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USING HUMAN DIMENSIONS INSIGHTS TO IMPROVE CONSERVATION EFFORTS FOR THE EASTERN MASSASAUGA RATTLESNAKE (*SISTRURUS CATENATUS CATENATUS*) IN MICHIGAN AND THE TIMBER RATTLESNAKE (*CROTALUS HORRIDUS HORRIDUS*) IN MINNESOTA

presented by

REBECCA ANN CHRISTOFFEL

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of the requirements for the

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By

Rebecca Ann Christoffel

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ABSTRACT

USING HUMAN DIMENSIONS INSIGHTS TO IMPROVE CONSERVATION EFFORTS FOR THE EASTERN MASSASAUGA RATTLESNAKE (*SISTRURUS CATENATUS CATENATUS*) IN MICHIGAN AND THE TIMBER RATTLESNAKE (*CROTALUS HORRIDUS HORRIDUS*) IN MINNESOTA

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Rebecca Ann Christoffel

Human-wildlife interactions, whether positive or negative, are driving forces for stakeholder desires for wildlife populations. Thus, wildlife managers must integrate both ecological and sociological information to formulate wildlife management decisions. The overall goal of this dissertation research was to enhance reptile conservation efforts through discovery and dissemination of human dimensions insights on which management decisions could be made, particularly those that pertain to development and maintenance of social acceptance capacity for reptiles. In the case of snakes, human-wildlife encounters frequently have resulted in the death of the animal and research to determine specific human beliefs and attitudes that resulted in lethal behaviors toward snakes was lacking. The eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*) is a candidate for listing and the timber rattlesnake *(Crotalus horridus horridus)* is under consideration for listing as a candidate species under the federal Endangered Species Act. Michigan is the stronghold for eastern massasauga populations and one large tract of extant habitat coincides with rapidly increasing human development pressures in the Ann Arbor and Detroit metropolitan areas. Minnesota paid bounties on the timber rattlesnake until 1989, and subsequently listed the species as threatened in 1996. Four counties in southeastern Minnesota still support populations of this species. To determine social carrying capacity for snakes in these two areas, I conducted semi-structured interviews to learn how people felt about the reptilies and amphibians found in their areas. Results were then used in the development of a mail questionnaire that was administered to 1,092 stakeholders in Michigan and 1,198 stakeholders in Minnesota. People who lived in the presence of rattlesnakes had more positive attitudes toward both non-venomous snakes and rattlesnakes than people who were unsure of their presence or people living in their absence. Social acceptance capacity was determined using two existing frameworks, cultural carrying capacity and wildlife stakeholder acceptance capacity. The variable that explained the greatest degree of variation in social acceptance capacities toward rattlesnakes was the rattlesnake stewardship score, a series of six items that were used to determine respondents' level of obligation toward the well-being of rattlesnakes. Risk perceptions were the most important determinants of whether or not a respondent would engage in a potentially lethal behavior toward a snake. Results of this study indicate a great need for education and communication efforts to correct mistaken beliefs and reduce heightened risk perceptions about snakes. An experiment was designed to test outreach methods for their efficacy in increasing knowledge and influencing attitudes toward snakes. Results indicate that face-to-face contact programs are most effective at changing attitudes toward snakes, but that any treatment can be used to increase knowledge. Information gained through this research can be used as the foundation for snake management efforts in Michigan and Minnesota. However, the process should be tested in other areas of the country where more than one rattlesnake currently exists and where rattlesnakes are more abundant on the landscape.

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CHAPTER 1

INTRODUCTION, STUDY AREAS AND DISSERTATION ORGANIZATION

1.1 Introduction

This dissertation research was undertaken to enhance reptile conservation efforts through discovery and dissemination of human dimensions insights on which management decisions could be made, particularly those that pertain to development and maintenance of social carrying capacity for reptiles. Integration of insights from the human dimensions of wildlife management was a key motivation for the research because of 1) recent changes in societal values pertaining to wildlife conservation and management (Decker and Enck 1996), and 2) its use in resolving human-wildlife conflicts (Decker and Chase 1997). In the case of snakes, human-wildlife encounters frequently resulted in the death of the animal (Whitaker and Shine 2000) and research to determine specific human beliefs and attitudes that resulted in lethal behaviors toward snakes was lacking.

Reptile populations were declining globally due to habitat degradation and loss, invasive species, environmental pollution, disease, unsustainable human use, and climate change (Gibbons et al. 2000). The International Union for the Conservation of Nature and Natural Resources (IUCN 2000) estimated that 25% of reptile species were threatened with extinction. Dodd (1987) reported that snake populations were declining globally due to habitat degradation, intentional killing, rattlesnake roundups, biocides and trade for fashion and pets. It was estimated that >50% of pit viper species were vulnerable to extinction (Greene and Campbell 1992). Most known conservation threats to reptile populations were anthropogenic in origin, yet the beliefs and attitudes of people toward reptiles seldom were considered in conservation planning.

Human dimensions insights gained through research reported herein may be used by wildlife managers to: 1) increase stakeholders' knowledge and familiarity with snakes, 2) modify risk perceptions among stakeholders regarding snakes to more closely reflect numerical risk, and 3) motivate stakeholders to co-exist amicably with, and manage for, sustainable snake populations.

1.1.1 Values and Conservation Status of Snakes

Globally, snake populations have had important economic, cultural, medicinal and ecological values to humans. Snakes and their eggs have been important sources of protein, especially in tropical areas (Morris and Morris 1965). Snakes have gained increasing popularity as pets and the pet market has been reported as the most significant segment of the live reptile market (Hoover 1998). Snake skins have provided leather for boots, belts and wallets; annual international trade in snake skins has involved millions of skins and vast monetary amounts (Klauber 1982; Dodd 1986, Morris and Morris 1965). Snakes have played important mythological roles for millennia in human cultures around the world (Menez 2003, Brown and McDonald 2000, Schwartz 1999, Klauber 1982, Nissenson and Jonas 1995, Burton 1993, LaBarre 1969, Morris and Morris 1965) and were used as symbols of power by ancient cultures (Stutesman 2005). In the United States' (US) colonies, timber rattlesnakes were pictured on flags carried into battle by revolutionary armies and on the masts of warships; rattlesnake images were used as symbols of power by the US military during World War II (Morris and Morris 1965) and as symbols of the enemy (Stutesman 2005). Snakes have frequently been the subject matter of folklore (LaBarre 1969, Morris and Morris 1965). Eastern cultures have used many parts of snakes for traditional medicinal purposes and aphrodisiacs (Morris and

Morris 1965). Western physicians have used snakes extensively as anatomical and physiological models, and used snake venoms and saliva to manufacture pharmaceuticals that have treated a plethora of diseases (Grenard 1994). Snakes have also served important roles in ecosystems as predators and prey (Shine and Webb 1990, Diller and Johnson 1988, Fitch and Bare 1978, Fitch 1974, Zug et al. 2001).

Snakes within the US have presented the same set of values discussed above. The American Pet Products Manufacturers Association (APPMA) reported that > 3.9 million (~4%) US households contained one or more pet reptiles or amphibians and the retail trade in live reptiles, amphibians and related products was worth a minimum of two billion dollars annually (Franke and Telecky 2001). It was estimated that the US trade in certain CITES-listed live reptiles increased from 28% of the world total to 81.5%, 1983-1993 (Hoover 1998). Vogt (1981) reported an estimated value of ≥ $400 annually for rodent control services per bullsnake (*Pituophis melanoleucus*) on agricultural properties in Wisconsin; rodent control by snakes in agricultural settings has also been asserted elsewhere (Mattison 1996). Local amphibian and reptile populations have been exploited for use in medical and toxicological research projects (Vogt 1981). Presumably, adult and hatchling snakes have also served as important predators and, along with snake eggs, as prey items within Great Lakes ecosystems (Harding 1997, Vogt 1981).

Humans have made repeated efforts to exterminate rattlesnakes, despite their values, since colonial times in the US (Klauber 1982). Bounties were paid on rattlesnakes in several states in the Great Lakes region including Iowa (IA) and Wisconsin (WI), and persisted in Minnesota (MN) until 1989 (Oldfield and Moriarty 1994). Prior to 1997, most reptiles were neither granted legal protection nor regulated in thirty-seven of fifty states (Levell 1997). As of this writing, twenty-three species and subspecies of snakes were listed as threatened or endangered in at least one of six Midwestern Great Lakes states (i.e. Illinois (IL), Indiana (IN), Michigan (MI), MN, Ohio (OH), and WI) (Table 5.2). In United States Fish and Wildlife Service (USFWS) Region 3, five snake species or subspecies were listed as Regional Conservation Priorities (USFWS 2002). Researchers have concluded repeatedly that rattlesnake survivorship is reduced when humans encroach on snake habitat (Galligan and Dunson, 1979, Seigel 1986, Dodd 1993, Rosen and Lowe 1994). Szymanski (1998) identified the top two causes of eastern massasauga (*Sistrurus catenatus catenatus)* population declines as habitat loss and persecution and reported that the magnitude of known population declines varied from 33% in MI to 100% in MN. Brown (1993) identified habitat degradation and human exploitation as being major threats to timber rattlesnake (*Crotalus horridus horridus)* conservation. Though causes for these declines were anthropogenic, little research has been conducted on how to influence human beliefs, attitudes and lethal human behaviors toward rattlesnakes.

1.1.2 Study Species and Conservation Threats

Eastern massasauga rattlesnakes and timber rattlesnakes were selected for study based on immediate conservation threat to the species, legal status and important life history characteristics. The eastern massasauga was a candidate for federal listing under the Endangered Species Act (Johnson et al. 2000), a Region 3 USFWS regional conservation priority (United States Fish and Wildlife Service, 2002), and one of two MI snakes to be listed as a species of special concern (Michigan Natural Features Inventory, 2007). Eastern massasaugas have been documented in forty-nine of sixty-eight counties in the lower peninsula of MI (Legge 1996). One of the areas believed to contain concentrated populations of eastern massasaugas consisted of Jackson, Livingston, Oakland and Washtenaw counties in southeastern MI (Legge and Rabe 1994). This area experienced a human population growth rate of ~12% and a household growth rate almost twice (21%) as great, particularly in the Ann Arbor area, southeastern Livingston County and western and northern Oakland County during the 1990s (Southeast Michigan Council of Governments 2001). The eastern massasauga was the focus of a Candidate Conservation Agreement with Assurances that the state of MI was entering into with the USFWS (L. Sargent, 2003, MI DNR, personal communication). However, more than 90% of the land base in the southern half of the lower peninsula of MI was held privately (MI DNR 2000); thus, it was imperative to consider humans and private lands in conservation efforts for this species. The timber rattlesnake was a Region 3 USFWS regional conservation priority, and in 1996 was listed as threatened in MN (Levell 1997). The eastern massasauga was listed as endangered in MN (Levell 1997), but there were no known extant populations (Szymanski 1998), though concerted searches were made (Naber et al. 2004). Several timber rattlesnake populations were found on publicly held lands, and known overwintering dens, i.e. hibernacula, had been vandalized and snakes poached (Abraham 2004, Keyler and Wilzbacher 2002).

Particularly in the northern latitudes in which this research occurred, these two rattlesnakes demonstrated pronounced k-selected survival strategies and were thus, unable to withstand great rates of adult mortality (Johnson et al. 2000, Congdon et al. 1995, Brown 1993). Ambush foraging snakes, such as eastern massasaugas and timber rattlesnakes, have experienced rapid declines in the presence of anthropogenic disturbance because of their dependence on particular microhabitat features for foraging and associated life history traits such as low rates of feeding, growth and reproduction (Reed and Shine 2002). Eastern massasauga rattlesnakes give birth to an average litter size of eight to eleven, and do not reach sexual maturity until they are three to four years of age (Ernst and Ernst 2003, Keenlyne 1978). It was thought that a number of extant populations were so small as to be at great risk of local extinctions (Seigel and Shiel 1999, Szymanski 1998, Johnson et al. 2000). Consistently removing even a low rate of individuals from a small population may result in the extirpation of an eastern massasauga population (Kingsbury 2002, Johnson et al. 2000). Female timber rattlesnakes do not reach sexual maturity in the more northern parts of their range until they are from seven to eleven years old (Brown 1991) and may not breed more than once every three years due to prey availability (Ernst and Ernst 2003) and low fat reserves (Gibbons 1972). Clutch size averaged just eight to ten in MN (Oldfield and Moriarty 1994) and eight in WI (Keenlyne 1978).

Eastern massasaugas are among the smallest pit vipers, measuring on average 47-76 cm overall length (Conant and Collins 1991, Ernst 1992). They are cryptically colored, having a gray dorsal background with a series of large blotches outlined in white or yellow down their back and two or three rows of smaller blotches running along each side, and a black belly with gray or yellow mottling (Harding 1997). The diet of the eastern massasauga typically consisted of small mammals, but also included other snakes, eggs, and nestling birds (Ernst 1992). Young garter snakes (*Thamnophis sirtalis)* are reported to be important food items to eastern massasaugas during their first year of life, but warm-blooded prey, such as meadow voles (*Microtus pensylvanicus)* are most often consumed by older snakes (Keenlyne and Beer 1973). The eastern massasauga rattlesnake is reported to use a variety of habitat types; preferred habitats have an open vegetation structure relative to surrounding areas and are close to water (Johnson et al. 2000).

The timber rattlesnake measures 90-152 cm in overall length (Conant and Collins 1991). In MN, timber rattlesnakes are generally yellow-brown in dorsal coloration, with a set of dark cross bands, an auburn mid-dorsal stripe, an unpatterned head, and a velvet-black tail (Oldfield and Moriarty 1994). Their diet consisted primarily of small mammals (Reinert et al. 1984), but also included small birds, lizards, snakes, frogs and insects (Ernst 1992). Timber rattlesnakes usually overwinter communally in rocky dens with a southern exposure (Klauber 1982). Timber rattlers existed in six southeastern MN counties (Henderson 1980), which included an area along the Mississippi River bluffs where human development pressures had increased (McMurry 2003).

1.1.3 Human-snake Interactions

An average of six bites to humans from eastern massasaugas occurred annually 1999-2005 in MI (Susan Smolinske, MI Poison Control Center, pers. communication and unpublished data, 2006). Data provided by Dr. Smolinske did not provide gender information, but the average age of snakebite recipients was twenty-nine. Of the forty snakebites reported to the Michigan Poison Control Center, thirty-two incidents involved adults and eight involved children.

Though timber rattlesnakes are larger than eastern massasaugas and are known to frequent open areas for basking, Keyler (2005) reported only fifteen bites from timber rattlesnakes to humans in MN, 1982-2002. Of those bites, only five were natural occurrences, for an average of one timber rattlesnake bite to a human every four years. Amateur herpetologists were involved in most (81%) snakebite incidents and four such individuals had a history of previous venomous snakebite. Keyler reported the average age for venomous snakebite recipient as 29 $\pm$ 10 years, and 94% as adult males. A quarter of recipients were intoxicated at the time of the incident.

1.1.4 Study Goal and Objectives

Because each of the more local conservation threats faced by eastern massasaugas and timber rattlesnakes was human in origin, it was thought that they may best be addressed through efforts to influence human traits such as beliefs, attitudes and behaviors, an aspect discussed in the following chapters.

The goal of this dissertation research was to provide human dimensions insights in reptile conservation. Of particular interest was how these insights could operate to develop and maintain a social acceptance capacity for rattlesnakes.

Specific research objectives included:

1.) To specify a mental model of social acceptance capacity for rattlesnakes that could be used as a foundation for this dissertation research.

2.) To characterize (SE MI and SE MN) stakeholder beliefs, attitudes and intentions toward non-venomous snakes and rattlesnakes.

3.) To compare and contrast MI and MN stakeholder beliefs, attitudes and intentions toward non-venomous snakes and rattlesnakes, especially as they pertained to social carrying capacity.

4.) To better understand social acceptance capacity and its applicability to conservation of snakes.

5.) To offer suggestions for management interventions directed toward influencing social acceptance capacity for snakes by testing different outreach delivery methods and their efficacy in influencing stakeholder attitudes toward snakes.

1.2 Study Area Descriptions

Two areas were selected for this research, one in southeastern MI and the other in southeastern MN. Areas were selected based on many factors, including: 1) experience, ongoing working relationship, and potential for funding through MN DNR, 2) familiarity with the natural history, ecology, conservation threats, and outreach activities of herptiles, 3) ability to procure research support, 4) the federal conservation status of the eastern massasauga and 5) the immediate needs of the MI DNR to address conservation of the eastern massasauga rattlesnake in an area of prime habitat that faced increasing human development pressures. Study areas also allowed for a comparison of stakeholder beliefs, attitudes and behavioral intentions between states using two similar, but importantly different, rattlesnake species. Each study area consisted of four counties in which one of two rattlesnake species (i.e., the timber rattlesnake in MN, and the eastern massasauga in MI) existed. Ecoregion descriptions were excerpted from Albert (1995). All county-level demographic data were obtained from the U.S. Census Bureau (State and County *QuickFacts* website, http://quickfacts.census.gov/qfd/states).

1.2.1 Michigan Demographic Information

Statewide, the MI land base consisted of 21% publicly held lands and 79% privately owned lands (MI DNR 2000). In the southern half of MI's lower peninsula, only 4% of the land base was publicly held, while 96% was privately owned. The four counties included in the study area were Jackson, Livingston, Oakland and Washtenaw. These counties contained a cluster of eastern massasauga populations (Legge and Rabe 1994). They were also near enough to the metropolitan Detroit and Ann Arbor areas that they were undergoing intense human development pressures (Table 1.1; Southeast MI Council of Governments 2001).

1.2.2. Michigan Ecoregion Description

Jackson, Livingston, Oakland and Washtenaw counties were located within the southern lower MI ecoregion, an area characterized by relatively warm conditions and a rather uniform climate as compared with the rest of the state. The entire state was glaciated and the southeastern portion consisted of a flat lake plain that transitioned in the west to a low plateau of moraines and outwash plains.

Pre-European settlement plant communities included beech-sugar maple forests, oak-hickory forests, swamps and some prairie. The region was home to a diversity of plant communities as compared to other parts of the state, due to the presence of many southern species not found elsewhere in the state.

Current land uses consisted of farming, woodlots, metropolitan areas, and rural residential. This area has experienced the greatest urban, industrial and residential development in MI. Almost all of the original tallgrass and wet prairies were converted to agricultural use. Some poorly drained sites still contained swamps and some marshes and wet prairie. Fire suppression led to the development of more closed-canopy oak-hickory forests, and decreased more open habitats such as prairie.

1.2.3. Minnesota Demographic Information

The MN land base was 23% publicly owned and 77% privately owned (MN State Planning Agency, 1983). The four study-area counties included Fillmore, Houston, Wabasha and Winona. They contained some of the last known extant populations of timber rattlesnakes, many of which existed on public lands frequented by recreational users. Some areas along the Mississippi River bluffs of southeastern MN were experiencing intense human development (McMurry 2003). Until recently, this area had consisted of large unbroken tracts of suitable habitat for wildlife, such as timber rattlesnakes. Table 1.2 provides a brief description of each county and its human growth rate during the last decade of the twentieth century.

1.2.4. Minnesota Ecoregion Description

Fillmore, Houston, Wabasha and Winona counties were located within the Driftless area of southwestern WI and southeastern MN. This area showed no signs of ever having been glaciated and exhibited highly dissected topography. In southeastern MN, this area was also known as the Blufflands (Kratz and Jensen 1983). Differences in elevation of up to 600 feet occurred along the Mississippi River. Other major rivers in the area were the Root, Whitewater and Zumbro. There were few natural lakes and the water table was often more than twenty feet below the surface (University of MN et al. 1973).

Finely (1976) and Lange (1990) provided detailed descriptions of the plant communities that were encountered by settlers of the area. They reported that pre-European settlement vegetation of this region consisted of bur oak savanna and tallgrass and midgrass prairies on ridge tops and steep slopes with south or southwest aspects. Sugar maple-basswood forests predominated in protected valleys and on north-facing slopes; oak forests were also common on the moister slopes. Wet prairies were found along the many rivers. Some tallgrass and midgrass prairie was present on the floodplain, as well as marsh and floodplain forests. Important natural disturbances in the area were fire, tornados, ice storms, and wind throws.

