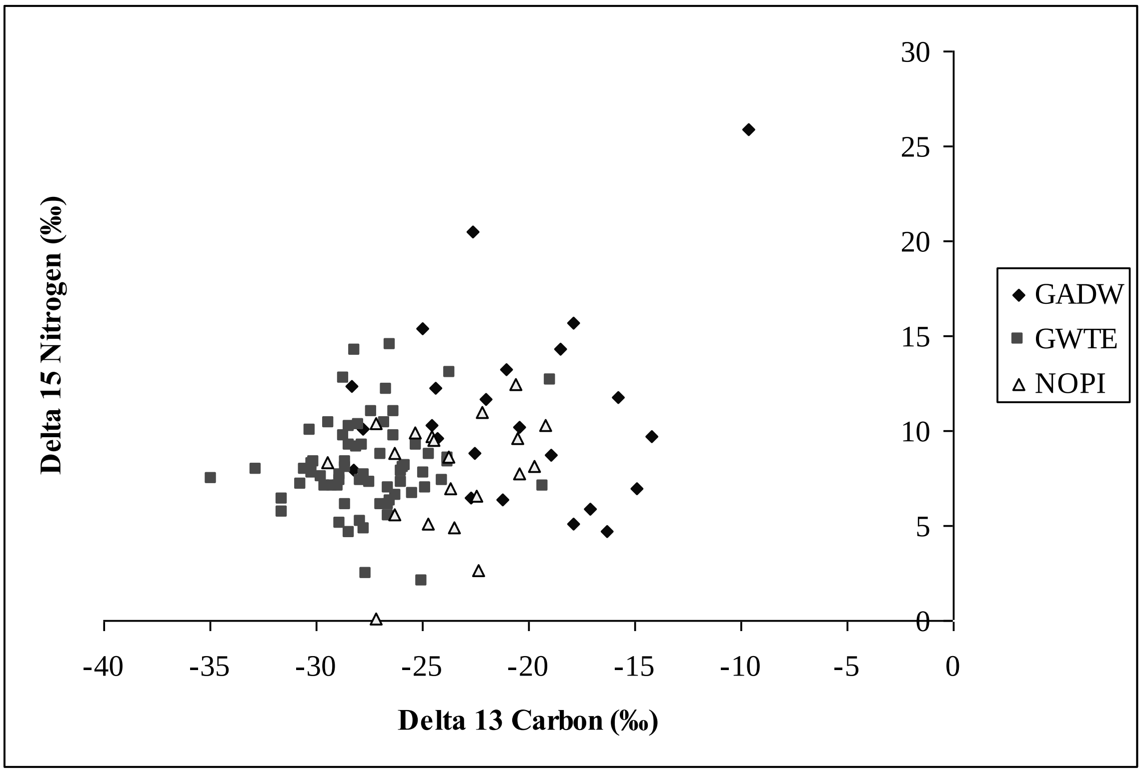


**Figure 4.15.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), among American wigeon (AMWI), gadwall (GADW), and Northern shoveler (NOSH) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

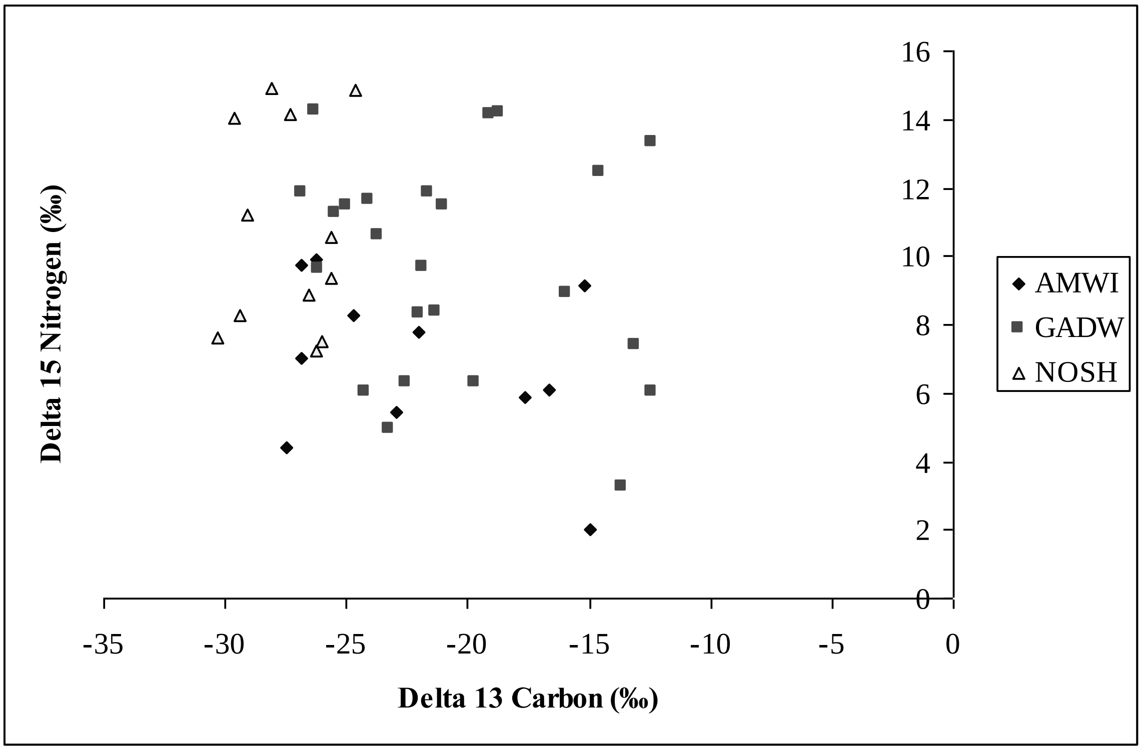


**Figure 4.16.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), between bufflehead (BUFF) and American green-winged teal (GWTE) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

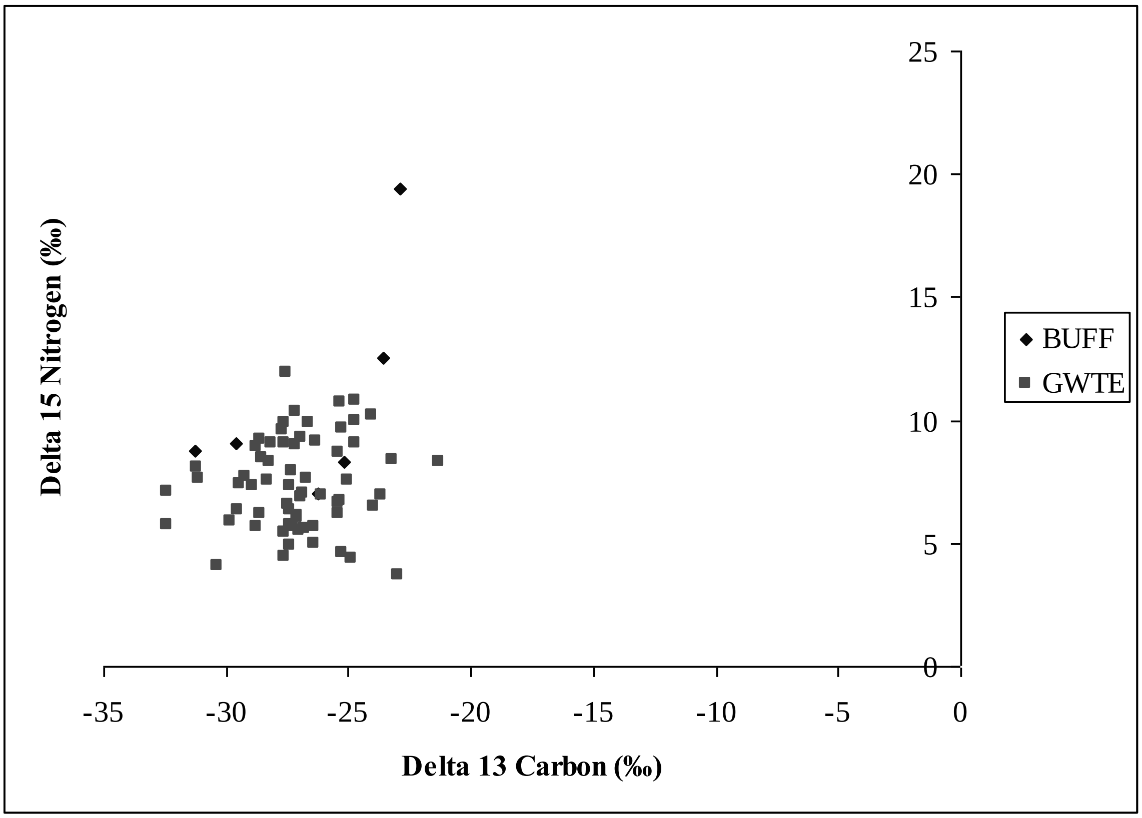


**Figure 4.17.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), between gadwall (GADW) and American green-winged teal (GWTE) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

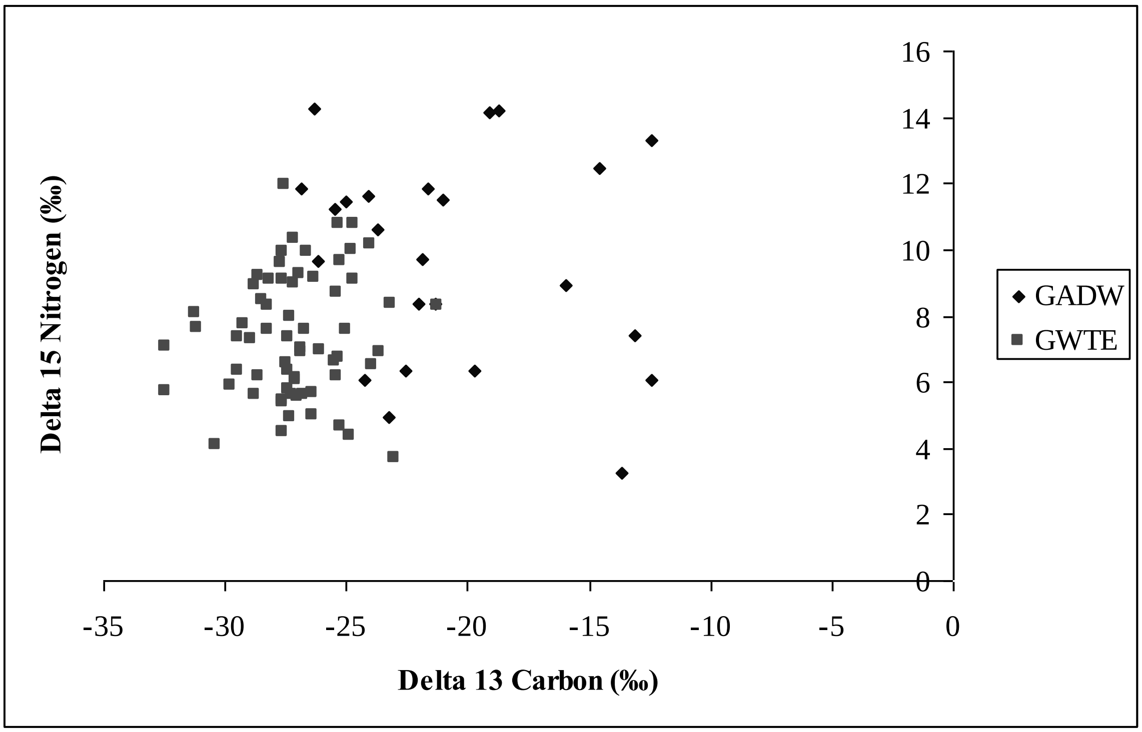


**Figure 4.18.** The relationship of $\delta^{13}C$ and $\delta^{15}N$ isotope feather values, in parts per mil (‰), between Northern shoveler (NOSH) and American green-winged teal (GWTE) sampled during the 2008 waterfowl season at Cheyenne Bottoms Wildlife Area.