More recently, human disturbances, such as logging, farming, drainage, and fire prevention significantly altered the vegetation. In MN's western portion of the Driftless area, more than 90% of the land was in crops and pasture, and the remainder was in woodland and residential development. In the more easterly portion, about 50-60% of the land was in crops and pasture, and the remainder was in woodlands and residential development. Albert (1995) reported that development pressure was increasing on the Blufflands, especially along the Mississippi River.

1.3 Dissertation Organization

The dissertation consists of an introductory chapter that includes a description of study areas and this organizational piece, followed by four chapters designed to "stand alone" as manuscripts; and ends with a summary that ties together previous chapters and discusses management implications of the research. Because the middle four chapters were written as manuscripts, there is some redundancy in the descriptions of methods, introductions and study areas.

In Chapter 2, two conceptual models to depict people's behaviors toward snakes are presented. Models were built to identify research questions and testable hypotheses. Antecedents to behaviors and factors contributing to those antecedents were investigated. This chapter examines relationships between individual beliefs and attitudes, including risk perceptions, particularly in terms of social acceptance capacity for snakes. The chapter concludes with a subset of recommendations for research based on the models.

Chapter 3 examines human traits toward snakes in light of the conceptual models presented in Chapter 2 and a series of semi-structured interviews that were conducted in MI and MN. Data for chapter 3 were collected via self-administered mail questionnaires. Goals of Chapter 3 were (1) to characterize stakeholder beliefs, attitudes and behavioral intentions toward non-venomous (NV) snakes and (RS) rattlesnakes, and (2) to examine whether stakeholders were more likely to support NV snake conservation efforts than RS conservation efforts. The three research questions investigated in Chapter 3 included:

1) Do stakeholders know more about NV snakes than RS?
2) Do stakeholders hold more negative attitudes toward RS than NV snakes?
3) Are stakeholders more likely to intend to engage in negative behaviors toward RS than NV snakes?

Chapter 4 examines stakeholders' desires for future snake populations. The chapter goal was to better understand factors affecting social acceptance capacity for snakes. The hypothesis being tested in this chapter stated that stakeholders who believed they were living in areas with extant RS populations would demonstrate a desire for reduced RS populations more often than stakeholders who did not live in such areas. Data were analyzed to illuminate the relationship between an individual's tolerance of and desires for RS and his or her perception of risk from a RS. Desire for future populations for RS and NV snakes were compared and contrasted for three stakeholder groups i.e., respondents who believed they lived in the same area as RS, respondents who believed that RS were absent and respondents who were unsure of RS presence. Information from this chapter was used to identify the status of stakeholders' risk perceptions of RS and NV snakes for use in educational outreach efforts aimed at influencing social acceptance capacity.

Chapter 5 builds on Chapter 4 by presenting results of an outreach experiment to test delivery methods for their efficacies in increasing knowledge and changing attitudes about snakes. The chapter goal was to offer suggestions for influencing social acceptance capacity for reptiles, particularly snakes. Data were collected from individuals initially via the self-administered mail questionnaires used in chapters 3 and 4; subsequent data were collected either at the conclusion of an outreach program, or approximately six months after initial mail questionnaire response for individuals who did not attend outreach programs (control and written materials treatment groups). A final data collection using a brief, self-administered assessment instrument was sent out approximately six months after the series of outreach programs. It was hypothesized that stakeholders who attended a snake workshop would have greater knowledge than stakeholders who were mailed written outreach materials and a control group. It was also hypothesized that stakeholders who attended a snake workshop that included behavioral modeling would have greater tolerance of snakes than stakeholders who did not attend a workshop or stakeholders who attended a workshop without behavioral modeling.

Chapter 6 is a summary, which presents conclusions and management recommendations. This chapter focuses on the two questions: 1) What did the author find out? and, 2) What are the implications for fisheries and wildlife management (generally and specifically)?

Table 1.1. Land area, human population estimates and housing unit estimates for four study area counties in southeastern Michigan (2000). (Source: U.S. Census Bureau, State and County *QuickFacts* website, http://quickfacts.census.gov/qfd/states).

County	Area (mi^2)	Estimate of Housing units	Estimate of Human population	Average human density (mi^2)	Percent change in human population (1990-2000)
Jackson	707	63,000	158,422	224	5.8
Livingston	568	59,000	156,951	276	35.7
Oakland	873	492,000	1,194,156	1,369	10.2
Washtenaw	710	131,000	322,895	455	14.1

Table 1.2. Land area, human population estimates and housing unit estimates for four study area counties in southeastern Minnesota (2000). (Source: U.S. Census Bureau, State and County *QuickFacts* website, http://quickfacts.census.gov/qfd/states).

County	Area (mi^2)	Estimate of Housing units	Estimate of Human population	Average human density (mi^2)	Percent change in human population (1990-2000)
Fillmore	861	8,908	21,122	24.5	1.7
Houston	558	8,168	19,718	35.3	6.6
Wabasha	525	2,000	21,610	41.0	9.5
Winona	626	19,600	49,985	80.0	4.5

CHAPTER 2

CONCEPTUAL MODELS OF HUMAN-RATTLESNAKE INTERACTIONS

2.1 Introduction

Reptile populations are declining globally due to habitat degradation and loss, invasive species, environmental pollution, disease, unsustainable human use, and climate change (Gibbons et al. 2000). The International Union for the Conservation of Nature and Natural Resources (IUCN 2000) estimated that 25% of reptile species were threatened with extinction. Reptile declines are believed at least as severe as global amphibian declines, but reptiles have not received the same public attention and funding (Gibbons et al. 2000). It does not appear that this lack of funding and attention is connected to the global importance of reptiles. For example, snakes hold a multitude of values to people, including aesthetic, spiritual, economic, pharmaceutical, ecologic, and dietary (Morris and Morris 1965, Dodd 1986, Grenard 1994, Nissenson and Jonas 1995, Hoover 1998, Franke and Telecky 2001, Zug et al. 2001, Menez 2003). Despite this multitude of values, the causes for snake population declines are solely human-induced, and include habitat degradation, direct population losses from humans killing snakes in real or perceived self-defense, malicious killings, rattlesnake roundups, biocides, and trade for fashion and pets (Dodd 1987). Furthermore, it is estimated that > 50% of pit vipers, including rattlesnakes, are vulnerable to extinction (Greene and Campbell 1992).

Humans have made repeated efforts to exterminate rattlesnakes, despite their values, since colonial times in the United States (Klauber 1982). Prior to 1997, most reptiles were not granted legal protection or even regulated in thirty-seven of fifty states (Levell 1997). Bounties were paid on rattlesnakes in several states and rattlesnake roundups still occurred in 2000 in Alabama, Florida, Georgia, Kansas, New Mexico, Oklahoma, Pennsylvania, and Texas (Fitzgerald and Painter 2000).

One species of rattlesnake of particular concern in the eastern United States is the eastern massasauga rattlesnake (*Sistrurus catenatus catenatus*), a candidate for listing under the federal Endangered Species Act (USFWS 1999). Its range extends from southern Ontario and central New York in the east to Iowa and eastern Missouri in the west (Ernst and Ernst 2003). Massasaugas are considered rare, threatened or endangered in every state east of the Mississippi River (Ashton 1976). They receive some form of legal protection in every state and province in which they occur, and Michigan is considered this species' last stronghold in the United States (Szymanski 1998). Legge (1996) identified human persecution as an important source of eastern massasauga mortality in Michigan and emphasized the importance of public cooperation in state efforts to manage and conserve this species.

One area of research that is focused on integrating human traits, such as beliefs, opinions and associated behaviors into natural resources management, is human dimensions. Insights from human dimensions research are increasingly incorporated into natural resources management (Decker et al. 2001), but little such research has been related to reptile conservation. However, one national survey to assess the public's attitudes toward wildlife species included snakes (Kellert and Berry 1979, 1980). In that survey, public willingness to sacrifice a variety of personal benefits to assure the well being of several endangered species was examined. Notably, respondents expressed little desire to make sacrifices to protect the eastern indigo snake *(Drymarchon corais couperi)*, a large non-venomous snake that was listed early in the 20th century under the federal Endangered Species Act. Rattlesnakes were disliked by 78% of respondents, and ranked as the fifth most disliked species of thirty-three included in the survey's list

(Kellert and Berry 1980). Only wasp, rat, mosquito, and cockroach were disliked to a greater degree. Snakes have consistently ranked among the most disliked animals around the globe (Surinova 1971, Morris 1960), particularly among female children (Surinova 1971). Boys, on the other hand, appear to have positive attitudes toward a wider diversity of animals than females, particularly predators (Collins 1976).

Regardless of species, there are costs involved in sharing one's land with wildlife that may include damage to personal property, disease, human injury, loss of life, and crop damage (Conover et al. 1995). Therefore, wildlife species are ideally managed for desired population levels as determined by wildlife agencies in conjunction with the public (Decker et al. 2001). When determining the desired population level for a wildlife species, managers must consider public benefits as well as costs in maintaining species' populations. One such measure of public acceptance for a wildlife species population level is wildlife stakeholder acceptance capacity (WSAC), a blend of stakeholder tolerance of problems and desires for wildlife benefits (Carpenter et al. 2000). Calculating WSAC for a species is complex and includes psychological variables such as value orientations and specific beliefs, behavioral variables such as past experience with wildlife, and situational specifics, such as wildlife encounter frequency and wildlife management actions (Zinn et. al 2000).

Acceptance capacity can vary a great deal, depending upon the species and stakeholder group in question. For example, acceptance capacity is generally high for species, such as white-tailed deer *(Odocoileus virginianus)* and Canada geese *(Branta canadensis)*, which are used on a recreational basis (Minnis 1997, West and Parkhurst 2002, Coluccy et al. 2001). Conversely, it appears that acceptance capacity may be quite low for snakes, especially venomous snakes. In a survey of visitors to an eastern national park, strong support was indicated for all "wildlife." Respondents were not as supportive toward snakes as a group when asked whether snakes in the park should be killed (Greene 1997). Likewise, a survey of college students in Kansas indicated that individuals chose to deliberately hit a snake when crossing a road with their automobiles more often than any other animal (Langley et al. 1989). More recently, work conducted in Australia indicates that a low public tolerance for snakes persists. Whitaker and Shine (2000) surveyed residents in the Murrumbidgee Irrigation Area in southern inland New South Wales, and found that about half of the snakes observed by people were approached and about one-third killed. Reasons given for killing snakes included concern for animal and human safety, fear and hate. Despite the need to incorporate humans in conservation efforts, little specific information exists regarding the factors that affect stakeholder values, beliefs, attitudes and behaviors toward snakes, which could aid in their conservation.

The goal of this paper is to examine antecedents to acceptance capacity for snakes and associated human behaviors, particularly toward eastern massasauga rattlesnakes in Michigan, and to build a conceptual model or models to explain acceptance capacity and lethal or potentially lethal human behaviors toward snakes. The following sections describe the theoretical and conceptual framework for human-snake interaction models, actual and hypothetical explanations for low acceptance capacity for snakes and possible avenues of research that may be used to test the conceptual models presented.

2.2 Methods

An extensive literature review was conducted to determine what is known and currently believed about human-snake interactions. The review was conducted by searching electronic databases including Web of Science, Wildlife Worldwide and Agricola and the electronic card catalog of Michigan State University and University of Wisconsin libraries. Additionally, research-based books as well as gray literature on snakes were read and bibliographic information was utilized to uncover further informative resources. This path of inquiry led to social psychology literature, human psychology, risk and risk perception literature, anthropological literature, biological and ecological literature, communication literature, child development literature and environmental education literature. Information gleaned through investigation of these resources was then used to build a conceptual model to examine how an individual's beliefs, attitudes, and behavioral intentions toward snakes may be developed and maintained, and may determine an individual's acceptance capacity for snakes and associated human behaviors toward snakes. The resulting human-snake interaction models are based on factors known to be important in development and maintenance of human attitudes toward wildlife (Kellert 1996) and existing theories of human behavior. Theories include Ajzen and Fishbein's (1980) Theory of Reasoned Action (TRA), Azjen's (1991) more recently expanded version, Theory of Planned Behavior (TPB), and Riley and Decker's (2000a) proposed model of WSAC for mountain lions.

2.2.1 Explanation of Existing Models

A useful model for the importance, abundance and tractability of human traits, such as beliefs and attitudes, is represented by the cognitive hierarchy (Figure 2.1). It consists of values, basic beliefs, attitudes and norms, behavioral intentions and behaviors. Values are defined as desirable end states or qualities of life that humans hold dear (Rokeach 1973). People have few values as compared to attitudes or behaviors, but values are strongly held and seldom changed. An individual's beliefs are based on what he or she presumes "true" about a particular attitude object and its characteristics (Ajzen and Fishbein1980), regardless of factual accuracy. Eagly and Chaiken (1993) define an attitude as "a psychological tendency that is expressed by evaluating a particular entity with some degree of favor or disfavor." Subjective norms are beliefs held by a person about whether significant others (e.g. family, friends, etc.) approve or disapprove of particular behaviors that he intends to engage in (Zimbardo and Leippe 1991). Behavioral intention is the direct antecedent to behavior but even if a person intends to undertake an activity, he may not due to finances, lack of time, lack of belief in being able to do so, or some other reason (Zimbardo and Leippe 1991, Ajzen 1991).

One model of human behavior that has been used and tested extensively in human dimensions literature over the past two decades (Young and Kent 1985, Bright et al. 1993, among others) is the TRA. It is based on the assumptions that humans use information available to them and that humans are rational (Ajzen and Fishbein 1980). According to TRA, a person's intention to behave in a particular way is a result of that person's attitude toward the behavior and their perception of what other significant individuals think about the behavior in question and whether or not a person should or should not behave in such a way (i.e., subjective norms). These two elements hold varying levels of importance dependent on the behavior in question. Attitudes and subjective norms, in turn, are based on beliefs held by an individual about the behavior and how significant others think the person should or should not behave (Figure 2.2).

A second and more recent human behavior model, TPB, builds on TRA. According to TPB, a person's attitude toward a specific behavior, subjective norm about a behavior, and self-efficacy, i.e. level of perceived difficulty in performing a behavior (Bandura 1977), are antecedents to his or her intention to engage in a specific behavior (Figure 2.3). When a person possesses the necessary resources and opportunities, behavioral intention is the immediate antecedent to the behavior (Ajzen 1991).

Finally, Riley and Decker's (2000a) model of WSAC for mountain lions is based on TRA but incorporates risk perceptions as a predecessor of a person's acceptance capacity for cougars, and lack of issue activity or complaints regarding their populations to natural resource agencies. As a result, knowledge of, and attitudes and risk beliefs about, cougars are antecedents to a person's risk perceptions regarding cougars. Risk perception is the immediate pre-cursor to acceptance capacity for cougars (Figure 2.4).

2.2.2. Individual Acceptance Capacities and Behavior Components

Factors important in the formation of an individual's attitudes and associated behaviors toward wildlife species include: basic wildlife values, knowledge of wildlife, perceptions of individual species and the human-animal relationship (Kellert 1996). With regard to rattlesnakes, these factors may include beliefs/knowledge about rattlesnakes, attitudes about rattlesnakes, fear, the risk perceptions that are a product of the belief system that integrates an individual's values and attitudes with respect to the risk (Slovic 1987), and finally, an individual's behavioral intentions, based on their acceptance capacity for rattlesnakes. In turn, an individual's knowledge, beliefs and attitudes are a result of several other interacting factors that may include the effects of influential others, direct experiences, indirect experiences, and emotions such as fear. These factors, or model components, are discussed below.

2.3 Results and Discussion of Literature Review

2.3.1 Model Components

2.3.1.1. Effects of Influential Others

If a parent is fearful of or dislikes snakes, it is likely that this will result in a fear or dislike of snakes in his or her children. Children learn much of their gender and moral behavior by observing other people – parents are important models, but also others such as day care workers (Bandura 1977, Mischel 1970). Parents have great influence in the development of their children's attitudes toward specific objects and conceptions of appropriate behavior in a given situation (Berger and Thompson 1996).

Teachers also affect the development of an individual's beliefs, attitudes and behaviors toward wildlife, including snakes. Teachers convey wildlife knowledge to students, and often expose students to animals in the classroom. However, as Siemer et al. (1987) found, close to half (43.5%) of their preschool to grade 12 teacher respondents expressed fear in handling a snake, though 85% indicated they were tolerant of having the animals physically close to them. This fear of snakes may be transmitted to students, who may, in turn, develop fearful attitudes. Many teachers also lack knowledge about basic wildlife concepts and thus, are unable to transmit such knowledge and understanding to their students (Taylor and Samuel 1975).

Friends can also influence a person's attitudes and behaviors toward snakes. First, people choose friends based on commonalities, i.e., to surround themselves with individuals that hold similar characteristics such as gender and interests (Hartup 1989). Second, to maintain a network of peers, people have a tendency to change their traits to more closely match those of friends, and a person is less likely to hold an attitude or view that is radically different than that of his or her network (Heider 1958). This is especially relevant for children as they get older because they become increasingly dependent on their peers, not only for companionship but also for self-validation (Nelson-Le Gall and Gumerman 1984). If peers in an individual's network, especially dominant peers, dislike or fear snakes, an individual may adopt this "accepted" attitude toward snakes rather than risk rejection or being ostracized.

2.3.1.2. Direct Experiences

Childhood experiences with animals have been demonstrated as important factors in adult attitude development toward wildlife (Kellert 1976). One relevant trend in society has been the increased selection of reptiles as pets (Franke and Telecky 2001). Such purposeful and enduring experiences with reptiles likely influence people's attitudes toward these animals. It's important to note, however, that the vast majority of reptiles that are kept as pets are turtles (46% of reptile owners); snakes are kept by fewer than half as many individuals as turtles or lizards (Franke and Telecky 2001).

Encounters with snakes in the wild, generally unplanned experiences, can vary from being pleasant to neutral or unrecognized to being startling or scary. Due to the fast and sudden movements undertaken by children outdoors, an initial encounter with a snake *may* come as a surprise for both child and snake. Such experiences may certainly influence attitudes toward snakes; however, studies of snake phobia (i.e. ophidiophobia) indicate that such direct experiences account for < 10% of reported cases (Davey, 1992; Murray and Foote 1979).

2.3.1.3. Indirect Experiences

Family members or friends who have had encounters with snakes may also influence beliefs and attitudes via renditions they share with others regarding the incident(s). Many urban children have little or no exposure to natural environments, and having no previous exposure, their interpretations may be based not only on renditions shared by family or friends, but also other indirect experiences such as films, TV programs, zoos, museums, and books (Bixler et al. 1994). These sources may influence a person's attitudes toward the outdoors, as well as toward specific plants or animals.

Newspaper accounts can be an important influence on attitude and belief formation (Loker et al. 1999), especially when a person has no personal experience with an issue or attitude object. Riley and Decker (2000b) found that the majority of questionnaire respondents who asserted having involvement with cougars referred to vicarious experiences, such as newspaper accounts or second-hand stories. Likewise, newspaper portrayals may be important in attitude development toward potentially dangerous wildlife species, such as bears (Slovic et al. 1974), cougars and rattlesnakes. Riley and Decker (2000b) hypothesized that mass media reports of human-cougar conflicts were influential in stakeholders' perceptions of cougar densities and attitudes toward cougars. Slovic et al. (1979) stated that the sensationalism associated with accounts of venomous stings and bites made such accounts easily remembered and thus led to an overestimate of risk by people of fatal bite or sting due to animals such as rattlesnakes.

Snakes have appeared in literature for millenia (Nissenson and Jonas 1995). Written and spoken language can have a powerful impact on how an animal is portrayed, particularly when there has been no direct experience with the animal (Bixler et al. 1994). Many popular sayings such as "speaking with a forked tongue" can perpetuate beliefs that snakes are dangerous or evil (Mattison 1996). Crist (1999) theorized that the language with which animals were written may even determine human perception of animals as subjects - beings experiencing the world as a meaningful place rather than just existing in it, or animals as objects - with no control or comprehension of the behaviors in which they engage. Bart (1972) suggested that fairy tales and children's books dictated what animals we should and should not like. Along these lines, More (1979) examined children's books that featured wildlife. Of the 4,932 books that featured animals, about 5% (n = 253) mentioned reptiles or a group of reptiles in their titles. Over 60% referred to mammals and almost 20% featured birds. A greater number of titles (n = 347) featured insects or insect groups than reptiles. More posited that the number of titles that featured a species or group was indicative of the preference (i.e., popularity) for a species or group. It may also be indicative of the groups of wildlife that the authors themselves were most familiar with, and thus able to write about though that information was not obtained or mentioned in the study.