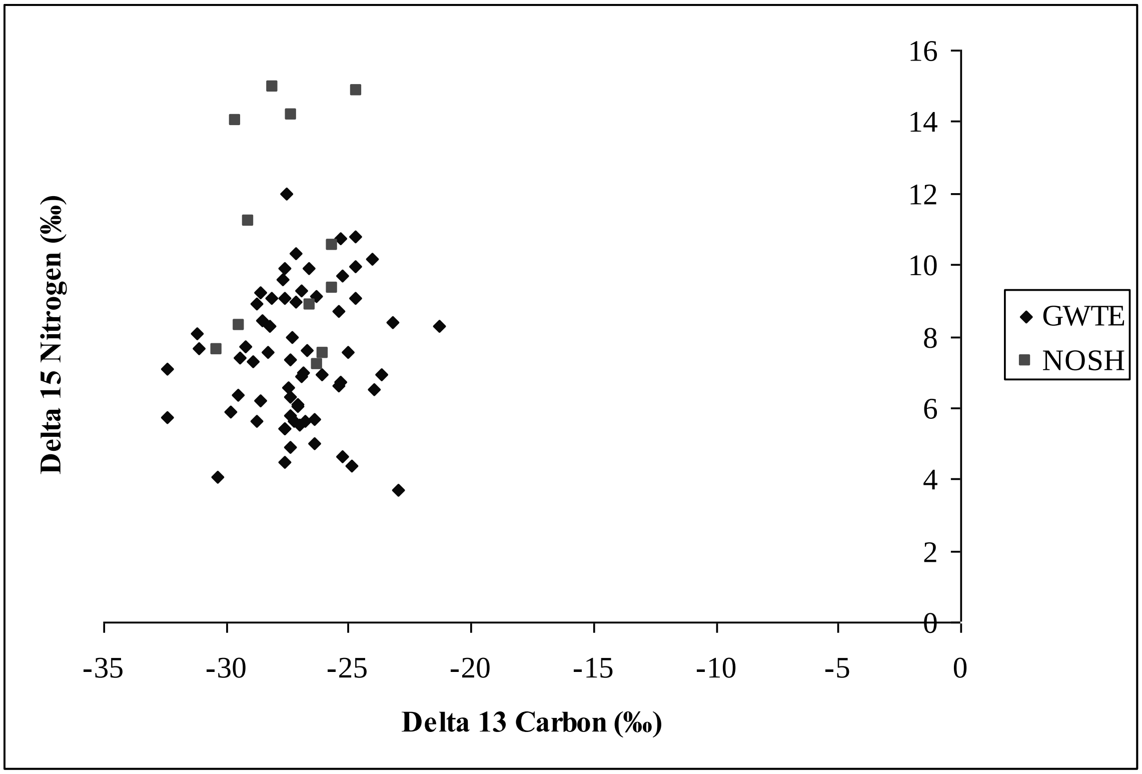


**Figure 4.19.** The proximity of the state of Kansas, the Cheyenne Bottoms Basin, and the Prairie Pothole Region, relative to the deuterium isoscape ($\delta^2H$, expressed in parts per mil [‰]) of North America.

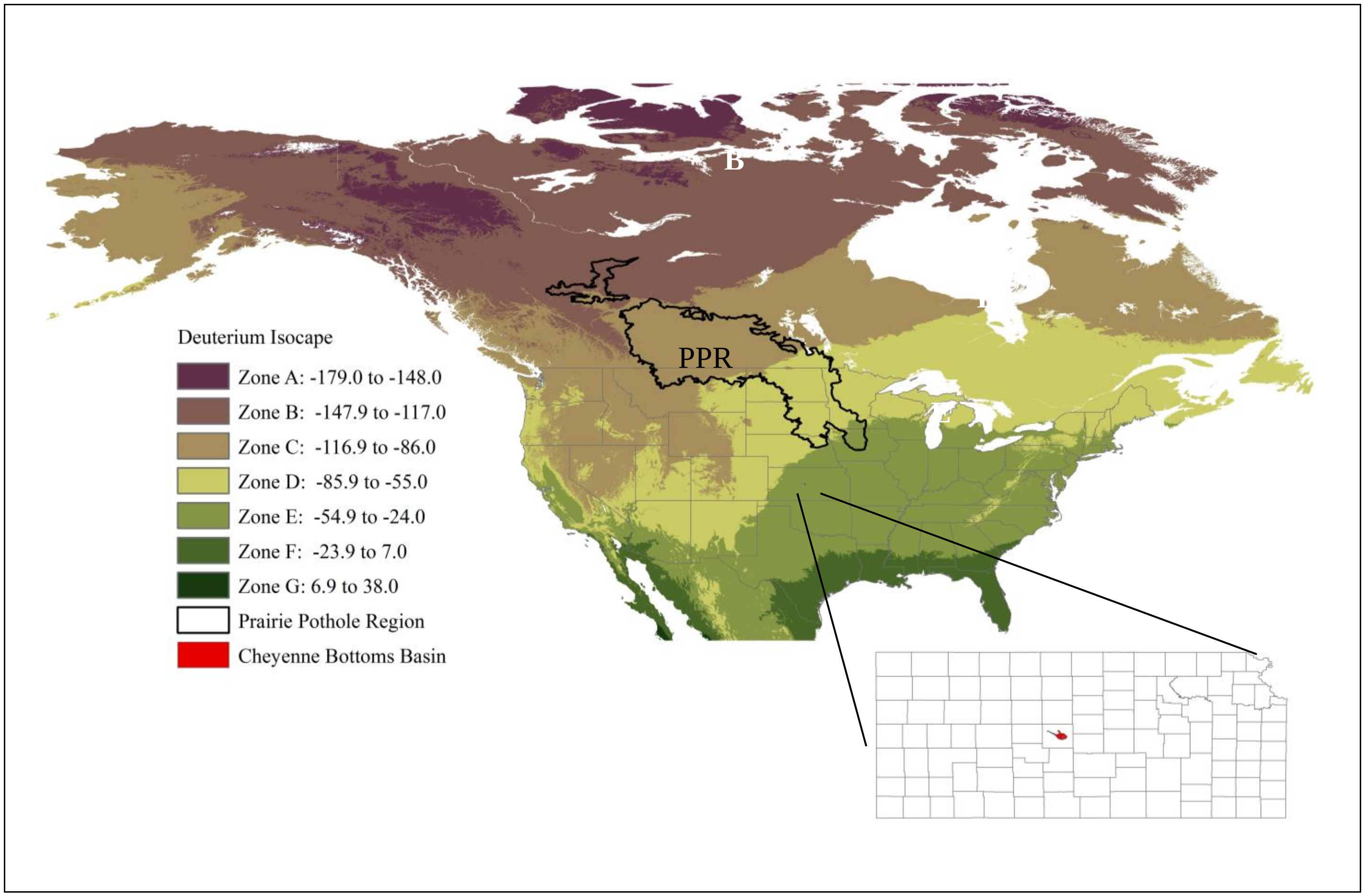
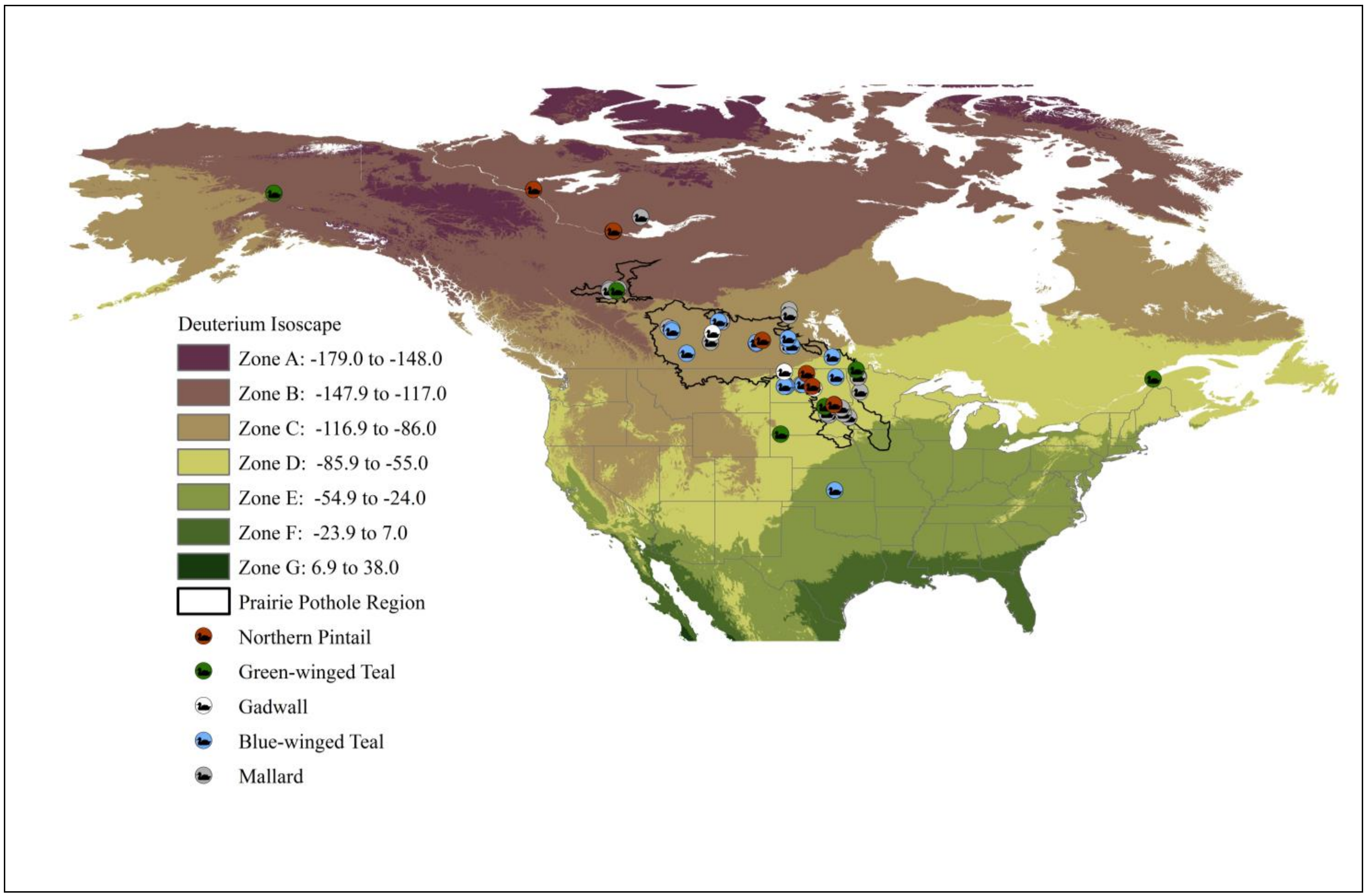


**Figure 4.20.** Banding locations of Northern pintail, green-winged teal, gadwall, blue-winged teal, and mallard (waterfowl icons) banded in 2007 and 2008 and recovered in Kansas during the 2007 and 2008 waterfowl seasons, relative to the deuterium isoscape ($\delta^2H$, expressed in parts per mil [‰]) of North America.



**Appendix A.** An example of the alternative management strategy options survey distributed to waterfowl hunters during the 2007 – 2008 and 2008 – 2009 waterfowl season survey periods at the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) Cheyenne Bottoms Wildlife Area (CHBW), Barton County, Kansas.