Myths and folklore are important influences in the development of beliefs and attitudes toward snakes (Menez 2003, Klauber 1982, Minton and Minton 1969). Snakes have figured in human mythology for millennia (Morris and Morris 1965, Nissenson and

Jonas 1995), primarily as an embodiment of evil (Burton 1993, Weidensaul 1991). Many myths and misconceptions about snakes are passed down from generation to generation (Brown and McDonald 2000), and because most people never or seldom have a direct experience with a snake, many misconceptions continue to be believed. One myth claims that if you encounter a snake, it will attack you. In fact, the opposite appears to be more likely the reality. A recent survey of Australian residents found that a significant portion (38%) of people attacked snakes that they encountered. In subsequent fieldwork walking along transects, researchers found that less than one in two hundred (0.38%) encountered snakes attacked. People were one hundred times more likely to attack than were the snakes (Whitaker and Shine 2000). Other myths are disseminated through popular literature; for example, in Kipling's (1894) *The Jungle Book*, readers are informed that snakes are fond of milk, and this idea has persisted despite its inaccuracy.

Snakes are among humankind's earliest gods (Nissenson and Jonas 1995). The earliest known snake shamans appeared about 3,500 years ago among the Psyllil of northern Africa (Minton and Minton 1969) and the earliest Egyptian symbol for goddess was the cobra (Nissenson and Jonas 1995). Snake-handling religious sects exist in at least six states (TN, KY, VA, WV, MI and IN) within the contiguous U.S. (Burton 1993). Members of these sects pick up serpents as a demonstration of their faith as they interpret the New Testament writings of Mark 16: 17-18: "And these signs shall follow them that believe; In my name shall they cast out devils; they shall speak with new tongues; they shall take up serpents; and if they drink any deadly thing, it shall not hurt them; they shall lay hands on the sick, and they shall recover" (Brown and McDonald 2000, Schwartz 1999, Burton 1993). Interestingly, more cults have been devoted to snakes than any other animal (Nissenson and Jonas 1995). Individuals who subscribe to various religions may have beliefs and attitudes about snakes associated with their religious beliefs. For example, Christoffel (unpub. data) interviewed a devout Lutheran from MN who was adamant that snakes are an embodiment of evil and that the story of Eve and the snake contained in Genesis was meant to be taken literally. For a complete review of myths and folklore about rattlesnakes, see Klauber 1982 or Nissenson and Jonas 1995.

Policies governing conservation and management of snakes contribute indirectly to the development and maintenance of human beliefs and attitudes toward snakes. Bounties offered and paid by county governments for rattlesnakes may be the most influential policy affecting stakeholder beliefs and attitudes toward snakes, particularly rattlesnakes. Several WI counties paid bounties on timber rattlesnakes and eastern massasaugas until 1975, at which time the eastern massasauga was placed on the state's endangered species list (Vogt 1981). Bounties were paid in MN to rattlesnake hunters until 1989 (Oldfield and Moriarty 1994) – the timber rattlesnake was state-listed as threatened in 1996, and though some concerted searches have been made, no eastern massasaugas have been reported in more than ten years (Oldfield and Moriarty 1994, Naber et al. 2004). Paying bounties for dead rattlesnakes communicates the message to stakeholders that rattlesnakes are of economic worth when dead, but not when alive.

In addition to bounties, many states have allowed rattlesnake roundups to persist despite their potential impacts to non-target species (Campbell et al. 1989) and to local snake populations by way of direct exploitation and disturbance of rattlesnake habitats (Warwick 1990, Arena et al. 1995, Fitzgerald and Painter 2000). It has been estimated that a minimum of 300,000 rattlesnakes are harvested annually in the US for round-ups and commercial processors (Warwick et al. 1991). The epitome of such roundups can be found in Sweetwater, TX, where Jaycee publications state that the roundup was initiated as a way to reduce, if not extirpate, the rattlesnake population (Weir 1992). This echoes the message that snakes are valuable when dead and valueless when alive.

Once collected, the rattlesnakes are often mistreated, and at some roundups, animals are skinned and butchered in public (Weir 1992, Arena et al. 1995, Fitzgerald and Painter 2000). Such treatment of rattlesnakes illustrates to attendants that rattlesnakes are not worthy of humane treatment and that it is perfectly appropriate to skin and butcher rattlensakes in public. While it's true that some states and sponsoring organizations have discontinued roundups or changed the rules so that snakes are no longer killed outright at such events, other states and sponsoring organizations have not. These events perpetuate non-humane treatment toward snakes because they sensationalize risk-taking for personal thrills (Thomas and Adams 1993), public adulation and prize money (Weir 1992) and permit the deaths of numerous snakes (both target and non-target species) due to injuries sustained while being captured and stress incurred during captivity (Campbell et al. 1989, Weidensaul 1991).

Organizers have claimed that rattlesnake roundups are held, in part, for educational purposes (Weir 1992); however, when tested, attendees leaving a roundup had similar knowledge levels about rattlesnakes whether or not they attended the educational program (Fitzgerald and Painter 2000). Such results hardly support the previously claimed benefit of education.

Historically, wildlife biologists have been engaged in game species management (Lancia 2005) and have largely ignored reptiles and amphibians (Scott and Seigel 1992).

At times, snakes have incidentally benefited from wildlife management aimed at other species, such as waterfowl, though timing of such management is critical in determining its beneficial or detrimental impact (Seigel 1986). Recreational activities on public lands may also be detrimental to slow-moving ectotherms. Seigel (1986) found that traffic was the most important activity impacting an eastern massasauga population present on a national wildlife refuge, with mortality patterns correlating directly with traffic patterns.

Protection for venomous snakes is unusual, and only comes when a species is on the brink of extinction (Weidensaul 1991). There is often great political pressure to refrain from listing snakes, or engaging in sound biological management of snake populations (Seigel 1986). Most regulations in the US governing the possession and sale of native reptiles, including snakes, are recent (Levell 1997). The only regulatory protection afforded western diamondback rattlesnakes (*Crotalus atrox*) in TX as of 1993, was that a hunting license was required to collect <u>any</u> vertebrate animal – no permit or license was legally required for the possession or sale of rattlesnakes (Adams et al. 1994) until after the turn of the century (Texas Parks and Wildlife 2004). In a survey of pet stores in NY, Hohn (2003) found that employees in at least five of thirty-seven stores queried, relayed incorrect information about regulations for native reptiles and amphibians. This misinformation was presumably relayed to customers interested in purchasing a reptile or amphibian as a pet and this in turn, helped perpetuate the collection of native reptiles and amphibians for the pet trade (75% of the reptiles sold in NY were reported as collected from the wild).

2.3.1.4. Knowledge

It may be more important that an individual understand the interconnectedness of animals within an ecosystem rather than specific factual information on snake species, per se, in order to appreciate the role of snakes in nature and to develop increased tolerance for snakes. Richmond (1977) demonstrated that conceptual knowledge rather than factual knowledge was more positively related to the formation of positive environmental attitudes and it may follow that this can be applied in terms of concern for wildlife species such as snakes. Kellert (1996) explains his "ecologistic" wildlife value orientation and associated worldview as one that emphasizes the interdependence among species and habitats. Ecologistic value orientations seem to be on the rise in the U.S. (Kellert 1996), an encouraging trend given the low level of snake specific knowledge possessed by the general public. For example, when responses of children and adults were compared regarding wildlife knowledge (Kellert and Berry 1980), it was revealed that only 31% of the children and 52% of adults responded correctly to the true/false statement, "Snakes have a thin covering of slime in order to move more easily."

2.3.1.5. Emotions and Attitudes about Snakes

There are a variety of emotions and attitudes that are associated with snakes, but prior literature is only available for a few. This includes fear, the evaluative attitude of like or dislike toward snakes, and perceived risk, which consists of both a cognitive, i.e. risk beliefs, and an affective or emotional component, i.e. fear or anxiety.

Fear is believed to be the most common emotional response to snakes (Shalev and Ben-Mordehai 1996), and has been identified as the major obstacle to snake conservation in India and as a contributing factor elsewhere (Seshadri 1984). Considerable research has been conducted regarding ophidiophobia and fear of snakes (Gear and Turtleltaub

1967; Blanchard 1969; Evans 1981: Davey 1994; among others). Though it is often believed that a large percentage of people are ophidiophobic, research results indicate that this is true for only 2-3% of the population (Lang and Lazovik 1963; Klieger 1987). In most instances, snake-fearful individuals are not truly phobic, but a large percentage of people in the U.S. (>50%) may feel at least mildly uncomfortable around snakes (Steinhart 1984), and in a national survey of more than 3,000 ten- to twelve-year-olds, 42% expressed a fear of snakes (Westervelt and Llewellyn 1985). Maurer (1965) reported that the vast majority of five- and six-year-olds, and more that half of seven- to twelve-year-olds reported reptiles as things to be afraid of, and most frequently, snakes. Snakes have also been reported to be among the most feared animals in a number of other surveys (Bowd 1983, Bennett-Levy and Marteau 1984; Merkelbach et al 1987; Davey 1994).

Research conducted at zoos and natural areas lends further support for the discomfort or fear than many people feel around snakes. Hoff and Maple (1982) reported that female visitors engaged more in avoidance behaviors and spent less time in zoo reptile exhibits than males, and teenagers spent more time in exhibits and refused to enter less often than children or adults. When visitors' comments regarding their avoidance of the reptile house were investigated, emphasis was placed on snakes rather than reptiles or reptile exhibits generally. Meyers et al. (2004) reported that zoo visitors experienced a greater intensity of fear and disgust when observing snakes than gorillas (*Gorilla gorilla*) or okapis (*Okapi johnstoni*). Interpreters, who were queried regarding urban students' uncomfortable behaviors and expressed fears when visiting wildland areas, most frequently cited fear of snakes (Bixler et al. 1994).

Debate has been ongoing regarding the origins of snake fear in humans (Ohman and Mineka 2003). Many people believe that snake fear is an innate trait, rather than a learned one (Wilson 1984). Evidence has been presented for both explanations, with most research having been conducted on non-human primates. Yerkes and Yerkes (1936) found that infant chimpanzees (*Pan troglodytes*) responded more to movement than to a particular object, showing greater fear responses to an active gopher tortoise (*Gopherus* polyphemus) than to an inactive glass lizard (*Ophisaurus sp.)* (an animal that morphologically resembles a snake, but is easier to handle). No evidence was found to support a specific fear response prior to or apart from individual experience with a given object type. Joslin and others (1964) compared responses of wild and lab-reared rhesus monkeys (*Macaca mulatta)* to snakes and snakelike objects. They reported that only wild-reared monkeys were consistently strongly fearful of snakes and concluded that fear is not innate, but learned. Maurer (1965) alternatively postulated that fear of being eaten by wild animals or poisoned by snakes may hold an evolutionarily-based ease of arousal. Mineka et al. (1980) presented evidence that observational conditioning is involved in the development of fear of snakes in rhesus monkeys. More recently, it has been asserted that snakes remain special stimuli for humans, and that fear of snakes is learned more easily than fear of most other stimuli (Ohman and Mineka 2003). A human evolutionary biologist has recently reported the hypothesis that the presence of venomous snakes was responsible for the development of forward facing eyes and keen eyesight in primates, including humans (Isbell 2006).

Fear is important, in particular, in terms of attitudes and behavioral intentions toward snakes due to its important influence on risk perceptions and the difficulty in extinguishing fear of snakes once it has been developed or activated (Ohman and Mineka 2003). Fear can lead to heightened risk perceptions regarding snakes, because of the tendency of highly fearful humans to over-predict risk. This overestimate comes from two sources: first, an over-prediction of the danger elements of a fearful object such as a snake, and secondly, an under-prediction of existing safety resources, such as the proximity of escape routes (Wright et al. 2002). Venomous bite or sting has been reported as one of the most overestimated causes of death (Slovic et al. 1979). Some likely reasons for this finding include the ways in which people judge risk. People are likely to judge an event as common or likely if it is easy for them to recall such events, or just by discussing such a hazard (Slovic et al. 1979). Given the memborability of newspaper accounts regarding wildlife attacks of various kinds, it seems likely that people who read such accounts are likely to judge such events as common, despite their rarity (Slovic et al. 1974, Slovic et al. 1979). Perceived risk was a determinant of desired population trends for mountain lions (Riley and Decker 2000a) and this same pattern may hold true for snakes, especially rattlesnakes.

Risk beliefs constitute the cognitive component of risk perception and are important to the formation and maintenance of a person's risk perceptions regarding a potential hazard (Keeney 1995). Riley and Decker (2000b) reported that the variable "risk beliefs" was one of three included in a model that predicted respondents' desire for future populations (as a proxy for WSAC) of cougars 85% of the time. Although rattlesnakes are not large carnivores like cougars, a bite from such a snake can pose considerable pain and risk to a person (Keyler 2005). Thus, information regarding perceived risk about a large carnivore such as a cougar may also be applicable to rattlesnakes.

During a series of semi-structured interviews ($n = 60$), the reason most often given by interviewees for not wanting to share their properties with rattlesnakes was the risk posed by the animal's presence (Christoffel, unpub. data). When probed, interviewees expressed that they were especially *fearful* for small children and old people that came and visited their properties. Interviewees were also asked to place pictures of animals representing the amphibian and reptile groups present in their state on fear and like scales. There was a strong inverse relationship between fear and like levels. Animals, such as frogs, that were not feared at all by interviewees were well-liked, while rattlesnakes (represented by V Snake) were not (Figure 2.5). Fear and like scores for each animal group were highly correlated (Fink 2003) ($r = 0.98$, $p < 0.01$).

A factor that can interact with an individual's fear of, and knowledge about, snakes is an individual's perceived risk from snakes. Individuals that are fearful of snakes are likely to feel at great risk when they are near one. This perception is related to an individual's knowledge of the risk presented and the dread associated with that risk. Risk perception research shows that unknown risks are characterized as not observable, unknown, or having a delayed impact, while dread risks are characterized by involuntary exposure, catastrophic potential, dire results, and an unfair allocation of risks and benefits (Slovic 1987).

Aspects of human-snake encounters that contribute to unknown risk perceptions may include an individual's lack of knowledge about local snakes. For example, most Australians were unable to identify and distinguish even the most abundant snakes living in their area (Morrison et al. 1983), an important skill to have when living and recreating in a country where there are more venomous than non-venomous snake species (O'Shea 2005). A second aspect may be the perceived lack of visibility of the risk. Many snakes, such as eastern massasauga rattlesnakes, are cryptically patterned and often undetected by people who cross the snake's path, even when within striking distance (Prior and Weatherhead 1994; Whitaker and Shine 1999). Aspects of dread risks that are manifested in human-snake encounters include involuntary exposure, and perhaps a perceived unfair allocation of risks and benefits (i.e. the public at large benefits from the existence of snakes, yet, only some people ever have to risk encountering one or being bitten by one on their properties) and the potential for catastrophe. Riley and Decker (2000a) posited that cougar attacks on humans may present the sort of low probability, high consequence event that leads to elevated risk perceptions. In Michigan, only a handful (six to eight) of eastern massasauga rattlesnake bites are reported annually (Susan Smolinske, MI Poison Control Center, pers. comm.) and there are no documented fatalities due to bites. However, a rattlesnake bite may still be perceived in much the same way as a cougar attack. Fearful individuals may also perceive a short decision time when they encounter a snake. This can be explained in part by the perceived threat and the probable close proximity of the snake to the individual before being detected due to its cryptic coloration and lack of movement (Steinhart 1984).

An additional factor that may contribute to heightened risk perceptions when a human encounters a snake is the desirability of the interaction. Alhakami and Slovic (1994) reported that people tended to judge benefits as high and risks as low when they were doing an activity they liked, but their judgments were opposite – low benefit and high risk – when doing an activity they disliked. If a person doesn't like the prospect of encountering a snake, it is probable that he or she will judge the benefits as few and risk as high of the encounter. Alternatively, if a person seeks out an encounter with a snake, it is likely that he or she will perceive high benefit and low risk from the activity.

2.3.2 Proposed conceptual models of human-rattlesnake interactions

The TRA (1980), TPB (1991) and Riley and Decker's proposed model of WSAC for mountain lions (2000a) largely help to explain the cognitive part of human behaviors toward wildlife. Riley and Decker acknowledged the importance of the affective component of risk perceptions and attempted to incorporate a measure of affect through risk beliefs, such as whether or not respondents felt that the same people who benefited from the presence of cougars in Montana were the same as the people who were at risk from cougars in Montana. However, unlike cougars or other large mammalian predators that have been previously studied, snakes present a 'special' stimulus for people in terms of fear (Ohman and Mineka 2003), an affective component of human behavior toward snakes. Because of this, it is essential that we move past a strictly cognitive explanation for human behaviors and acceptance capacities for snakes, and incorporate the influence of fear and the associated stress that is introduced when a fearful individual encounters a snake. This is especially important given the large percentage of individuals who are estimated to be at least mildly uncomfortable around snakes (Steinhart 1984), and the large percentage of human-snake encounters that come as a surprise to the human, the snake, or both parties. In these cases, a human is making a behavioral decision under stress and strictly cognitive models are not as likely to account for behavior.

An alternative model that may help to explain human behaviors toward snakes when an individual's cognitive abilities are compromised, such as in a stressful encounter, is Fazio's (1986) attitude-behavior process model (Figure 2.6.). It is based on the premise that behavior is largely determined by an individual's perceptions and subsequent definition of a given situation (Fazio 1986). Attitude, and its accessibility, i.e. risk perceptions in the case of snakes, is perhaps the most important element in the model because of its 'filter' function within the entire attitude-behavior process. Fazio's model helps to explain the affective part of human behaviors toward snakes and may be applicable when one is surprised or stressed by a snake encounter. One acts before one reflects. In such cases, a person's ability to consider safe alternatives, positively identify the snake, and clearly think through the situation is compromised (Wright et. al 2002). Likewise, Zajonc (1980) posited that affective reactions to stimuli are often our first reactions, and may guide subsequent information processing and judgment.

Based on the above literature review, two models were fashioned after Azjen and Fishbein's TRA, Fishbein's TPB, Riley and Decker's WSAC model for mountain lions and Fazio's attitude-to-behavior process model (Figures 2.7a and 2.7b). Unlike any of the models on which they are based, my models incorporate fear as a separate component or determinant, of risk perceptions, and subsequent behavioral intentions and behaviors. This is because of the influence, or impact, of fear on associated risk perceptions and behaviors as outlined previously. Additionally, the models do not incorporate all elements of the cognitive hierarchy but instead, are truncated because this research did not focus on values or value orientations. This does not preclude these elements; they simply are not the focus of the current research project.

In the first model, that of a planned encounter or behavior toward a rattlesnake (Figure 2.7a), we begin with beliefs as they pertain to wildlife, and more specifically rattlesnakes, and beliefs as they pertain to subjective norms, i.e., what others think an individual should or should not do in the presence of rattlesnakes, as the antecedents to all other elements in the model. From beliefs, the models flow to fear, an affective component of risk perception. Past research on fear of snakes by non-human primates indicates that "fear" must be learned, i.e. particular beliefs about snakes as dangerous must be formed prior to the development of fear, such as through behavioral examples provided by experienced adults (Mineka et al. 1984). Thus, beliefs about rattlesnakes contribute to risk perceptions directly but also indirectly, through their influence on fear levels held by individuals toward snakes.

Subjective norms result from the beliefs an individual holds regarding what other important people in that individual's life or social circle, think the individual should or should not do when encountering a rattlesnake. Subjective norms and attitudes work in concert to form behavioral intentions as presented in TRA (Figure 2.2).