When three or more hunting pools at Cheyenne Bottoms (Pools 2, 3A, 3B, 4A, 4B) have water during the waterfowl season, rate your support for the following hunting restrictions on a scale of 1 to 5 (1 = no support at all to 5 = complete support):

A. One hunting pool open for hunting on odd number dates only.

1 2 3 4 5

B. One hunting pool managed as a 'primitive pool' (i.e., no motorized watercraft allowed).

1 2 3 4 5

C. One hunting pool open for hunting from 1/2 hour before sunrise to 1 P.M. daily.

1 2 3 4 5

**Appendix B.** An example of a survey question with Likert Scale (Likert 1932) response choices, which assigns a numerical value to a series of possible answers to the survey question to evaluate the range of responses.

Do you think that the bird flu is a serious risk to the health of waterfowl hunters and their families?

1 - Strongly agree

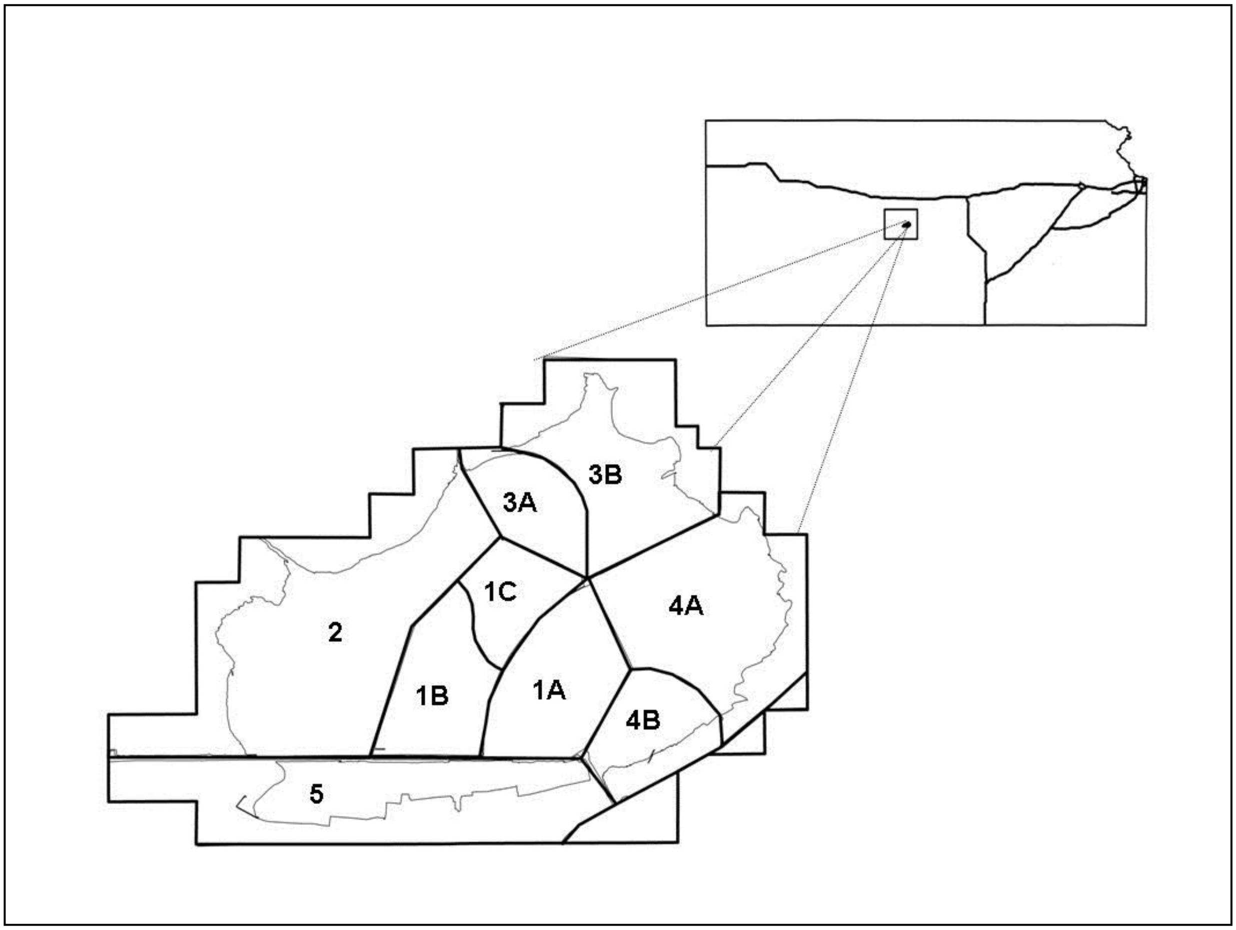
2 - Agree

3 - No opinion

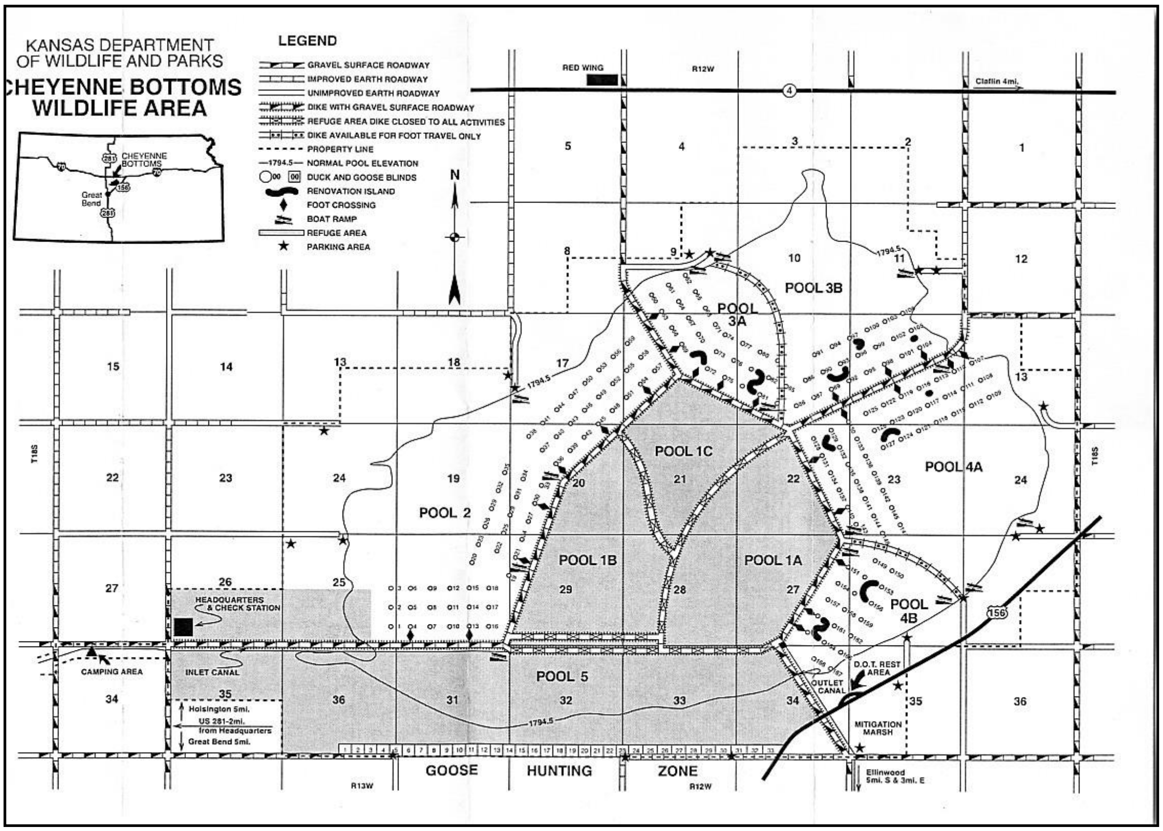
4 - Disagree

5 - Strongly Disagree

**Appendix C.** Map showing the location of Barton County, Kansas, and the proximity and property boundaries of the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) Cheyenne Bottoms Wildlife Area (CHBW), Barton County, Kansas.



**Appendix D.** Public use map of the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) Cheyenne Bottoms Wildlife Area (CHBW), Barton County, Kansas.



**Appendix E.** Kansas Statute 115-8-1 outlining public use of Kansas Department of Wildlife, Parks, and Tourism (KDWPT) lands and waters, which illustrates the law applying to Daily Hunt Permits (DHP) at Cheyenne Bottoms Wildlife Area (CHBW), Barton County, Kansas.

K.S.A. 115-8-1. Department lands and waters: hunting, fur harvesting, and discharge of firearms.

(a) Subject to provisions and restrictions as established by posted notice or as specified in the document adopted by reference in subsection (e), the following activities shall be allowed on department lands and waters:

(1) Hunting during open seasons for hunting on lands and waters designated for public hunting;
(2) fur harvesting during open seasons for fur harvesting on lands and waters designated for public hunting and other lands and waters as designated by the department;
(3) target practice in areas designated as open for target practice; and