Risk perception is hypothesized to be an attitude or evaluative judgment (Slovic 1987) in terms of rattlesnakes that results from (1) an affective component such as fear, and (2) beliefs, and thus, this component is subsequent to these elements. However, risk perceptions can interfere with further information processing, i.e., belief formation, as stated previously in this manuscript, and therefore, the arrow that flows between risk perceptions and rattlesnake beliefs is double-ended. Risk perceptions then flow to behavioral intentions (Figure 2.7a). As in the case of TRA (Figure 2.2), behavioral intentions are the immediate precursors to behaviors toward rattlesnakes.

In the model of a surprise encounter with a rattlesnake, we begin with attitude activation (Figure 2.7b), per Fazio (1986). I haven't included norms in this model because it seems unlikely that a person reacting under stress accesses thoughts about what others think they should or should not do in the situation. Instead, once attitudes are activated, especially in the presence of stress, selective processing of the situation occurs and risk or hazard perceptions regarding rattlesnakes are activated. From risk perceptions, the event or encounter is defined, and resulting behaviors ensue. This difference in chronology of the process may be due to an impairment of cognitive abilities that is present during stressful situations (Wright et al. 2002), such as the strong sensory experience provided by the surprise encounter (Sjoberg 1998).

The arrows in the models indicate that the processes are not necessarily linear or unidirectional. Instead, model elements are highly integrated into a mental representation of the attitude object, i.e. rattlesnakes. Because of the interconnectedness of the components, a change in any one component may lead to change in another (Zimbardo and Leippe 1991). For example, a change in behavior may necessitate a change in beliefs and/or attitudes when cognitive dissonance has been created (Festinger 1957).

2.4 Suggestions for Model Testing

The two conceptual models (Figures 2.7a and 2.7b) of human behaviors toward rattlesnakes presented here are testable in several ways. We can test the strength of relationships between beliefs and behavioral intentions by asking people about their beliefs and behavioral intentions toward snakes (see Chapter 3, this ms), although this portion of the model is a replicate of TRA and has been tested and validated via research that has been conducted during the past twenty years. This particular test is relevant to the model of a planned encounter with a rattlesnake (Figure 2.7a).

We can test the strength of the relationship between fear and attitudes by asking people directly about their fears and evaluation of the attitude object of interest, i.e. rattlesnakes. This was done in an informal sense by Christoffel (unpub. data and Figure 2.5). The two constructs are highly correlated but we are unable to ascribe causality.

We can test whether engaging in behaviors may cause positive changes in beliefs by surveying fearful individuals regarding their beliefs about snakes, having them touch or handle snakes, and then re-surveying them regarding their beliefs about snakes, i.e., a test of the effects of cognitive dissonance on prior beliefs (Festinger 1957). However, prior research with 5^{th} – 8^{th} grade girls indicated a prevention of dissonance arousal after handing snakes and an increase in negative attitudes toward snakes after touching them in a program (Morgan 1996). Morgan posited that females may not have felt motivated to change their beliefs or attitudes toward snakes after touching one as would happen under the theory of cognitive dissonance (Festinger 1957), but instead, may have felt forced into touching the snakes due to peer pressure.

The relationship between behavioral intentions toward snakes and acceptance capacities toward snakes may be investigated by asking individuals about their acceptance capacities and behavioral intentions toward snakes, and examining their responses for correlation.

Similarly, the relationship between fear levels and behavioral intentions toward snakes can be investigated by asking individuals about their level of fear toward snakes and associated behavioral intentions, and examining the correlation between these two measures.

The conceptual models of human-rattlesnake interactions presented here (Figures 2.7a and 2.7b) are hypothetical, but their elements are supported by literature from various realms and there are ample opportunities to test various aspects of the models, as illustrated above. An adaptive management approach, using a framework such as that proposed by Riley et. al (2002) under the guise of adaptive impacts management (AIM) may then be used to guide efforts to reduce lethal human behaviors and increase acceptance capacity for snakes.

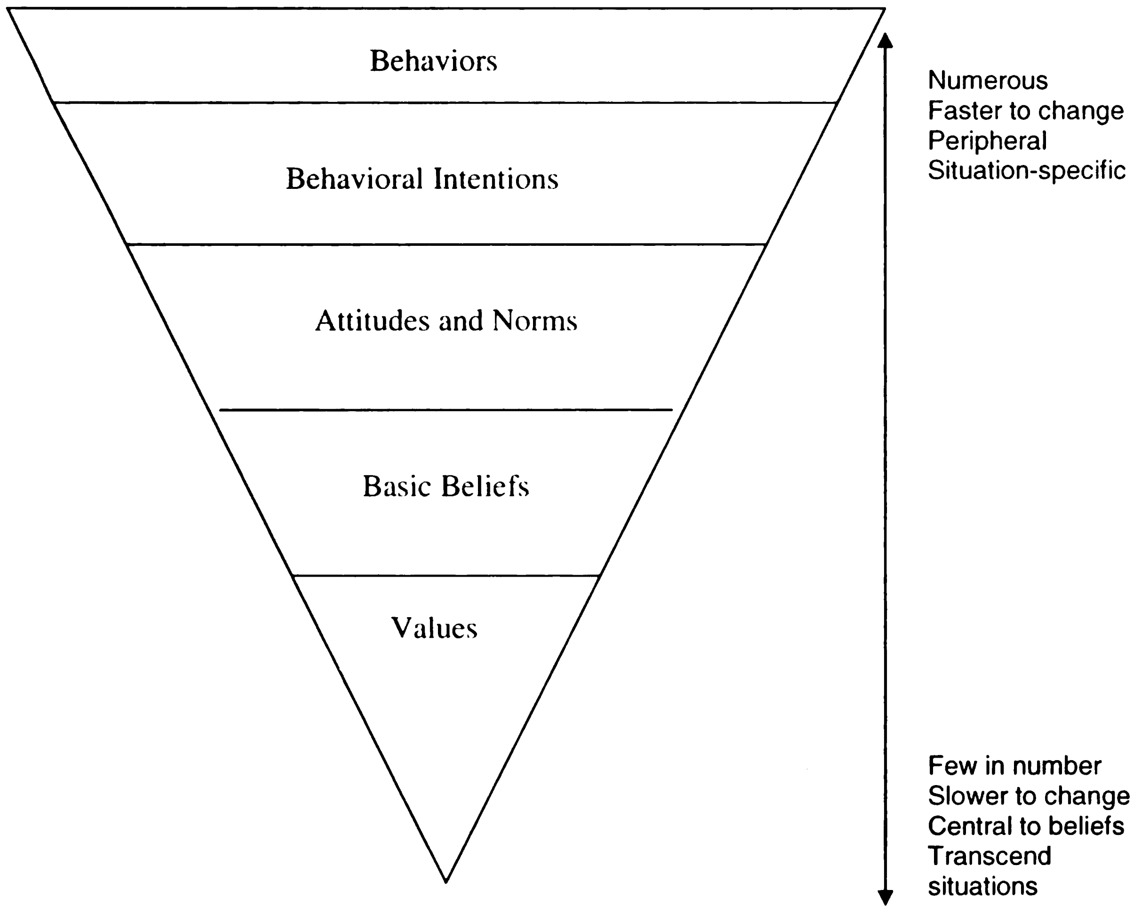

Figure 2.1. Cognitive hierarchy, adapted from Pierce et. al, in Decker et al. 2001.

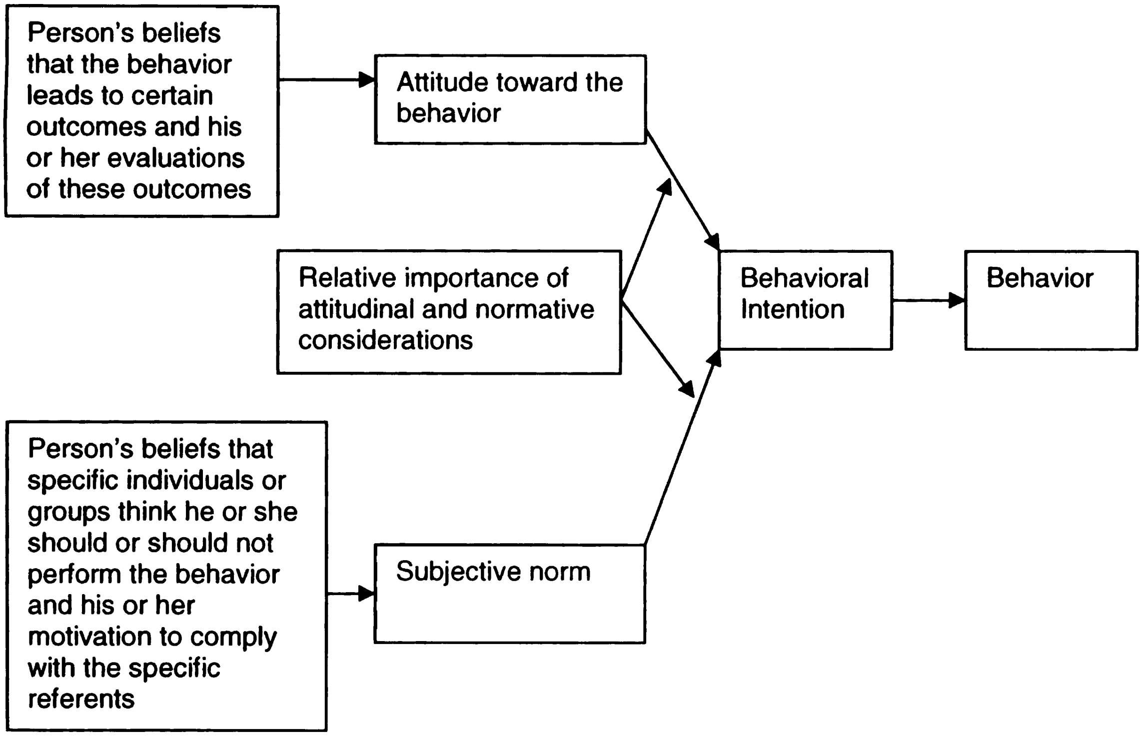

Figure 2.2. Factors determining a person's behavior according to the Theory of Reasoned Action (adapted from Azjen and Fishbein 1980).

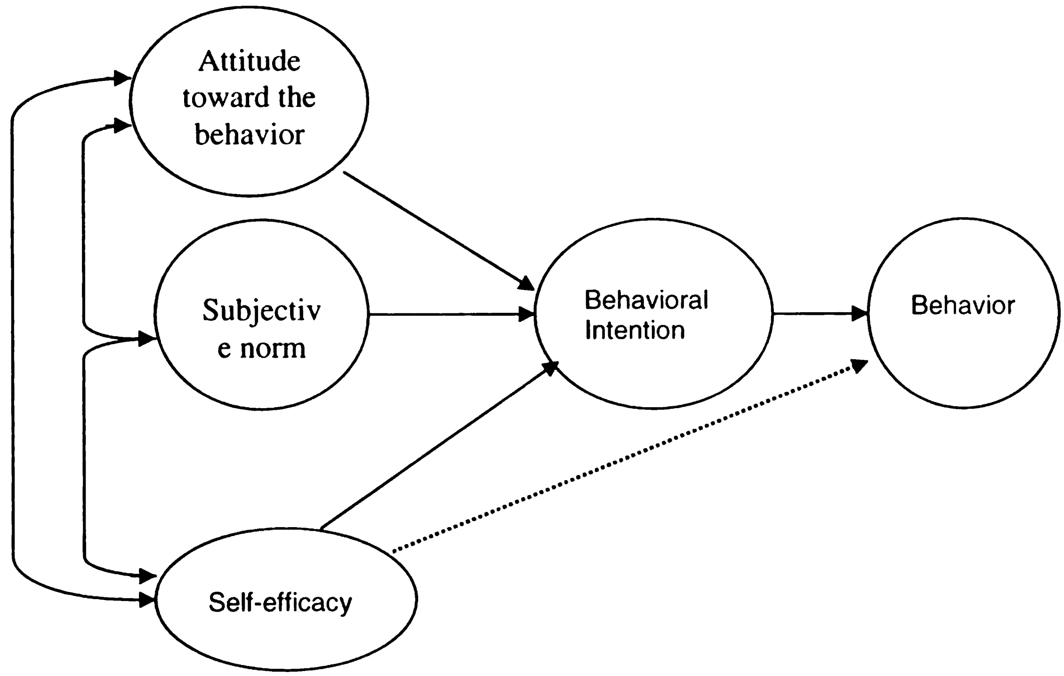

Figure 2.3. Theory of planned behavior (TPB) adapted from Ajzen 1991.

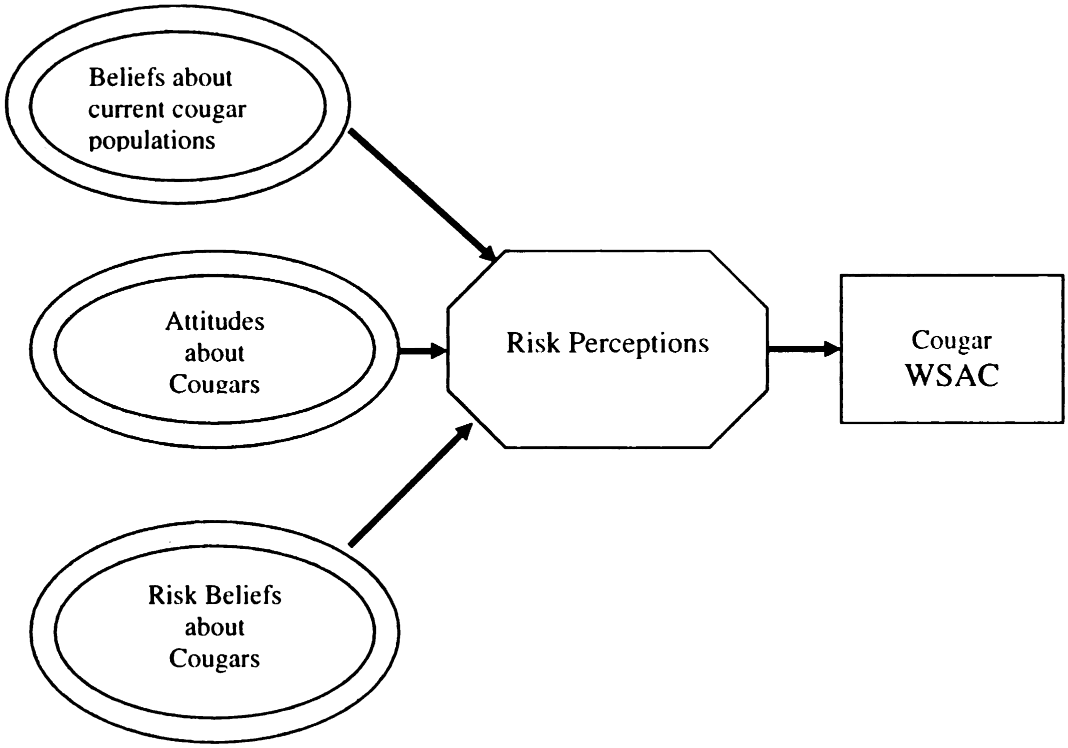

Figure 2.4. A conceptual model of wildlife stakeholder acceptance capacity (WSAC) for cougars (adapted from Riley and Decker 2000).

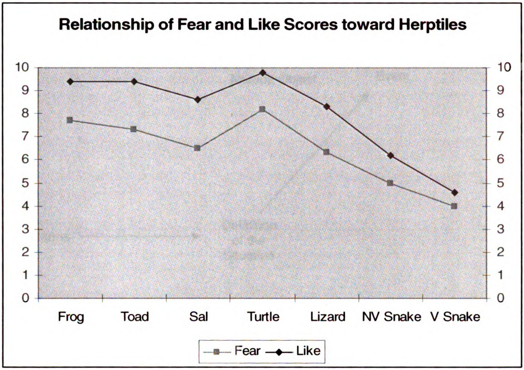

Figure 2.5. Average fear and like scores for MI and MN semi-structured interviewees (*n* = 60). (Sal = Salamander, NV Snake = non-venomous snake, and V Snake = venomous snake) For like scores, a "0" represents the sentiment, "The only good one is a dead one", a "5" represents neutrality and the sentiment, "I can take them or leave them", and a "10" represents the sentiment, "This is one of my favorite groups. I would do whatever I could to help this group, such as managing habitat or donating money." For fear scores, a "0" represents being phobic and the sentiment, "If there is a TV program on in the room that features this group, I am unable to stay in the room," while a "10" represents a total lack of fear, and the sentiment, "I feel perfectly comfortable around this group, and would not hesitate to pick one up and move it should that be necessary."

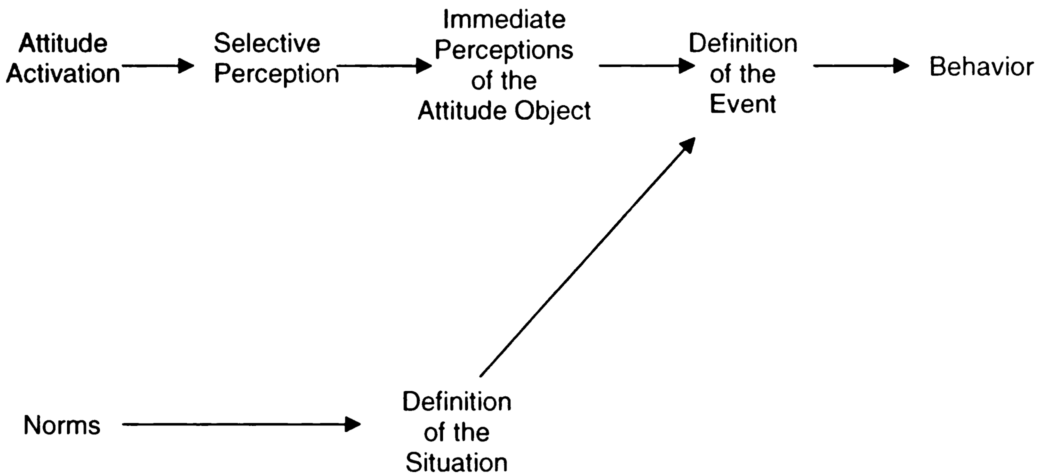

Figure 2.6. An attitude-to-behavior process diagram, modeled after Fazio (1986).

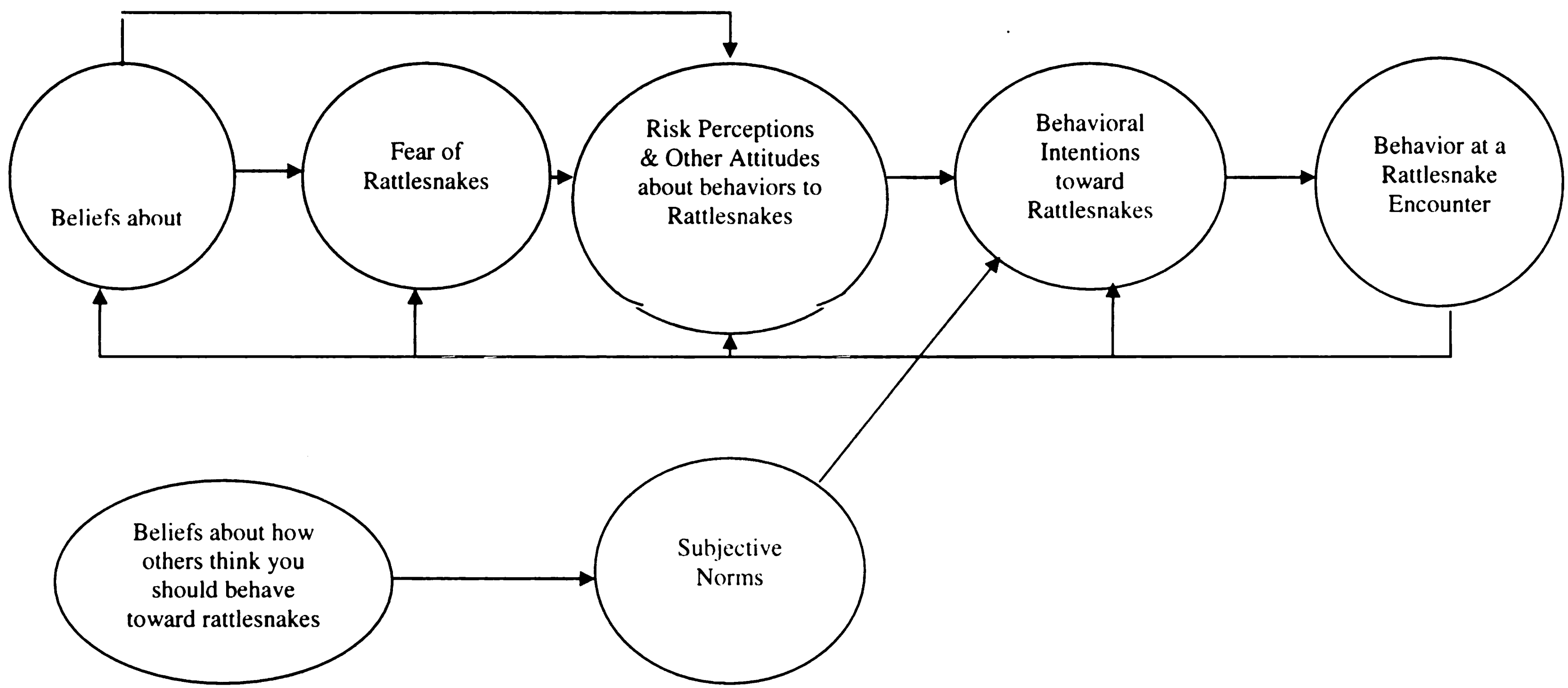

Figure 2.7a. Conceptual model (per Christoffel) of human behavior toward rattlesnakes in a planned encounter.

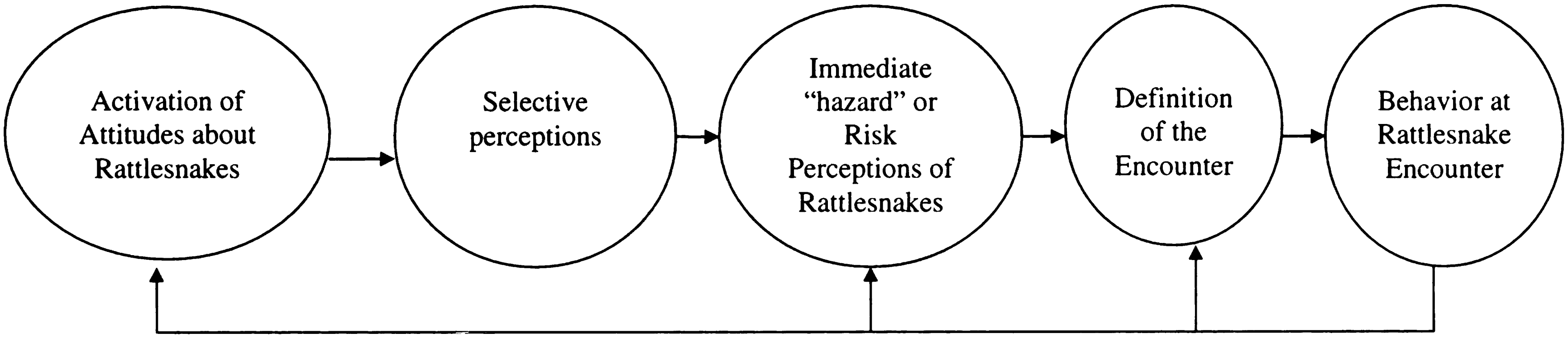

Figure 2.7b. Conceptual model (as conceived by Christoffel) of human behavior toward rattlesnakes when an encounter is unplanned, i.e. a surprise.

CHAPTER 3

SURVEY OF HUMAN BELIEFS, ATTITUDES AND BEHAVIORAL INTENTIONS TOWARDS NON-VENOMOUS SNAKES AND RATTLESNAKES

3.1 Introduction

Insights from human dimensions research increasingly are incorporated into natural resources management (Decker et al. 2001). Theory and methods used in human dimensions research have drawn heavily from social psychology, which is the study of people's perceptions and interpretations of the social world (Aronson et al. 1999). A cognitive approach has been proposed as a means to examine human attitudes and behaviors toward wildlife (see Chapter 1 of this ms, Pierce et al. 2001). This approach is based on the cognitive hierarchy (Chapter 1, Figure 1.1, Fulton et al. 1996), which predicts that people's values determine their attitudes, which, in turn, affect behavioral intentions and ultimately, human behaviors (Pierce et al. 2001).

As noted (Chapter 2, this ms), one human behavior model often incorporated into human dimensions research on attitudes and subsequent behaviors is the Theory of Reasoned Action (Ajzen and Fishbein 1980; Figure 2.2, this ms). This model was later expanded to include self-efficacy and termed the Theory of Planned Behavior (Ajzen 1991; Figure 2.3, this ms).

Kellert (1996), without reference to any existing human behavior model, posited that the factors important in the formation of an individual's attitudes and associated behaviors toward wildlife species include: wildlife values, knowledge of wildlife, perceptions of individual species and the human-animal relationship. However these elements can be referenced back to TRA to include beliefs, i.e. knowledge of wildlife; attitudes, i.e., perceptions of individual species; and behavioral intentions, i.e., the specifics of the human-animal interaction. Specifically to rattlesnakes, this may include knowledge of rattlesnakes, attitudes about rattlesnakes, risk beliefs about rattlesnakes, the risk perceptions that are a product of these three factors, and finally, behavioral intentions. A person's knowledge, beliefs and attitudes are a result of factors such as direct and indirect experiences (see Chapter 1, this ms). Some factors may be more influential than others and may be context-dependent.

Snakes pose a special case of human-wildlife interactions for three reasons. First, venomous snakes pose potential risks and non-venomous (NV) snakes create perceptions of personal risks to humans. Thus, both taxa are commonly feared (Seshadri 1984, Steinhart 1984, Westervelt and Lewellyn 1985, Shalev and Ben-Mordehai 1996). Second, humans generally do not value snakes. In semi-structured interviews conducted in MI and MN (n = 60), the only advantages most individuals mentioned for sharing their properties with snakes were pest control and existence value (Christoffel, unpubl. data). Third, most people know little about snakes, e.g., only 31% of child and 52% of adult respondents knew snakes were not covered with a coating of slime (Kellert and Berry 1980).

Past work to study human traits toward snakes has centered on human fear (Gear and Turteltaub 1967, Evans 1981, Somervill et al. 1981, Klieger 1987, Merkelbach et al. 1987, Bixler et al. 1994, Davey 1994 among others) toward snakes. However, early research also found that snakes were among the least liked animals by adults, with only wasp, rat, mosquito, cockroach and spider ranking lower in a survey of thirty-three species (Kellert and Berry 1980) and only rat and scorpion ranking lower by children in a survey of thirty species (Bart 1972). Children ranked the snake as *the* most unpopular animal in the United Kingdom (Morris 1960) and Czechoslovakia (Surinova 1971). Hoff and Maple (1982) reported a greater avoidance of the zoo's reptile house by females than males, with snakes being mentioned in thirty-seven of thirty-eight overheard conversations. Kellert and Berry (1979) reported that survey respondents were less likely to support the protection of an endangered snake than a mammal or bird. Seventy-three percent of their respondents supported protection of mountain lions *(Puma concolor)*, whereas only 43% indicated support for protection of the eastern indigo snake (*Drymarchon corais couperi)*, a large NV snake found in the southeastern United States (Conant and Collins 1991). Zoo visitors cared more about saving gorillas (*Gorilla gorilla*) and okapis (*Okapia johnstoni*) than snakes and reported having greater feelings of disgust and fearfulness and lesser feelings of attraction, caring, peacefulness and a sense of beauty while observing a snake than a gorilla or okapi (Meyers et al. 2004). College students reported that they would deliberately hit a snake more often than any other animal if seen crossing a road (Langley et al. 1989). Whitaker and Shine (2000) observed that humans were 100 times more likely to attack a snake than a snake was to attack a human in Australia.

In contrast to the above findings, many of the (forty-five) individuals who participated in focus groups in OH supported protection for timber rattlesnakes and were opposed to commercial collecting and wanton killing (Zuefle 2000). Koval and Mertig (2002) reported that 53% of their MI respondents thought protecting endangered reptiles was *very* important; only 8% thought that protecting reptiles was *not at all* important.

Conflicting reports of people's attitudes toward snakes highlight a need to better understand how people perceive snakes. There is a need for more directed studies of human-snake relationships and interactions for their management, especially given the number of snake populations that are either in decline or for which we have very little information. Twenty-three species and subspecies of snakes are listed as threatened or endangered in at least one of six Midwestern Great Lakes states (IL, IN, MI, MN, OH, and WI). Two are venomous, the eastern massasauga rattlesnake (*Sistrurus catenatus catenatus)* and the timber rattlesnake (*Crotalus horridus horridus),* and are listed by United States Fish and Wildlife Service (USFWS) Region 3 as Regional Conservation Priorities (USFWS 2002).

The eastern massasauga rattlesnake is a candidate for listing under the federal Endangered Species Act (ESA) (USFWS 1999). It is listed as threatened or endangered in every state (WI, MN, IA, MO, IL, IN, OH, PA, NY) and province (Ontario) in which it is found (Ernst and Ernst 2003), except MI in the geographic center of its range. Although bounties are no longer paid, there is evidence of human persecution occurring at numerous sites across the species' range, including within MI (Legge 1996). Szymanski (1998) identified the top two causes of declining eastern massasauga populations as habitat loss and persecution; the magnitude of known population declines varied from 33% in MI to 100% in MN. In MI, the species is listed as special concern and is protected by a Department of Natural Resources (DNR) Director's order, prohibiting the keeping of the species or its parts, without a permit issued by DNR.

The timber rattlesnake is under consideration for listing as a candidate species under the federal ESA. It has been extirpated in RI and ME, and is listed as endangered (CT, MA, NH, NJ, OH, VT, VA, IN) threatened (IL, NY,TX, MN) or a species of special concern (PA, WV, WI) in fifteen states (Ernst and Ernst 2003, IN DNR 2007, MN DNR 2007). More than any other factor, human exploitation through harvest, particularly the high proportion of reproductive females taken during such harvests, has been suggested as the cause for recent depletions and extirpations of many timber rattlesnake populations (Brown 1993). MN discontinued offering bounty payments on timber rattlesnakes in 1989 (Oldfield and Moriarty 1994) and listed the species as threatened in 1996 (MN DNR 1998).

MI and MN each currently host only one rattlesnake (RS) and more than a dozen NV snake species (Hohlman et al. 1999, Oldfield and Moriarty 1994). NV snakes pose no risk to humans, other than a potentially startling encounter. In semi-structured interviews, Christoffel (unpubl. data) found that interviewees held at least moderately positive feelings toward NV snakes, though these animals were feared more than salamanders, frogs, toads, turtles and lizards. Only RS scored less than neutral on the like scale used in the interviews, and RS were the most feared of the seven groups of amphibians and reptiles presented to individuals in pictures.

One goal of this work was to characterize stakeholder experiences and knowledge as it pertains to local snake species and associated regulations, beliefs, attitudes and behavioral intentions toward NV snakes and RS in MI and MN, and to compare and contrast results from the two states. A second goal was to determine whether stakeholders were more likely to support the conservation of NV snakes than RS by testing three hypotheses using data collected through self-administered mail questionnaires. The hypotheses were: (1) stakeholders possess less knowledge about RS than NV snakes, (2) stakeholders hold more negative attitudes toward RS than NV snakes, and (3) stakeholders are more likely to intend to engage in negative behaviors toward RS than NV snakes.

3.2 Study Areas

Two areas were selected in southeastern MI and southeastern MN. The most important criterion for area selection was the conservation status of eastern massasauga rattlesnakes and timber rattlesnakes and the immediate needs of the states' natural resources agencies to address RS snake conservation in areas of habitat that were facing increasing human development pressures. Study areas allowed for a comparison of stakeholder beliefs, attitudes and behavioral intentions between states and consisted of four counties in which one of two RS snake species (i.e., the timber rattlesnake in MN, and the eastern massasauga rattlesnake in MI) existed. Complete descriptions of the county-wide demographic information and ecoregions are provided in Chapter 1.

3.3 Methods

Data were collected via self-administered mail questionnaires (Appendix A.3.). Residents of eight counties where RS existed in MI and MN were randomly sampled (n = 4,000) for survey participation. It was assumed that stakeholders who lived in more rural areas would be more likely to have a snake encounter of any kind. Therefore, the sampling scheme was designed to assure that there would be an adequate number of individuals from rural areas as well as the densely populated areas in each of the study counties. In MI, 200 respondents were selected randomly from urban ZIP codes and 300 respondents were selected randomly from rural ZIP codes in each county. In MN, the only urban area included in the four study counties was Winona (estimated population of 27,069). Two hundred respondents were sampled randomly from Winona ZIP codes and the remaining respondents were chosen from less populated ZIP codes. Sampling lists were purchased from Survey Sampling International (SSI, Fairfield, CT), a national firm specializing in survey sampling and research.

Prior to finalizing the survey instrument, it was reviewed for clarity by an expert panel consisting of faculty at MI State University (MSU) and a research associate from Cornell University. The instrument was pre-tested by thirty MSU undergraduate students enrolled in an introductory fish and wildlife management course (winter term 2005). Survey questions were revised based on input from the expert panel and pre-testing with MSU undergraduates, prior to their inclusion in the final instrument.

A modified version of Dillman's (2000) tailored design method consisting of six mailings was used to conduct the mail survey. A pre-notice was sent to individuals three days prior to questionnaire mailing to ask for participation (Appendix A.1.a.). The survey mailing included an introductory cover letter, the questionnaire, a self-addressed stamped envelope, and an incentive (three first-class postage stamps) for completion and return of the instrument (Appendix A.1.b.). The cover letter included an explanation of the survey, its relevance, informed consent language, and a request that the residing adult ($\geq$ 18 years) who would next celebrate his or her birthday fill out the questionnaire. In addition to asking stakeholders about their beliefs, attitudes, and behavioral intentions toward snakes, information was sought pertaining to resources used by individuals to learn about wildlife in their area. A reminder and thank you postcard (Appendix A.4.) was sent out one week after the initial survey mailing to thank participants who had already completed and mailed back their surveys and to remind others to do the same. For individuals who did not respond, a modified second letter (Appendix A.5.) and a complete second survey was mailed out four weeks after the initial survey mailing. A final survey and modified cover letter (Appendix A.6.) were mailed two months after the initial survey mailing to individuals who still did not respond. Finally, an abbreviated instrument (Appendix A.7.) was mailed to non-respondents three months after the initial survey mailing to assess non-response bias. A detailed chronology of the mail surveys is contained in Appendix A.8.

To test the first hypothesis that stakeholders possess less knowledge about RS than NV snakes, knowledge was measured using seven questionnaire items to construct a knowledge scale (Table 3.4). Responses were scored as "correct" = 1 or "incorrect, unsure or no opinion" = 0. Knowledge scale scores ranged 0 - 7, with 7 being a perfect score. Three items were specific to NV snakes, three items were specific to RS, and one item queried respondents regarding their awareness of state laws protecting any types of snakes. A paired samples t-test was used to compare NV and RS scores (0-3 in each case). Linear regression was used to identify the variables that explained the greatest degree of variation in overall (0-7) snake knowledge scores.

To test the role that prior experiences (direct or indirect) potentially play in determining attitudes toward snakes, respondents were asked to report their experiences with NV snakes and RS. Direct experiences with wildlife during childhood have been shown to be influential in adult attitudes toward wildlife (Kellert 1976). Eleven possible experiences with NV snakes and RS were listed and respondents were asked to mark an "X" in the box to the right of each statement that applied as relevant to them (Table 3.8). Each marked box was scored as "1" and each blank box was scored as "0" in each column. NV snake and RS experience scores ranged 0 - 11. A separate item asked respondents the number of times they personally had observed a RS in their neighborhoods in the past year. We used this item to gauge whether respondents had recent direct evidence for the presence of RS in their neighborhoods.

To test whether stakeholders held more negative attitudes toward RS than NV snakes, NV snake and RS attitude scales were constructed, based upon twelve belief statements (Appendix A.3.) derived, in part, from Riley (1998). A Likert-type scale (Babbie 1973) including *Strongly Agree, Agree, Unsure, Disagree, and Strongly Disagree* was used to collect data and derive scale scores. Scale items were scored from +2 (most positive) to –2 (most negative), dependent on the valence and intensity of their attitude evaluative component (positive or negative, somewhat or very, toward snakes). "Unsure" responses were coded as "0" because unsure responses could not be interpreted to either add to or subtract from a person's attitude score. Respondents having one or more missing items for either the NV snake or RS scales were excluded from that scale's analysis. Linear regression was used to identify the variables that explained the greatest degree of variation in NV snake and RS attitude scores.

Reliability analyses were run for the NV snake and RS attitude scales, yielding Cronbach's alphas of (0.91) and (0.91), respectively. Factor analyses were run on each set of belief statements that composed the attitude scales. Two factors were identified for each of the attitude scales. The first factor for the NV snake attitude scale was identified as impersonal risk and consisted of six belief statements; the second factor was stewardship, consisting of five statements (Table 3.1). The first factor for the RS attitude scale was stewardship and included six belief statements; the second was impersonal risk and consisted of six belief statements (Table 3.1).

It was hypothesized that individuals who were at least somewhat interested in snakes would have greater knowledge about, experiences with, and more positive attitudes toward, snakes. Therefore, respondents were queried regarding their personal interest level in snakes. Response options included: *very interested (+4), somewhat interested (+3), no opinion (88, excluded from analyses), somewhat disinterested (+2) and very disinterested (+1).*

A wildlife and outdoor activities scale was constructed from fourteen questionnaire items, in which respondents indicated whether or not they participated in a particular activity, and if so, how often (Appendix A.3.). This scale was constructed as a relative measure of the amount of time that an individual regularly spent recreating outdoors and participating in wildlife-related activities. It was thought that people who engaged more frequently and in greater numbers of activities would have greater knowledge about snakes and more positive attitudes toward wildlife (Koval and Mertig 2002), including snakes. Listed activities included: view wildlife, feed birds, garden, hike or bike in natural or recreational areas, visit zoos or nature centers, camp, view wildlife TV programs, read about wildlife, watch wildlife-related movies, feed wildlife, photograph wildlife, use wildlife in artwork, hunt and trap. Response options and scores included: *Frequently (3), Occasionally (2), Rarely (1), and Never (0).* A wildlife and outdoor activities score (0 - 42) was calculated by summing a respondent's score for the fourteen questionnaire items.

Finally, to test the hypothesis that more stakeholders intend to engage in negative behaviors toward RS than NV snakes, a statement that examined an individual's intention to act in a manner that would likely result in a lethal outcome for NV snakes and RS was used as a proxy for behaviors because such behaviors could not be directly measured (Appendix A.3.). Linear regression was used to identify the factors that explained most of the variation in whether respondents would have a NV snake or RS removed from their properties regardless of the consequences for the animal.

Respondents were classified into three stakeholder groups based on their geographic proximity to RS, and knowledge, attitudes and behavioral intentions were compared among stakeholder groups. A questionnaire item which asked, "How many rattlesnakes do you think currently live in your neighborhood?" and had several response options was recoded into a variable with "0" indicating the belief that no RS existed in a respondent's neighborhood, "1" indicating beliefs that few, some, or a lot of RS existed in the respondent's neighborhood, and "99" indicating uncertainty regarding the presence of RS in the respondent's neighborhood.

Analytical procedures included reliability analysis on attitude scale items to confirm their utility in future work with other audiences. Factor analysis was used to confirm the scales' construct validity. Independent samples t-tests, Chi-squared tests, ANOVA and general linear models were used to test for differences in knowledge, experience, attitudes, desires and intentions between rural and urban respondents, males and females, MI and MN respondents, previously defined RS stakeholder groups and other post de facto groups. Linear regression, employing a stepwise procedure, was used to identify factors that explained the greatest degree of variation in dependent variables such as snake knowledge and NV snake and RS attitude scores and behavioral intentions toward NV snakes and RS. Model selection was based on changes in adjusted R^2 values using a significance level of $p \leq 0.05$. Effect sizes for independent variables included in models were calculated and are reported as suggested by Gliner et al. (2001). SPSS (SPSS Inc., Chicago, IL) versions 13.0 and 15.0 were used to run all analyses.