(4) noncommercial training of hunting dogs.

(b) Other than as part of an activity under subsection (a), the discharge of firearms and other sport hunting equipment capable of launching projectiles shall be allowed on department lands and waters only as specifically authorized in writing by the department.

(c) The discharge of fully automatic rifles or fully automatic handguns on department lands and waters shall be prohibited.

(d) Department lands and waters shall be open neither for commercial rabbit and hare fur harvesting nor for commercial harvest of amphibians and reptiles.

(e) The department's "KDWPT fisheries and wildlife division public land special use restrictions," dated July 18, 2011, is hereby adopted for reference. (Authorized by K.S.A. 32-807; implementing K.S.A 32-807; effective Dec. 4, 1989; amended July 13, 2001; amended May 16, 2008; amended May 15, 2009; amended July 23, 2010; amended Nov. 14, 2011).

<u>Reference:</u>
Special Permits (Daily / Use Hunt Permit): Daily hunt permits are available on the property at select parking lots and informational kiosks. Designated properties (*) require a permit for all activities.

<u>Region 3:</u>
(*) Cheyenne Bottoms Wildlife Area: In addition to Daily Hunt Permits, trapping permits are required from the manager to trap.

**Appendix F.** An example of the Daily Hunt Permit (DHP) used in the self-registration of hunters at the Cheyenne Bottoms Wildlife Area (CHBW) during the 2007-2008 and 2008-2009 waterfowl season survey periods.

**CHEYENNE BOTTOMS**
**WILDLIFE AREA**
**DAILY HUNT PERMIT**

**No.** 45531

Date ________

Name (optional) ____________________

Address (optional) ____________________

City ________________ State ________

Each hunter must fill out this portion of card and deposit it in box **BEFORE** hunting.

- - - - - - - - - - - - - - - - - - - -

**CHEYENNE BOTTOMS**
**WILDLIFE AREA**
**DAILY HUNT PERMIT**

**No.** 45531

Each hunter must keep this portion on their person while hunting. Fill out and return within one hour of the end of your hunt.

Date: ________

Species Hunted: ____ Ducks ____ Geese
____ Pheasant ____ Deer ____ Other (specify)

Pool(s) Hunted (check all that apply): ____1C
____ 2 ____ 3A ____ 3B ____ 4A ____ 4B
____ 5 ____ Goose Hunting Zones
____ Mitigation Marsh ____ Other