3.4 Results

A response rate for each state was calculated using procedures recommended by Babbie (1973). Of the 2,000 questionnaires mailed in MN, forty-five were returned as undeliverable or unable to respond, resulting in an effective sample size of 1,955. Of these, 1,298 were at least partially completed and returned, yielding a response rate of 66.4%. Of the 2,000 questionnaires mailed in MI, thirty-eight were returned as undeliverable or unable to respond yielding an effective sample size of 1,962 of which 1,092 surveys were at least partially completed and returned, resulting in a response rate of 56.6%. Ninety-eight (98/1955 = 5%) and seventy-eight (78/1962 = 4%) completed non-response instruments were returned in MN and MI, respectively. MN and MI respondents expressed greater interest in snakes and were more likely to believe that RS should be protected than non-respondents. MN respondents were also less likely to feel at personal risk from RS than non-respondents.

Results were not pooled for MI and MN respondents because of obvious differences between the two samples (Table 3.2). MN respondents were older, lived in more rural settings currently and as children, and had lived longer at their current residences than MI respondents. A greater proportion of MI respondents (52.7%) held college degrees than MN respondents (33.5%).

3.4.1 Wildlife and Outdoor Activities and Interests

Rural respondents scored higher than urban respondents on the wildlife and outdoor activities scale in MI (means = 21.66 $\pm$ 0.27 and 19.04 $\pm$ 0.39 respectively, t = -5.589, df = 902, p < 0.001) and MN (means = 20.94 $\pm$ 0.24 and 19.33 $\pm$ 0.70 respectively, t = -2.123, df = 937, p = 0.03), but mean wildlife and outdoor activities scores did not differ by state (MI = 20.74 $\pm$ 0.23 and MN = 20.79 $\pm$ 0.23, t = -0.147, df = 1841, p = 0.88). Respondents who believed that they lived in the presence of RS scored higher than respondents who thought otherwise (Table 3.3). Males scored higher than females in MI and MN (means = 21.24 $\pm$ 0.27 and 19.72 $\pm$ 0.42, t = 3.098, df = 888, p = 0.02, 95% CI for difference = 0.555 – 2.474 and means = 21.23 $\pm$ 0.26 and 19.46 $\pm$ 0.48, t = 3.32, df = 887, p = 0.001, 95% CI for difference = 0.693 – 2.790, respectively). MI respondents who held a college degree scored lower on the wildlife and outdoor activities scale than respondents who did not hold a college degree (*n* = 855, means = 20.02 $\pm$ 0.31 and 21.46 $\pm$ 0.34, t = -3.09, df = 853, p = 0.002). Average wildlife and outdoor activities scores in MN did not differ between respondents who held a college degree and those who did not (*n* = 847, means = 20.97 $\pm$ 0.36 and 20.55 $\pm$ 0.31, t = 0.90, adj. df = 723, p = 0.37).

3.4.2 Knowledge about Snakes

Mean knowledge scores differed in MI and MN, 3.3 $\pm$ 0.06 and 2.8 $\pm$ 0.05 respectively (*n* = 2,068, t = 5.41, adj. df = 1,972, p < 0.01), although effect size (*r* = 0.1) was small. Less than a quarter (23.8%) of respondents completed all seven knowledge items on the questionnaire without using an "unsure" response one or more times. For respondents who did complete all seven items without marking unsure to any, the average score was 71%. Only thirteen respondents (0.6%) scored all seven items correctly. The two items most often answered incorrectly included one in which respondents were asked to indicate the number of NV snake species living in their state (i.e. q9, Appendix A.3; 91.5%, n = 876 and 93.1%, n =1,033 in MI and MN, respectively) and knowledge of existing snake regulations (i.e. q13, Appendix A.3, 87.3%, n = 1,042 and 81.9%, n = 1,204 in MI and MN, respectively). Frequency of correct responses regarding numbers of NV snake species did not differ between states (n = 2067, χ^2 = 1.697, df = 1, p = 0.213), but a lesser proportion of MI respondents (12.7%) knew of existing snake regulations than MN respondents (18.1%) (n = 2,246, χ^2 = 12.56, df = 1, $p < 0.001$, r = 0.08). Proportions of individuals in each state that scored incorrectly on specific items sometimes differed dramatically, but often demonstrated very similar patterns across groups (Table 3.4).

In MI, knowledge about NV snakes and RS did not differ (n = 961, means = 1.58 $\pm$ 0.03 and 1.53 $\pm$ 0.04 respectively, t = 1.82, df = 960, p = 0.07). However, MN respondents scored more items about NV snakes correctly than items about RS (n = 1,119, means = 1.50 $\pm$ 0.03 and 1.15 $\pm$ 0.03, respectively, t = 13.37, df = 1,118, $p < 0.01$). In MI and MN, males scored higher than females (n = 942, means = 3.44 $\pm$ 0.07 and 2.86 $\pm$ 0.10, t = 4.707, df = 940, $p < 0.001$ and n = 1,050, means = 3.05 $\pm$ 0.06 and 2.14 $\pm$ 0.10, t = 7.842, df = 1,048, $p < 0.001$, respectively). Rural respondents scored higher than urban respondents in MI but not MN (n = 921, means = 3.35 $\pm$ 0.07 and 3.07 $\pm$ 0.10, t = 2.29, df = 955, $p < 0.02$ and n = 1,111, means = 2.86 $\pm$ 0.05 and 2.63 $\pm$ 0.16, t = 1.372, df = 1,109, p = 0.17, respectively). Respondents in MI had slightly greater mean NV snake and RS knowledge scores than in MN (n = 2.155, NV snake knowledge means

= 1.59 ± 0.03 and 1.50 ± 0.03, t = 2.66, df = adj. df = 2,132, $p = 0.008$, $r = 0.05$ and n = 2,177, RS knowledge means = 1.51 ± 0.03 and 1.15 ± 0.03, t = 8.24, adj. df = 2,005, $p < 0.001$, $r = 0.18$). In MI and MN, respondents who believed they lived in areas with RS scored more snake knowledge items correctly than respondents who believed RS were absent and respondents who were unsure whether RS were present (Table 3.5).

A stepwise regression procedure indicated that the NV impersonal risk variable explained the greatest degree of variation in snake knowledge scores in MI and MN (Tables 3.6 and 3.7). This was the only variable that had a large effect; all other variables included in the models had small effects (Tables 3.6 and 3.7).

3.4.3 Snake Experiences

Respondents had few kinds of experiences with NV snakes or RS (Table 3.8). The average number of types of experiences that MI respondents had with NV snakes (mean = 2.04 ± 0.04) was greater than MN respondents (mean = 1.88 ± 0.04, n = 2,247, t = 2.88, df = 2,245, $p = 0.004$). MI respondents more often had observed a NV snake in the wild (n =2,258, $\chi^2 = 10.051$, df = 1, $p = 0.002$), had a NV snake as a pet (n = 2,2,55, $\chi^2 = 4.156$, df = 1, $p = 0.045$) and had a friend or neighbor who had a NV snake as a pet (n = 2,258, $\chi^2 = 8.129$, df = 1, $p = 0.005$) than MN respondents. In contrast, MN respondents had a greater average number of types of experiences with RS (mean = 1.41 ± 0.04) than MI respondents (mean = 0.93 ± 0.04, n = 2,247, t = 8.36, df = 2,245, $p < 0.001$). MN respondents had more often observed a RS in the wild (n = 2,257, $\chi^2 = 42.971$, df = 1, $p < 0.001$), had a friend or neighbor who had observed a RS in the wild (n = 2,255, $\chi^2 = 90.562$, df = 1, $p < 0.001$), witnessed a RS being killed by authorities, such as police (n = 2,258, $\chi^2 = 5.197$, df = 1, $p = 0.023$), read or heard of a RS being killed by authorities, such as police (n = 2,258, $\chi^2 = 14.960$, df = 1, $p < 0.01$), had a pet threatened or bitten by a RS (n = 2,254, $\chi^2 = 4.918$, df = 1, p = 0.027), been personally bitten or threatened by a RS (n = 2,256, $\chi^2 = 13.024$, df = 1, $p < 0.01$) and had a friend or neighbor who was bitten or threatened by a RS than MI respondents (n = 2,256, $\chi^2 = 5.486$, df = 1, p = 0.02).

Rural respondents in MI had more often observed a RS in the wild (n = 1,045, 30.0% vs. 23.1%, $\chi^2 = 5.74$, df = 1, p = 0.02) than their urban counterparts. No other differences in experiences were detected between rural and urban respondents in either MI or MN.

Male respondents in MI had more often observed a NV snake in the wild (n = 1,030, 89.7% vs. 79.3%, $\chi^2 = 21.07$, df = 1, $p < 0.01$), been bitten or threatened by a NV snake (n = 1,031, 9.7% vs. 4.3%, $\chi^2 = 9.23$, df = 1, $p < 0.01$), more often observed a RS in the wild (n = 1,028, 30.7% vs. 21.8%, $\chi^2 = 9.09$, df = 1, $p < 0.01$), and known others who had observed a RS in the wild (n = 1,028, 32.1% vs. 22.1%, $\chi^2 = 11.10$, df = 1, $p < 0.01$) than female respondents. A greater proportion of female than male respondents in MI reported having a RS experience other than those listed (n = 1,028, 2.9% vs. 1.2%, $\chi^2 = 3.85$, df = 1, p = 0.05). In MN, males had more often observed a NV snake in the wild (n = 1,142, 86% vs. 68.3%, $X^2 = 45.264$, $p < 0.001$) had been bitten or threatened by a NV snake (n = 1,141, 7.7% vs. 2.0%, $X^2 = 11.775$, p = 0.001), observed a RS in the wild (n = 1,143, 45.5% vs. 28.0%, $X^2 = 15.064$, $p < 0.001$), knew others who had observed a RS in the wild (n =1,142, 51.7% vs. 38.6%, $X^2 = 15.064$, $p < 0.001$) and had been bitten or threatened by a RS (n = 1,41, 7.2% vs. 2.7%, $X^2 = 7.634$, p = 0.006) than females.

Overall, in both states combined, 186 respondents (8.2%, n = 2,255) indicated they had personally observed a RS in their neighborhoods in the past year. A greater proportion of MN respondents had observed RS in their neighborhoods in the past year (n = 2,255, 9.6% vs. 6.7%, $X^2 = 6.306$, df = 1, p = 0.012) than MI respondents. Of the respondents who indicated they had personally observed a RS in their neighborhoods in the past year, 92.3% (n = 169) had been classified in the group of stakeholders with RS in their neighborhoods, 3.8% (n = 7) had been classified in the group of stakeholders without RS in their neighborhoods, and 3.8% (n = 7) had been classified as unsure whether or not RS were in their neighborhoods.

3.4.4 Attitudes toward Snakes

Respondents' interest level in snakes averaged 2.5 on a scale from 1-4. Interest levels did not differ between MI (mean = 2.50 $\pm$ 0.03) and MN (mean = 2.46 $\pm$ 0.03) (n =1,746, t = 0.77, df = 1,744, p = 0.44). In MI, interest levels were greater for males (mean = 2.58) than females (mean = 2.37 $\pm$ 0.04) (n = 819, t = 2.91, adj. df = 475, $p < 0.01$) and greater for rural (mean = 2.56 $\pm$ 0.04) than urban (mean = 2.39 $\pm$ 0.05) (n = 833, t = 2.57, df = 831, p = 0.01) respondents. Interest levels did not differ between respondents who had a college degree (mean = 2.52 $\pm$ 0.05) and those who did not have a college degree (mean = 2.48 $\pm$ 0.05) (n = 784, t = 0.61, adj. df = 760, p = 0.55).

In MN, interest levels were greater for males (mean = 2.56 $\pm$ 0.04) than females (mean = 2.19 $\pm$ 0.07) (n = 857, t = 5.00, adj. df = 388, $p < 0.01$). Respondents who had a college degree (mean = 2.62 $\pm$ 0.05) had greater interest in snakes than respondents who did not have a college degree (mean = 2.37 $\pm$ 0.04) (n = 811, t = 3.52, adj. df = 630, $p < 0.01$). Rural (mean = 2.46 $\pm$ 0.03) and urban (mean = 2.53 $\pm$ 0.11) respondents did not differ (n = 913, t = - 0.59, df = 911, p = 0.56).

MI and MN stakeholder groups differed in their interest levels toward snakes (Table 3.9). Respondents who believed that they lived in areas with RS had greater interest levels about snakes than both respondents who believed RS were absent and unsure respondents. Interest in snakes also differed among age groups in MI and MN (Table 3.10). Respondents who were > 65 years old had the lowest levels of interest in snakes in both states.

ANOVA was used to test for differences among levels of interest and NV and RS snake experience in MI and MN (Tables 3.11 and 3.12), snake knowledge scores in MI and MN (Table 3.13), NV snake and RS snake attitude scores in MI and MN (Table 3.14 and Table 3.15), and NV and RS snake behavioral intentions in MI and MN (Tables 3.16 and 3.17).

Mean scores for the NV snake and RS attitude scales in each state were calculated and an independent samples t-test was used to identify differences in scores between states (Table 3.18). Rural respondents (mean = 13.00 $\pm$ 0.33) and urban respondents (mean = 12.29 $\pm$ 0.44) (n = 1,065, t = 1.29, df = 1,063, p = 0.20) in MI did not differ in their attitudes toward NV snakes. MI males held more positive attitudes (mean = 13.89 $\pm$ 0.29) than female respondents (mean = 10.53 $\pm$ 0.53) (n =1,048, t = 5.54, adj. df = 550, p < 0.01). MI respondents who held a college degree had more positive attitudes (mean = 13.55 $\pm$ 0.35) than respondents who did not hold a college degree (mean = 12.51 $\pm$ 0.41) (n = 1,002, t = 1.940, adj. df = 951, p = 0.05). MI respondents who were greater than sixty-five years old held less positive attitudes toward NV snakes than any other age class (Table 3.19). Each of the MI stakeholder groups differed in their NV attitude scores

(Table 3.20); respondents who believed that RS lived in their area held more positive attitudes than respondents who believed that RS were absent and unsure respondents.

Similar to MI, MN rural (mean = 10.85 $\pm$ 0.26) and urban (mean 11.00 $\pm$ 0.87) respondents did not differ in their NV attitude scores (n = 1,192, t = -0.176, df = 1,190, p = 0.86). MN males held more positive attitudes (mean = 12.02 $\pm$ 0.27) toward NV snakes than females (mean = 7.36 $\pm$ 0.55) (n = 1,125, t = 7.56, adj. df = 428, $p < 0.01$). MN respondents who held a college degree had more positive NV attitudes scores (mean = 12.20 $\pm$ 0.43) than respondents without a college degree (mean = 9.91 $\pm$ 0.32) (n = 1,074, t = 4.23, df = 1,072, $p < 0.01$). MN respondents who were greater than sixty-five years old held the least positive attitudes toward NV snakes (Table 3.19). As in MI, each of the three MN stakeholder groups differed in their NV attitude scores (Table 3.20); respondents who believed that RS lived in their area held more positive attitudes than respondents who believed that RS were absent and unsure respondents.

MI rural respondents held more positive attitudes toward RS (mean = 5.94) than their urban counterparts (mean = 3.24) (n = 1,017, t = -4.23, df = 1,015, $p < 0.01$). Male respondents held more positive attitudes (mean = 6.50) than female respondents (mean = 2.24) (n = 1,042, t = 7.004, df = 1,040, $p < 0.01$). Respondents who held a college degree (mean = 5.72) did not differ from respondents without a college degree (mean = 4.75) on the RS attitude scale (n = 999, t = 1.623, df = 997, p = 0.11). Respondents greater than sixty-five years old held the least positive attitudes toward RS (Table 3.21) of any age class. Each of the MI stakeholder groups differed in their RS attitude scores (Table 3.22); respondents who believed that RS were present in their areas had the most positive scores.

MN rural (mean = 4.11 $\pm$ 0.27) and urban (mean = 4.28 $\pm$ 0.92) respondents did not differ in their RS attitude scores (n = 1,185, t = -0.18, adj. df = 133, p = 0.86). Male MN respondents (mean = 5.22 $\pm$ 0.30) held more positive attitudes than female respondents (mean = 1.16 $\pm$ 0.52) (n = 1,120, t = 6.82, df = 1,118, $p < 0.01$). MN respondents who held a college degree (mean = 5.64 $\pm$ 0.46) had more positive RS attitude scores than respondents without a college degree (mean = 3.29 $\pm$ 0.33) (n = 1,071, t = 4.18, df = 1,069, $p < 0.01$). The oldest age class of respondents held the least positive RS attitude scores of any of the age classes (Table 3.21). MN stakeholder groups differed from one another in their RS attitude scores; respondents who believed that RS were present in their areas had the most positive attitudes (Table 3.22).

Some respondents marked "unsure" for each of the NV snake and RS attitude items, particularly RS attitude items (Figures 3.1, 3.2). More than 50% of respondents were unsure whether or not RS caused deaths annually to MI (53.8%) or MN (55.8%) residents. Almost half (48%) of MI respondents marked no items as "unsure" on the NV snake attitude scale, yet only 18% marked no items as "unsure" on the RS attitude scale. In MN, 41% of the respondents marked no items as unsure on the NV snake attitude scale, but only 22% of respondents marked no items as unsure on the RS attitude scale.

MI respondents expressed more positive attitudes toward NV snakes and RS than MN respondents. NV attitude scores in MI and MN averaged 12.75 $\pm$ 0.27 and 10.87 $\pm$ 0.25 (n =2,257, t = 5.21, df = 2,255, $p < 0.01$), and RS attitude scores averaged 5.09 $\pm$ 0.29 and 4.12 $\pm$ 0.26 (n = 2,177, t = 2.49, df = 2,175, p = 0.01). NV snake attitude scores for rural respondents in MI and MN differed 13.00 $\pm$ 0.33 and 10.85 $\pm$ 0.26, respectively (n = 1,759, t = 5.18, df = 1,757, $p < 0.01$), as did RS attitude scores 5.46 $\pm$ 0.37 and 4.11

$\pm$ 0.27 (n = 1,750, t = 2.94, df = 1,335, p < 0.01). NV snake attitude scores did not differ for urban respondents in MI and MN 12.29 $\pm$ 0.44 and 11.00 $\pm$ 0.87 (n = 498, t = 1.38, df = 496, p = 0.17) nor did RS attitude scores (4.43 $\pm$ 0.46 and 4.28 $\pm$ 0.92, respectively; n = 493, t = 0.15, df = 491, p = 0.88). MI and MN respondents who believed that RS were present in their neighborhoods had more positive NV snake and RS attitude scores than respondents who thought otherwise (Table 3.23).

The variables that explained the greatest degree of variation in NV snake attitude scores for MI respondents were (1) snake knowledge score, (2) interest level in snakes, (3) whether a respondent managed for wildlife, and (4) gender (Table 3.24). The variables that explained the greatest degree of variation in NV snake attitude scores for MN respondents were (1) snake knowledge score, (2) interest level in snakes, (3) educational level achieved, (4) gender, and (5) whether a respondent had observed a RS in his or her neighborhood in the past year (Table 3.25).

The variables that explained the greatest degree of variation in RS attitude scores for MI respondents were (1) snake knowledge score, (2) interest level in snakes, and (3) gender (Table 3.26). The variables that explained the greatest degree of variation in RS attitude scores for MN respondents were (1) snake knowledge score, (2) interest level in snakes, (3) perceived change in the RS population in a respondent's area, (4) whether or not a respondent had observed a RS in the past year, and (5) a respondent's wildlife and outdoor activity score (Table 3.27).

3.4.5 Behavioral Intentions toward Snakes

Some MI and MN respondents were unsure whether they would be less likely to have a NV snake (16.8% and 27.3%, respectively) or RS (28.2% and 28.0%, respectively) moved from their properties if they knew that the snake would likely die as a result. A greater proportion of MN respondents were unsure whether they would be less likely to have a NV snake moved (n = 2,245, $X^2 = 35.33$, df = 1, $p < 0.01$) than MI respondents. The proportion of MI and MN respondents who were unsure whether they would have a RS moved did not differ (n = 2,236, $X^2 = 0.02$, df = 1, $p = 0.89$). Unsure responses were not included in the following analyses.

Respondents in MI were much more likely to consider not having a NV snake (79%) than a RS (45.1%) removed from their property, given that the snake would likely die as a result (n = 652, $X^2 = 111.99$, df = 1, $p < 0.01$). In MN, respondents were also much more likely to consider not having a NV snake (71.3%) than a RS (39.6%) removed from their property, given the snake would likely die as a result (n = 666, $X^2 =$ 120.66, df = 1, $p < 0.01$). Regardless of its fate, 21.0% of MI respondents and 28.7% of MN respondents would move a NV snake. In contrast, 54.9% of MI respondents and 60.4% of MN respondents would move a RS regardless of its fate.

The variables that explained the greatest degree of variation in whether a MI respondent would be less likely to have a NV snake removed included (1) NV impersonal risk score and (2) whether a respondent seeks information on local wildlife issues (Table 3.28). The variables that explained the greatest amount of variation in whether a MN respondent would be less likely to have a NV snake removed included (1) NV impersonal risk score, (2) whether a respondent seeks information on local wildlife issues, and (3) belief of how the NV snake population has changed in a respondent's area during the time the respondent has lived there (Table 3.29).

The variables that explained the greatest amount of variation in whether a MI respondent would be less likely to have a RS removed included (1) RS impersonal risk score, (2) whether or not a respondent felt that close contacts between RS and humans was increasing in their area, and (3) whether or not a respondent had seen a RS in their neighborhood in the past year (Table 3.30). The variables that explained the greatest amount of variation in whether a MN respondent would be less likely to have a RS removed included (1) RS impersonal risk score, (2) interest level in snakes and (3) self-perceived personal risk from RS (Table 3.31).

3.5 Discussion

Given that the average level of interest in snakes expressed by respondents was "somewhat interested" and non-respondents gave "lack of interest in the survey issues" as one of the reasons for not completing and returning their questionnaires, it may be interpreted that snake conservation and management was more salient to respondents than non-respondents. Respondents were also more likely to feel that RS should be legally protected than non-respondents. In addition, MN non-respondents felt at greater personal risk from RS than MN respondents and had I been able to collect data from these individuals, the results could have differed for MN.

Not surprisingly, respondents had fewer types of experiences with RS than NV snakes, but types of experiences were low in both cases. The most commonly experienced encounter consisted of observing a NV snake or RS in the wild. Though the types of experiences were especially low for RS, the experiences did have impact in terms of MN respondents' snake knowledge scores and NV snake and RS attitude scores, and in terms of MI respondents' behavioral intentions toward RS. These findings are consistent with the human behavior models that underlie this work (Chapter 2, this ms).

As hypothesized, interest level in snakes was positively related to snake experience scores, snake knowledge scores, snake attitude scores and behavioral intentions towards snakes. Respondents appeared to have little knowledge about NV snakes and RS, at least in terms of the seven knowledge items included in the mail questionnaire used in this study. Low knowledge about most wildlife in the U.S. was observed by Kellert and Berry (1980) more than 20 years ago, and others more recently (Zinn and Andelt 1999). There was a particularly low level of knowledge regarding local snake species richness and policies protecting snakes. Such a lack of cognizance of existing regulations may not bode well for adherence to such regulations. Knowledge or awareness of existing regulations, however, does not always appear to stop people from killing snakes (Whitaker and Shine 2000). Other aspects of snakes seemed quite well known, such as the extremely low likelihood of transfer of disease from wild snakes to humans and knowledge of a lack of deaths caused by NV snakebite. This study supports the hypothesis that stakeholders are more knowledgeable about NV snakes than RS.

Knowledge about snakes explained the greatest degree of variation and was the most important determinant of NV snake and RS attitude scores in MI and MN. These findings also offer support for models of human behavior as presented in Chapter 2, but Kellert (1993) posited that knowledge is used more often as a basis for reinforcing and rationalizing attitudes rather than as an agent of attitude change.

One of the most surprising findings of this research was that despite the mistaken beliefs that people often hold about snakes, people do appear to have more positive than negative attitudes toward snakes, especially NV snakes. This was in contrast to study expectations that people would be more likely to hold negative rather than positive attitudes toward snakes. However, there was support for the study's second hypothesis, in that stakeholders held more positive beliefs and fewer negative beliefs toward NV snakes than RS. One factor that may be responsible for fewer positive beliefs toward RS is the fact that large percentages of respondents were either unsure (54.9%) or believed that RS bites caused deaths (13.5%) to MI or MN residents annually. This risk belief may result in elevated risk perceptions regarding RS. Snake experts have posited that fear of being bitten is the number one landowner concern regarding eastern massasauga rattlesnakes (D.J. Case and Associates 2002). Venomous bite or sting was identified as one of the ten most over-estimated causes of mortality in a study of risk beliefs (Slovic et al. 1979). Additionally, fewer questionnaire respondents had experiences with RS than NV snakes, and of those, fewer kinds of experiences for RS than NV snakes. The associated lack of familiarity may also contribute to fewer positive beliefs and less positive attitudes toward RS.

Another unexpected finding of this study was the demonstration of more positive attitudes toward both NV snakes and RS by rural residents than urban residents. Prior research on wildlife attitudes and value orientations suggested that rural residents were more likely to hold utilitarian value orientations and less likely to hold humanistic and moralistic value orientations toward wildlife than urban residents (Kellert and Berry 1982). More recently and specifically, three studies examining rural and urban respondents' attitudes toward prairie dogs in the Great Plains (Reading et al. 1999; Zinn and Andelt 1999; Wyoming Agricultural Statistics Service 2001) suggested that urban respondents held more positive attitudes than rural respondents toward these rodents. Given that interviewees provided few recognized utilitarian benefits of snakes in MI and MN when queried in semi-structured interviews (Christoffel, unpub. data), it was expected that rural respondents would have less positive attitudes than urban respondents.

Contrary to expectations, individuals who believed they were living in areas with RS expressed more positive attitudes toward both NV snakes and RS than respondents who felt that RS were absent or were unsure whether RS were present. Individuals who live in RS habitat are more likely to be able to observe snakes in the wild and benefit from their rodent control, but also live with the risk of encountering and potentially being bitten by them. This finding is similar to Peyton et al.'s (2001) work on black bears in MI but differs from past research on cougars (Riley and Decker 2000b) and wolves (Williams et al. 2002), where individuals who believed that they did not live in proximity to potentially dangerous wildlife held more positive attitudes than respondents who believed that they lived in proximity to potentially dangerous wildlife. It may be that individuals who live in close proximity to RS acclimate to RS presence over time, or that individuals living in close proximity to RS so seldom have recognized encounters that their risk perceptions are reduced over time. This latter explanation has some support provided by the NV snake and RS experience reports of respondents. Snakes are cryptically colored, and can often be within inches of a human but not detected (Whitaker and Shine 2000), or respondents may be out in their neighborhoods in the presence of snakes without knowing it. Perhaps encounters with at least some of the snake species native to respondents' areas are not very memorable because of the animals' small size (Hohlman et al. 1999, Oldfield and Moriarty 1994) or other features of the encounter.

Less than 10% of respondents reported having observed a RS during the past year in their neighborhoods.

As expected, people were more likely to engage in potentially lethal behaviors toward RS than NV snakes. Consistent with the study's third hypothesis, respondents were more than twice as likely to desire to have RS removed from their properties regardless of the consequences for such animals as they were to have NV snakes removed. Heightened risk perceptions may be responsible for this result, as indicated by the importance of RS impersonal risk scores in explaining variability regarding whether a respondent would be less likely to have a RS removed from their properties if the snake probably would die as a result. Respondents may simply feel that they put themselves at undue risk to RS bite and the potentially catastrophic consequences associated with such bites, similar to other forms of wildlife attacks (Slovic et al. 1979, Riley and Decker 2000a), by allowing a RS to remain on their properties. NV impersonal risk scores also explained the greatest degree of variability regarding whether a respondent would be less likely to have a NV snake removed from his or her property if the snake would likely die as a result. Risk perceptions were clearly the most important determinants in respondents' consideration of having a NV snake or RS removed from their properties. When queried, interviewees had indicated that they would not want to kill a RS but would want to have it removed from their properties for safety reasons, concerns particularly targeted toward children and older adults who might be visiting (Christoffel, unpubl. data). However, a large portion of respondents were unsure of whether or not they would be less likely to move either a NV snake or a RS if it was likely to die as a result of their actions. Regardless, such statements suggest elevated risk perceptions toward snakes that motivate individuals to remove snakes from their properties regardless of the likely lethal results of such actions.

3.6 Management Implications

Results of this study can be used to enhance snake conservation and management efforts. This can be accomplished, in part, by attempting to build stakeholder capacity to co-exist with snakes. Low levels of knowledge and incorrect knowledge result in less-informed decision-making by stakeholders and wildlife agency personnel. This study begins to address gaps in the knowledge of agency personnel by increasing their awareness of issues surrounding NV snake and RS conservation and management, and by providing an overview of current experiences, beliefs, attitudes and behavioral intentions by stakeholders for the MI DNR and MN DNR. Such a first step has been identified as necessary to the development of an educational outreach effort aimed at various stakeholders (Johnson et al. 2000).

Because basic knowledge of local NVsnakes and RS and the regulations associated with these groups is currently so low for stakeholders, educational outreach efforts may be used to inform residents of existing regulations protecting snakes, to raise awareness of local snake species, promote interest in snakes, and to reduce risk perceptions pertaining to snakes and snakebites. Part of this need was addressed in MI through a collaboration including Michigan Natural Features inventory, the Detroit Zoological Institute and MSU (Lee and Christoffel 2005) with funding provided by United States Environmental Protection Agency. New outreach materials should include information regarding local snake species richness, descriptions and identifying field characteristics of local species, characteristic behaviors, and distributions for native snake species and directions on behaving safely around snakes, particularly RS. Stakeholders should also be provided with information regarding how snakes' presence may positively impact their quality of life, because this is one of the characteristics of the most successful symbols of environmental concern (Greenberg Quinlin Research Inc. 2000), and thus, might make snake conservation and management a more salient issue for them.

To address stakeholders' uncertainty and the mistaken belief that RS bites cause deaths annually to residents held by some respondents, I recommend that state agencies develop accurate outreach materials concerning RS bites in their states, actions people can take to reduce snakebite risk, and appropriate actions to take should a person be bitten by a RS. This may involve working with their respective state poison control centers to track RS bite cases and their outcomes in their states. Such information could then be used to provide residents with accurate, detailed information regarding the incidence and circumstances of RS bites that do occur. A twenty-year history of venomous snakebites was recently published for MN (Keyler 2005) in which the frequency of RS bites is discussed as well as the lack of deaths caused by RS bites in MN, but no such publication exists for MI. Such information may help to correct misgivings that some stakeholders expressed about living in the presence of RS. This is especially relevant given interviewees' voiced concerns about small children and older visiting adults. Nationally, and in MN specifically, it has been documented that adult white males are the most frequent RS bite victims, and a large percentage of cases involve purposefully handling RS or alcohol (Keyler 2005). Respondents already held more positive than negative attitudes toward NV snakes and RS, but their attitudes may become even more positive toward NV snakes and RS as some of their incorrect beliefs and current misconceptions are addressed, particularly about deaths to residents due to venomous snakebites.

Educational outreach also can be used in attempts to change stakeholders' behaviors toward snakes. Elevated risk perceptions, particularly as they pertain to RS, may lead to behaviors that are lethal or potentially lethal to snakes. Stakeholders put themselves at greater risk when they attempt to kill snakes rather than leave them alone, particularly RS. Such human behaviors toward snakes, in addition to the purposeful handling of venomous snakes, account for a large percentage of venomous snakebites reported annually to the Center for Disease Control and Arizona Poison Control Center. It is important that educational outreach be used to influence human behaviors not only to discourage hostile behavior toward snakes, but to protect humans as well.

D.J. Case and Associates (2002) interviewed prominent eastern massasauga rattlesnake experts regarding the utility of different outreach methods to address stakeholder concerns. They posited that face-to-face contact is the best method of communication regarding eastern massasauga rattlesnake-human issues. Research is needed to test this assumption (see Chapter 5, this ms). Managing snake habitat and snake populations are challenging tasks, particularly as a result of our current incomplete knowledge of these species and their needs. However, as a result of this study, we now have greater capacity to address the management of human beliefs, attitudes and resultant behaviors toward snakes.

Table 3.1. Eigenvalues, Cronbach's alphas and factor loadings for each of two factors underlying NV and RS snake belief statements used to construct NV and RS attitude scales for MI and MN snake mail surveys (2005).

Factor name and item content loading	Stewardship		Impersonal risk	
	NV	RS	NV	RS
I enjoy seeing NV snakes/ RS snakes in the wild (in MI or MN).	.754	.771		
NV snakes/RS snakes help to control mice, rats and other pests (in MI or MN).	.721	.671		
Whether or not I see one, I get some benefit from just knowing that NV snakes/RS snakes live (in MI or MN).	.856	.828		
NV snakes/RS snakes are important to the balance of nature (in MI or MN).	.818	.792		
NV snakes/RS snakes pose a threat to people by their presence (in MI or MN).			.663	.565
NV snakes/RS snakes are likely to spread disease to humans (in MI or MN).			.731	.693
In (MI or MN), NV snakes/RS snakes pose an unacceptable threat to dogs and cats.			.760	.683
NV snake/RS snake bites cause deaths to (MI or MN) residents each year.			.779	.747
In (MI or MN), the risk of a person being *injured* by a NV snake/RS snake is acceptably low.			.722	.778
In (MI or MN), the risk of a person being *killed* by a NV snake/RS snake is acceptably low.			.726	.796

Table 3.1. (Continued)

Factor name and item content loading	Stewardship		Impersonal risk	
	NV	RS	NV	RS
I would be *less* likely to have a NV snake/RS snake moved off of my property if I knew that it probably would not survive as a result.	,622	.676		
If I knew a NV snake/RS snake lived within a mile of my home, it would decrease my enjoyment of living there.		.581		
Eigenvalue	1.227	6.104	6.224	1.207
Proportion of variance explained	10.23%	50.87%	51.87%	10.06%
Cumulative variance explained	62.09%	50.87%	51.87%	60.92%
Mean scale score	5.47	1.87	5.47	3.32
Cronbach's alpha	0.87	0.87	0.87	0.87

Table 3.2. A comparison of characteristics of MI and MN respondents to snake mail surveys conducted in spring 2005. Chi-squared and independent samples t-tests were used to test for differences between states.

Characteristic	MI Mean value	MN Mean value	Degrees of Freedom	Test Statistic
Age class	3.48	3.57	2184	$t = -1.751$ $p = 0.08$
Gender (% male)	66.5	74.3	1	$X^2 = 15.746$**
College Degree (yes/no)	52.7	33.5	1	$X^2 = 79.697$**
Kids (yes/no)	23.7	21.4	1	$X^2 = 1.731$
Dogs (yes/no)	53.2	49.7	1	$X^2 = 2.722$
Description of Living Area	2.78	2.40	1,969	$t = 8.420$**
Description of Childhood Living Area	3.00	2.13	2,077	$t = 15.733$**
No. Years in State	45.03	45.12	2,260	$t = -0.112$ $p = 0.91$
No. Years in Residence	14.31	17.35	2,235	$t = -5.049$**

** significant at the $p = 0.01$ level, * significant at the $p = 0.05$ level

Table 3.3. Wildlife and outdoor activities scores for 2005 MI and MN mail survey RS snake stakeholder groups.

Michigan Stakeholder Groups							
Group	N	Mean	Standard Error	Levene Statistic	F	95% Confidence Interval for Mean	
No rattlesnakes (a)	338	19.35	0.36	3.003*	25.818**	18.65	20.05
Yes rattlesnakes (b)	305	22.87	0.36			22.15	23.58
Unsures (a)	228	19.68	0.48			18.74	20.62
Minnesota Stakeholder Groups							
Group	N	Mean	Standard Error	Levene Statistic	F	95% Confidence Interval for Mean	
No rattlesnakes (a)	334	19.92	0.38	3.716*	21.637**	19.17	20.67
Yes rattlesnakes (b)	432	22.31	0.30			21.72	22.91
Unsures (a)	164	18.71	0.57			17.59	19.84

Group names followed by the same letter (a,b) do not differ from one another within each state. ** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table.3.4. Frequency of wrong responses in MI and MN to each of seven questionnaire items included in snake knowledge scores (n = 2,067).

Knowledge Score Item	(% wrong) MI	MN
Q9. Prior to receiving this survey, how many kinds of non-venomous snake(s) did you think live in (MI/MN)? *None (0), 1-4 (0), 5-10 (0), 11-15 (0), 16-20 (1), more than 20 (0), Unsure (0))*	91.5% *(876)*	93.1% *(1,033)*
Q10. Prior to receiving this survey, how many kinds of rattlesnake(s) did you think live in (MI/ MN)?* ($\chi 2$ =183.61, df=1, r=0.29) *None (0), 1 (1), 2 (0), 3 (0), more than 3 (0), Unsure (0)*	45.5% *(435)*	74.6% *(828)*
Q13 Are you aware of any specific laws that protect (MI or MN) snakes? * ($\chi 2$ =12.56, r=0.08) *"Yes"(1), "No"(0) or "No opinion"(0).*	87.3% *(910)*	81.9% *(986)*
Q20a6. Non-venomous snakes are likely to spread disease to humans in (MI or MN). *People that agreed or strongly agreed with the statement and unsure responses were marked "wrong" (0); individuals that disagreed with the statement were marked "correct"(1)..*	24.8% *(237)*	27.9% *(310)*
.Q20b6. Rattlesnakes are likely to spread disease to humans in (MI or MN).	35.8% *(343)*	39.3% *(436)*
Q20a8. Non-venomous snakebites cause deaths to (MI or MN) residents each year.	25.4% *(243)*	29.0% *(322)*
Q20b8. Rattlesnake bites in (MI or MN) cause deaths to residents each year.* ($\chi 2$ = 7.37, p=0.007, r=.06)	65.5% *(627)*	71.1% *(789)*

* significant difference in proportions of MI and MN respondents at p = 0.01 level

Table 3.5. Analysis of variance table illustrating mean snake knowledge scores for 2005 MI and MN snake survey respondents after being classified into stakeholder groups based on geographic proximity to RS snakes.