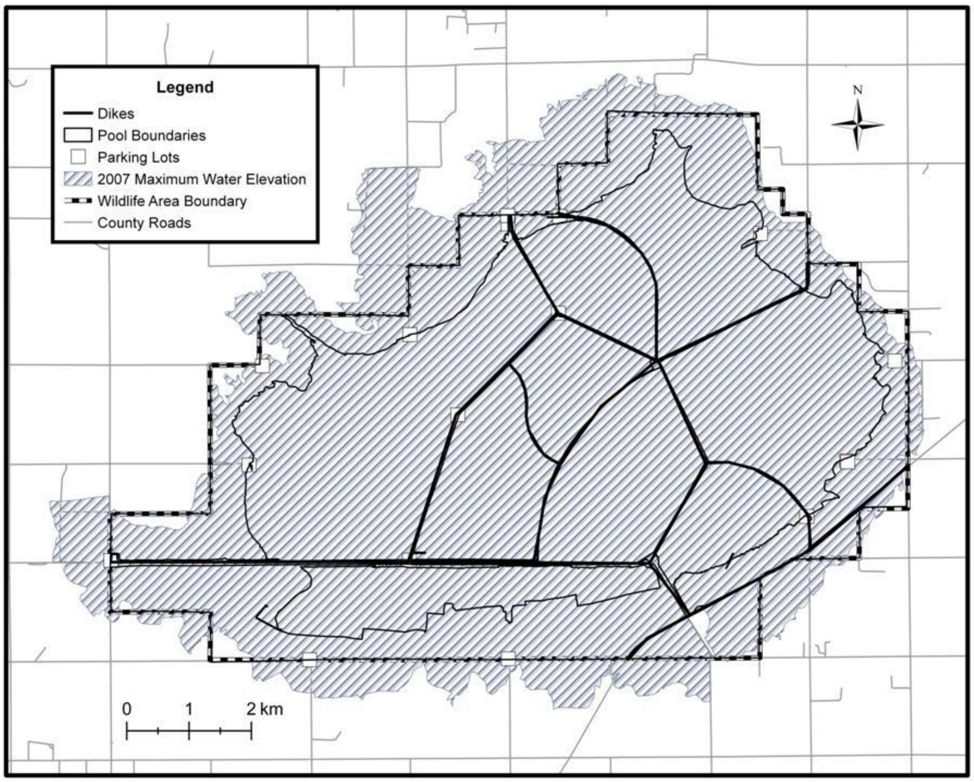
**NUMBER OF BIRDS HARVESTED**

Ducks: ____ Mallard ____ Green-winged teal
____ Pintail ____ Blue-winged teal
____ Gadwall ____ Widgeon
____ Shoveler ____ Redhead

Geese: ____ Canada ____ White-fronted
____ Snow and Blue

Pheasant: ____ Other (Specify) ____

**Appendix G.** Area map of the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) Cheyenne Bottoms Wildlife Area (CHBW), Barton County, Kansas, showing the extent of flooding and the boundaries of the floodwaters at the onset of the 2007-2008 waterfowl season survey period.



**Appendix H.** An example of the new and re-designed Daily Hunt Permit (DHP) used in the self-registration of hunters at the Kansas Department of Wildlife, Parks, and Tourism's (KDWPT) Cheyenne Bottoms Wildlife Area (CHBW), which was implemented in August 2012.

# DAILY HUNT PERMIT
## CHEYENNE BOTTOMS WA

**DATE:** ______

**NAME:** ________________________________

**ADDRESS:** ________________________________

**CITY:** ____________________ **STATE:** ________

Each hunter must fill out this portion of the Daily Hunt Permit and deposit it in survey box **BEFORE** hunting.

**CHBW 05931**

Tear Here

Each hunter must keep this portion of the Daily Hunt Permit on their person while hunting. Fill out and deposit this portion of the permit in survey box within one hour **AFTER** hunting.

**05931 CHBW**

**DATE:** ________

**SPECIES HUNTED** (check all that apply)

____ Duck/Goose ____ Dove ____ Crane
____ Pheasant/Quail ____ Rabbit ____ Squirrel
____ Rail/Snipe ____ Deer ____ Turkey
____ Other ________________________________

**AREA HUNTED** (check all that apply)

____ Pool 1C ____ Pool 2 ____ Pool 3A
____ Pool 3B ____ Pool 4A ____ Pool 4B
____ Pool 5 ____ Goose Zone ____ Mit Marsh
____ Other ________________________________

**NUMBERS HARVESTED**

____ No Game Harvested

**DUCKS**

____ Mallard ____ Gadwall ____ Pintail
____ Blue-wing ____ Shoveler ____ Widgeon
____ Green-wing ____ Redhead ____ Scaup
____ Canvasback ____ Ringed-neck ____ Ruddy
____ Other ________________________________

**GEESE**

____ Canada ____ White-Fronted ____ Snow

**OTHER GAME**

____ Pheasant ____ Quail ____ Rabbit
____ Dove ____ Turkey ____ Squirrel
____ Deer-BUCK ____ Deer-DOE
____ Other ________________________________

________________________________________

**Appendix I.** An example of the mail survey sent to waterfowl hunters in the state of Kansas, which was used to assess waterfowl hunter attitudes relative to avian influenza and the effects of avian influenza on waterfowl hunter participation.

Dear Waterfowl Hunter,

Duck and goose hunters face important issues, and hunters' opinions about those issues are very important. We need your help obtaining your opinions and concerns, as a waterfowl hunter, about avian influenza (also known as "the bird flu"). You are part of an elite group, chosen at random, to participate in this survey. This survey is being conducted by Fort Hays State University, Department of Biological Sciences, in cooperation with the Kansas Department of Wildlife and Parks (KDWP). This survey has no commercial or business sponsorship. Please take a few minutes to complete this survey as accurately as you can, and mail it back to us in the enclosed postage paid envelope. Thank you very much for your time, effort, and contribution to a better understanding of waterfowl hunters' opinions and concerns about bird flu.

Sincerely,

Jason K. Black and Dr. Elmer J. Finck, Fort Hays State University, Department of Biological Sciences

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- **For each of the following questions, please circle the answer that most closely agrees with your opinion:**

**1.** Did you hunt waterfowl during the 2005 – 2006 waterfowl season?

Yes No

**2.** Did you hunt waterfowl during the 2006 – 2007 waterfowl season?

Yes No

**3.** Did the Kansas Department of Wildlife and Parks or other agency personnel swab the

ducks you harvested for Avian Influenza (bird flu)?

Yes No

**4.** How many kinds of bird flu are there?

1 – Many 2 – Few 3 – One 4 – Don't Know

**5.** Are all types of bird flu equally dangerous to waterfowl?

1 – Yes 2 – No 3 – Don't Know

**6.** Are all types of bird flu equally dangerous to people?

1 – Yes 2 – No 3 – Don't Know

**7.** How much do you need or want to know about bird flu?

1 – As much as possible 2 – Only as much as necessary to be safe

3- No need / no interest

**8.** Do you think that the bird flu is a serious risk to the health of waterfowl hunters and

their families?

1 – Strongly Agree 2 – Agree 3 – No Opinion / Don't Know

4 – Disagree 5 – Strongly Disagree

**9.** How concerned is your family about getting bird flu from eating the waterfowl you

bring home?

1 – Very concerned 2 – Slightly Concerned

3 – No Opinion / Don't Know

4 – Slightly unconcerned 5 – Not concerned at all

**10.** How concerned are you that your dog will get bird flu from retrieving ducks shot by waterfowl hunters?

1 – Very concerned
2 – Slightly Concerned
3 – No Opinion / Do not own a dog
4 – Slightly unconcerned
5 – Not concerned at all

**11.** Do you think that bird flu could be a significant factor affecting the health of North American waterfowl populations?

1 – Strongly Agree
2 – Agree
3 – No Opinion / Don't Know
4 – Disagree
5 – Strongly Disagree

**12.** Are you concerned that the United States Fish and Wildlife Service will close waterfowl seasons due to bird flu?

1 – Very concerned
2 – Slightly Concerned
3 – No Opinion / Don't Know
4 – Slightly unconcerned
5 – Not concerned at all

**13.** Are you concerned that the Kansas Department of Wildlife and Parks will close waterfowl seasons due to bird flu?

1 – Very concerned
2 – Slightly Concerned
3 – No Opinion / Don't Know
4 – Slightly unconcerned
5 – Not concerned at all

- **Please answer questions 14 & 15 only if you did NOT hunt waterfowl during the 2006 – 2007 OR 2007 – 2008 hunting season. If you hunted during both seasons, please go to question 17.**

**14.** If you did not hunt waterfowl at all during 2006 - 2007 or 2007 - 2008, did bird flu have anything to do with your decision?

1 – Definitely      2 – Somewhat      3 – Not at all

**15.** If you chose not to hunt waterfowl at all during the 2006 - 2007 or 2007 - 2008 waterfowl season, **please put an "X" to the left of the one reason** that most contributed to your decision not to hunt:

____ Waterfowl hunting has become too expensive

____ Poor hunting conditions

____ Too many regulations associated with waterfowl hunting

____ Lack of places to hunt

____ Not enough time to hunt

____ Cost of gasoline

____ Fears and concerns associated with bird flu

____ Crowded hunting areas

____ Too few waterfowl

____ Other interests

**16.** If you **did not hunt** in the 2006 - 2007 **or** 2007 - 2008 hunting seasons, please rate the importance of the reasons why you did not hunt with an **H, M, or L.**

(H = Highly Important, M = Moderately Important, L = Low/Not Important)

Please rate all of the choices that apply. You may use each letter more than once.

____ Waterfowl hunting has become too expensive

____ Poor hunting conditions

____ Too many regulations associated with waterfowl hunting

____ Lack of places to hunt

____ Not enough time to hunt

____ Cost of gasoline

____ Fears and concerns associated with bird flu

____ Crowded hunting areas

____ Too few waterfowl

____ Other interests

- **For the following questions, please place an "H, M, or L" (H = Highly Important, M = Moderately Important, L = Low / Not Important) in the blank to the left of the answer depending on how important that answer is to you:**

**17.** Depending on how you currently obtain most of your information about bird flu, please rate the importance of these choices with an **H, M, or L** (H = Highly Important, M = Moderately Important, L = Low/Not Important). Please rate all the choices that apply. You may use each letter more than once.

___ Television

___ Newspaper

___ Outdoor Magazines (Ducks Unlimited, Delta Waterfowl, Wildfowl, etc.)

___ KDWP website

___ Friends

___ Radio

___ Public Meeting

___ Other Internet sites

**18.** Please list any additional sources for obtaining bird flu information that are more important than those you rated in question 17.

_______________________________________________

**19.** Depending on how you would most prefer bird flu updates to be provided to you, please rate the importance of these choices with an **H, M, or L** (H = Highly Important, M = Moderately Important, L = Low/Not Important). Please rate all the choices that apply. You may use each letter more than once.

___ Television

___ Newspaper

___ Outdoor Magazines (Ducks Unlimited, Delta Waterfowl, Wildfowl, etc.)

___ KDWP website

___ Friends

___ Radio

___ Public Meeting

___ Other Internet sites

**20.** Please list any additional sources for delivery of bird flu information that would be more important than those you rated in question 19.

______________________________________________

- **For each of the following questions, please circle the answer that most closely agrees with your opinion:**

**21.** Do you wish to be informed about bird flu news by the Kansas Department of Wildlife and Parks (KDWP)?

Yes No

**22.** The Kansas Department of Wildlife and Parks' bird flu surveillance and monitoring efforts (swabbing hunter-harvested ducks and collecting dead birds) are sufficient efforts for detecting bird flu in Kansas.

1 - Strongly Agree 2 – Somewhat Agree 3 - No Opinion

4 – Somewhat Disagree 5 - Strongly Disagree

**23.** Waterfowl are the correct group of birds to be monitoring for the presence of bird flu.

1 - Strongly Agree 2 – Somewhat Agree 3 - No Opinion

4 – Somewhat Disagree 5 - Strongly Disagree

**24.** The Kansas Department of Wildlife and Parks should be monitoring wild waterfowl for the presence of bird flu.

1 - Strongly Agree 2 – Somewhat Agree 3 - No Opinion

4 – Somewhat Disagree 5 - Strongly Disagree

**25.** The Kansas Department of Agriculture should be monitoring domestic fowl for bird flu.

1 - Strongly Agree 2 – Somewhat Agree 3 - No Opinion

4 – Somewhat Disagree 5 - Strongly Disagree

- **Thank you very much** for completing our survey! Your time is greatly appreciated. Please return the survey to us in the enclosed postage paid envelope. Thanks again for your time and effort!