Michigan Stakeholder Groups							
Group	N	Mean	Standard Error	Levene Statistic	F	95% Confidence Interval for Mean	
No rattlesnakes (a)	366	3.32	0.09	3.53*	51.686**	3.14	3.50
Yes rattlesnakes (b)	327	3.83	0.09			3.65	4.00
Unsures (c)	255	2.40	0.11			2.18	2.61
Minnesota Stakeholder Groups							
Group	N	Mean	Standard Error	Levene Statistic	F	95% Confidence Interval for Mean	
No rattlesnakes (a)	399	2.85	.08	0.80	43.668**	2.69	3.00
Yes rattlesnakes (b)	511	3.19	.07			3.05	3.32
Unsures (c)	197	1.93	.12			1.70	2.16

(** significant at the p = 0.001 level, * significant at the p = 0.01 level)

Table 3.6. Regression table for variation in snake knowledge for 2005 MI snake survey respondents (n = 778).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 NV Imp Risk	0.533	904.913**	0.73	0.323	0.011	0.731	30.082	.302-.344
2 NV Imp Risk	0.541	466.652**	0.71	0.313		0.708	28.477	.291-.334
Rattlesnakes?			0.14	-0.004	0.001	-0.092	-3.710	-.006--.002
3 NV Imp Risk	0.545	317.008**	0.71	0.309	0.011	0.700	28.127	.287-.331
RS snakes?			0.15	-0.004	0.001	-0.094	-3.787	-.006 – (-.002)
Rural/Urban			0.10	0.273	0.093	0.071	2.943	.091-.455
4 NV Imp Risk	0.548	241.210**	0.71	0.307	0.011	0.695	27.951	.285-.328
RS snakes?			0.13	-0.004	0.001	-0.090	-3.623	-0.006 – (-.002)
Rural/Urban			0.09	0.250	0.093	0.065	2.691	.068-.432
Gender			0.10	-0.240	0.092	-0.063	-2.609	-.421 – (-.059)

Table 3.6. (cont'd)

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
5 NV Imp Risk	0.550	194.464**	0.71	0.306	0.011	0.693	27.920	.285-.328
RS snakes?			0.13	-0.004	0.001	-0.092	-3.720	-.006 – (-.002)
Rural/Urban			0.08	0.224	0.094	0.058	2.395	.040-.408
Gender			0.10	-0.233	0.092	-0.061	-2.533	-.413- (-.052)
#Years in State			0.07	0.058	0.029	0.048	1.978	.000 - .115
6 NV Imp Risk	0.553	164.139**	0.70	0.304	0.011	0.689	27.759	.283-.326
RS snakes?			0.12	-0.003	0.001	-0.084	-3.388	-.005 – (-.001)
Rural/Urban			0.10	0.259	0.094	0.067	2.741	.073-.444
Gender			0.09	-0.227	0.092	-0.060	-2.473	-.407 – (-.047)
#Years in State			0.09	0.077	0.030	0.064	2.557	.018-.136
Educ Level			0.08	0.062	0.025	0.063	2.479	.013-.112

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.7. Regression table explaining variation in snake knowledge scores for MN survey respondents (n = 891).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 NV Impersonal Risk	0.479	820.018**	0.70	0.300	0.010	0.693	28.636**	.279 - .320
2 NV Impersonal Risk	0.490	428.664**	0.68	0.289	0.011	0.669	27.265**	.269 - .310
RS snakes?			0.14	-0.005	0.001	-0.109	-4.460**	-.007 - -.003
3 NV Impersonal Risk	0.497	293.784**	0.66	0.281	0.011	0.649	25.986**	.260 - .302
RS snakes?			0.13	-0.005	0.001	-0.106	-4.350**	-.007 - -.003
Manage habitat for wildlife			0.12	-.293	0.082	-0.087	-3.566**	-.455 - -.132
4 NV Impersonal Risk	0.502	225.301**	0.66	0.283	0.207	0.653	26.248**	.261 - .304
RS snakes?			0.14	-0.005	0.011	-0.103	-4.235**	-.007 - -.002
Manage habitat for wildlife			0.11	-0.277	0.082	-0.082	-3.376**	-.438 - -.116
Age Class			0.10	0.110	0.034	0.077	3.234**	.043 - .177
5. NV Impersonal Risk	0.506	183.047**	0.66	0.282	0.011	0.651	26.237**	.260 - .303
RS snakes?			0.14	-0.005	0.001	-0.104	-4.297**	-.007 - -.003
Manage habitat for wildlife			0.09	-0.237	0.083	-0.070	-2.855**	-.400 - -.074
Age Class			0.11	0.127	0.034	0.088	3.680**	.059 - .194
Dogs Present?			0.08	0.224	0.082	0.067	2.731**	.063 - .384

Table 3.7. (cont'd)

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
6 NV Impersonal Risk	0.509	154.829**	0.65	0.276	0.011	0.637	25.276**	.254 - .297
RS snakes?			0.13	-0.004	0.001	-0.098	-4.042**	-.006 - -.002
Manage habitat for wildlife			0.09	-0.236	0.083	-0.070	-2.848**	-.398 - - 0.073
Age Class			0.11	0.129	0.034	0.090	3.758**	.062 - .197
Dogs Present?			0.08	0.224	0.082	0.067	2.750**	.064 - .384
Gender			0.09	-0.254	0.094	-0.065	-2.695**	-.440 - -.069
7 NV Impersonal Risk	0.511	133.864**	0.65	0.274	0.011	0.632	25.024**	.252 - .295
RS snakes?			0.13	-0.004	0.001	-0.093	-3.824**	-.006 - -.002
Manage habitat for wildlife			0.09	-0.227	0.083	-0.068	-2.750**	-.389 - -.065
Age Class			0.12	0.135	0.034	0.094	3.930**	.068 - .203
Dogs Present?			0.08	0.225	0.081	0.067	2.763**	.065 - .385
Gender			0.06	-0.254	0.094	-0.065	-2.696**	-.439 - -.069
RS Experience Score			0.09	0.033	0.016	0.050	2.109*	.002 - .063

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.8. Eleven statements used to measure survey respondents' (n = 2,067) experiences with NV snakes and RS snakes in MI and MN (2005). Percentages of respondents who listed having experiences are reported.

Types of Experiences people may have with non-venomous snakes and rattlesnakes.	**Non-venomous snake**		**Rattlesnake**	
	MI	MN	MI	MN
I have observed at least one in the wild.	86.0%*	81.1%	27.5%*	40.8%
I have a friend or neighbor who observed at least one in the wild.	66.1%	63.5%	28.4*%	48.0%
I personally had or have one as a pet..	6.8*%	4.9%	0.5%	0.4%
I have a friend or neighbor who keeps or has kept one as a pet.	15.1*%	11.2%	1.3%	1.9%
I have witnessed one being killed by authorities, such as police.	1.2%	1.4%	0.7*%	1.8%
I have read or heard of one being killed by authorities, such as police.	4.6%	5.4%	9.1*%	14.6%
I had a pet threatened or bitten by one.	2.8%	2.0%	1.6*%	3.1%
I have read or heard of pets being threatened or bitten by one.	7.2%	5.6%	15.0%	17.8%
I have personally been threatened or bitten by one.	7.7%	6.3%	2.7*%	5.9%
I have a friend or neighbor that has been threatened or bitten by one.	5.2%	4.9%	4.3*%	6.4%
Other (please specify)____________________	1.2%	1.4%	1.7%	0.9%

* significant difference between MI and MN respondents at the p = 0.05 level

Table 3.9. ANOVA table showing differences between MI and MN stakeholder groups' experience scores.

Michigan Stakeholder Groups							
Stakeholder Group	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F
No RS snakes (a)	300	2.42	0.905	0.052	2.32 – 2.52	18.556**	29.742**
Yes RS snakes (b)	288	2.78	0.850	0.050	2.68 – 2.88		
Unsures (c)	209	2.15	1.003	0.069	2.02 – 2.29		
Minnesota Stakeholder Groups							
Stakeholder Group	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F
No RS snakes (a)	300	2.32	0.970	0.056	2.21 – 2.43	17.595**	27.680**
Yes RS snakes (b)	445	2.68	0.870	0.041	2.60 – 2.76		
Unsures (a)	160	2.11	0.984	0.078	1.96 – 2.27		

Groups that have the same letter (a, b) after them do not differ from one another. ** significant at the 0.01 level,

* significant at the 0.05 level

Table 3.10. ANOVA table showing differences in snake interest among five age groups of snake survey respondents.

Age Class	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Age Class Differences
MI Age Groups								
1 = 18 – 30 years	43	2.72	0.854	0.130	2.46 – 2.98	7.884**	5.366**	1 > 5*
2 = 31 – 40 years	106	2.55	0.967	0.094	2.36 – 2.73			
3 = 41 – 50 years	214	2.68	0.819	0.056	2.57 – 2.79			3 > 5**
4 = 51 – 65 years	289	2.46	0.935	0.055	2.36 – 2.57			
5 = >65 years	151	2.26	1.016	0.083	2.09 – 2.42			5 < 1*, 3**
MN Age Groups								
1 = 18 – 30 years	43	2.44	1.007	0.154	2.13 – 2.75	5.581**	5.403**	
2 = 31 – 40 years	113	2.54	0.916	0.086	2.37 – 2.71			2 > 5*
3 = 41 – 50 years	189	2.65	0.841	0.061	2.53 – 2.77			3 > 5**
4 = 51 – 65 years	287	2.50	0.985	0.058	2.38 – 2.61			4 > 5*
5 => 65 years (5)	216	2.23	0.975	0.066	2.10 – 2.36			5 < 2*, 3**, 4*

** significant at the 0.01 level, * significant at the 0.05 level

Table 3.11. ANOVA table illustrating differences among MI respondents' interest levels toward snakes and NV and RS snake experience scores.

NV Snake Experiences								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	175	1.44	1.201	.091	1.26 – 1.62	.708**	29.861**	1 < 2*, 3**, 4**
2 = Somewhat disinterested	137	1.85	1.169	.100	1.65 – 2.04			1*< 2 < 3**, 4**
3 = Somewhat interested	407	2.30	1.213	.060	2.18 – 2.42			3 > 1**, 2**
4 = Very interested	80	2.83	1.741	.195	2.44 – 3.21			4 > 1**, 2**
RS Snake Experiences								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	175	0.64	1.318	0.100	0.44 – 0.84	4.704**	8.730**	1 < 3**, 4**
2 = Somewhat disinterested	137	0.80	1.168	0.100	0.61 - .100			2 < 3*, 4*
3 = Somewhat interested	408	1.12	1.290	0.064	0.99 – 1.25			3 > 1**, 2*
4 = Very interested	80	1.35	1.406	0.157	1.04 – 1.66			4 > 1**, 2*

** = significant at the p = 0.01 level, * = significant at the p = 0.05 level

Table 3.12. ANOVA table illustrating differences among MN respondents' interest levels toward snakes and NV and RS snake experience scores.

NV Snake Experiences								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	210	1.21	1.293	.089	1.04 – 1.39	0.136	32.964**	1 > 2**, 3**, 4**
2 = Somewhat disinterested	149	1.72	1.229	.101	1.53 – 1.92			1** < 2 < 3**, 4**
3 = Somewhat interested	455	2.14	1.290	.060	2.02 – 2.26			1**, 2** < 3
4 = Very interested	89	2.52	1.341	.142	2.23 – 2.80			1**, 2**, < 4
RS Snake Experiences								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	210	0.82	1.295	.089	0.65 – 1.00	3.429*	26.201**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	149	1.30	1.393	.114	1.07 – 1.52			1** < 2 < 3**, 4**
3 = Somewhat interested	455	1.76	1.494	.070	1.62 – 1.90			3> 1**, 2**
4 = Very interested	89	2.08	1.532	.162	1.76 – 2.40			4 > 1**, 2**

** = significant at the p = 0.01 level, * = significant at the p = 0.05 level

Table 3.13. ANOVA table illustrating differences among MI and MN respondents' interest levels toward snakes and snake knowledge scores.

MI Respondents' Snake Knowledge								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
Very disinterested (1)	159	1.97	1.636	0.130	1.71 – 2.22	0.793	58.214**	1 < 2**, 3**, 4**
Somewhat disinterested (2)	134	2.88	1.599	0.138	2.61 – 3.15			1** < 2 < 3**, 4**
Somewhat interested (3)	391	3.82	1.628	0.082	3.66 – 3.98			3 > 1**, 2**
Very interested (4)	71	4.21	1.780	0.211	3.79 – 4.63			4 > 1**, 2**
MN Respondents' Snake Knowledge								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	185	1.86	1.594	.117	1.63 – 2.10	1.365	49.314**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	140	2.75	1.504	.127	2.50 – 3.00			1** < 2 , 3*, 4**
3 = Somewhat interested	431	3.24	1.539	.074	3.10 – 3.39			1**, 2* < 3 < 4**
4 = Very interested	86	4.00	1.564	.169	3.66 – 4.34			1**, 2**, 3** < 4

** = significant at the p = 0.01 level, * = significant at the p = 0.05 level

Table 3.14. ANOVA table illustrating differences among MI respondents' interest levels toward snakes and NV and RS snake attitude scores.

NV Snake Attitudes								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	168	4.34	8.367	0,646	3.06 – 5.61	11.642**	122.102**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	145	10.62	6.356	0.528	9.58 – 11.66			1** < 2 < 3**, 4**
3 = Somewhat interested	425	16.66	6.611	0.321	16.03 – 17.29			3 > 1**, 2**
4 = Very interested	81	16.16	10.184	1.132	13.91 – 18.41			4 > 1**, 2**
RS Snake Attitudes								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	166	-2.89	7.609	0.591	- 4.06 – (-1.73)	11.211**	96.575**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	144	1.27	7.100	0.592	0.10 – 2.44			1** < 2 < 3**, 4**
3 = Somewhat interested	425	8.58	8.642	0.419	7.75 – 9.40			3 > 1**, 2**
4 = Very interested	78	11.49	11.546	1.307	8.88 – 14.09			4 > 1**, 2**

** = significant at the p = 0.01 level, * = significant at the p = 0.05 level

Table 3.15. ANOVA table illustrating differences among MN respondents' interest levels toward snakes and NV and RS snake attitude scores.

NV Snake Attitudes								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	197	4.01	7.125	.508	3.00 – 5.01	.221	124.327**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	149	7.90	7.397	.606	6.70 – 9.10			1** < 2 < 3**, 4**
3 = Somewhat interested	455	14.27	7.236	.339	13.61 – 14.94			1**, 2** < 3 < 4**
4 = Very interested	89	18.02	8.452	.896	16.24 – 19.80			1**, 2**, 3** < 4
RS Snake Attitudes								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	196	-2.58	7.089	.506	-3.58 – (-1.58)	13.519**	99.,626**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	148	0.76	6.275	.516	-0.26 – 1.78			1** < 2 < 3**, 4**
3 = Somewhat interested	449	7.11	8.417	.397	6.33 – 7.89			1**, 2** < 3 < 4**
4 = Very interested	89	11.94	11.211	1.188	9.58 – 14.31			1**, 2**, 3** < 4

(** = significant at the p = 0.01 level, * = significant at the p = 0.05 level)

Table 3.16. ANOVA table illustrating differences among MI respondents' interest levels toward snakes and behavioral intentions toward NV and RS snakes.

NV Snake Behavioral Intention								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	167	-0.07	1.249	.097	-0.26 – 0.12	6.722**	56.984**	1 < 2**, 3**, 4**
2 = Somewhat disinterested	146	0.47	1.018	.084	.31 – 0.64			1** < 2 < 3**, 4**
3 = Somewhat interested	420	1.15	1.029	.050	1.05 – 1.25			3 > 1**, 2**
4 = Very interested	79	1.22	1.278	.144	0.93 – 1.50			4 > 1**, 2**
RS Snake Behavioral Intention								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = Very disinterested	166	-0.95	1.097	.085	- 1.11 – (-0.78)	7.306**	56.350**	1 < 3**, 4**
2 = Somewhat disinterested	144	-0.75	1.000	.083	-0.91 – (-0.59)			2 < 3**, 4**
3 = Somewhat interested	420	0.14	1.178	.057	.03 - 0.26			3 > 1**, 2**
4 = Very interested	78	0.53	1.412	.160	.21 – 0.84			4 > 1**, 2**

** = significant at the p = 0.01 level, * = significant at the p = 0.05 level

Table 3.17. ANOVA table illustrating differences among MN respondents' interest levels toward snakes and behavioral intentions toward NV and RS snakes.

NV Snake Behavioral Intentions								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
Very disinterested (1)	197	-0.33	1.077	.077	-0.48 – (-0.18)	1.269	67.911**	1 < 2**, 3**, 4**
Somewhat disinterested (2)	148	0.24	0.952	.078	0.09 – 0.40			1** < 2 < 3**, 4**
Somewhat interested (3)	454	0.81	1.073	.050	0.71 – 0.91			1**, 2** < 3 < 4*
Very interested (4)	88	1.20	1.224	.130	0.95 – 1.46			1**, 2**, 3* < 4
RS Snake Behavioral intentions								
Interest level in snakes	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
Very disinterested (1)	195	-0.95	1.007	.072	-1.10 – (-0.81)	12.020**	49.109**	1 < 3**, 4**
Somewhat disinterested (2)	147	-0.80	0.941	.078	-0.96 – (-0.65)			2 < 3**, 4**
Somewhat interested (3)	453	-0.13	1.169	.055	-0.24 – (-0.02)			3 > 1**, 2**
Very interested (4)	88	0.50	1.398	.149	.20 - .80			4 > 1**, 2**

** = significant at the p = 0.01 level, * = significant at the p = 0.05 level

Table 3.18. Mean attitude scores of MI (MI) and MN (MN) 2005 mail questionnaire respondents toward NV snakes (NV) and RS snakes (RS).

NV Attitude Scores						
Dependent Variable	*n*	Mean	Standard Deviation	Mean Difference	Levene Statistic	t
MI NV Snake Attitudes	1,065	12.8	8.67	1.88	1.384	5.209**
MN NV Snake Attitudes	1,192	10.9	8.46			
RS Attitude Scores						
Dependent Variable	*n*	Mean	Standard Deviation	Mean Difference	Levene Statistic	t
MI RS Snake Attitudes	1,058	5.10	9.44	0.97	3.958* Adj. df = 2,213	2.485*
MN RS Snake Attitudes	1,185	4.12	8.89			

Table 3.19. NV snake attitude scores of five age classes of MI and MN mail survey respondents (2005).

MI Age Groups								
Age Class	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = 18 – 30 years	53	14.98	7.82	1.07	12.83 – 17.14	0.854	6.750**	1 > 5*
2 = 31 – 40 years	150	11.63	8.85	.72	10.20 – 13.06			
3 = 41 – 50 years	269	14.11	7.79	.48	13.18 – 15.05			3 > 5**
4 = 51 – 65 years	377	13.27	8.77	.45	12.39 – 14.16			4 > 5*
5 = > 65 years	177	10.49	8.80	.66	9.18 – 11.79			5 < 1*, 3**, 4*
MN Age Groups								
Age Class	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = 18 – 30 years	66	9.95	9.75	1.20	7.56 – 12.35	1.794	9.137**	
2 = 31 – 40 years	159	9.58	7.83	.62	8.35 – 10.81			2 < 3**
3 = 41 – 50 years	261	12.86	7.92	.49	11.90 – 13.83			3 > 2**,5**
4 = 51 – 65 years	361	11.60	8.33	.44	10.74 – 12.46			4 > 5**
5 = > 65 years	263	8.93	8.67	.53	7.88 – 9.98			5 < 3**, 4**

** significant at the 0.01 level, * significant at the 0.05 level

Table 3.20. ANOVA table showing differences between 2005 MI and MN mail survey respondent stakeholder groups' NV snake attitude scores.

Michigan Stakeholder Groups								
Stakeholder Group	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
0 = No RS snakes	393	13.40	7.94	.40	12.61 – 14.18	5.049**	43.019**	0 > 99**
1 = Yes RS snakes	354	14.75	8.19	.44	13.89 – 15.60			1 > 99**
99 = Unsures	275	8.69	9.29	.56	7.59 – 9.79			99 < 0,1**
Minnesota Stakeholder Groups								
Stakeholder Group	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
0 = No RS snakes	418	10.49	8.15	.40	9.71 – 11.28	3.443*	34.014**	99** < 0 < 1**
1 = Yes RS snakes	551	12.68	7.94	.34	12.01 – 13.34			1 > 0**, 99**
99 = Unsures	213	7.33	8.70	.60	6.16 – 8.51			99 < 0**, 1**

** significant at the 0.01 level, * significant at the 0.05 level

Table 3.21. RS attitude scores of five age classes of MI and MN mail survey respondents (2005).

MI Age Groups								
Age Class	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = 18 – 30 years	53	6.13	8.75	1.20	3.72 – 8.54	2.780*	4.845**	
2 = 31 – 40 years	148	4.14	9.38	.77	2.62 – 5.67			
3 = 41 – 50 years	269	5.96	9.64	.59	4.81 – 7.12			3 > 5**
4 = 51 – 65 years	376	5.90	9.83	.51	4.90 – 6.90			4 > 5**
5 = > 65 years	175	2.64	7.86	.59	1.47 – 3.81			5 < 3**, 4**
MN Age Groups								
Age Class	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
1 = 18 – 30 years	66	3.44	8.96	1.10	1.24 – 5.64	2.323*	10.683**	
2 = 31 – 40 years	158	2.50	8.02	.64	1.24 – 3.76			2 < 3**, 4**
3 = 41 – 50 years	260	6.30	8.91	.55	5.21 – 7.39			3 > 2**, 5**
4 = 51 – 65 years	359	5.29	9.11	.48	4.34 – 6.23			4 > 2**, 5**
5 = > 65 years	262	2.09	8.21	.51	1.09 – 3.09			5 < 3**, 4**

** significant at the 0.01 level, * significant at the 0.05 level

Table 3.22. ANOVA table showing differences between 2005 MI and MN mail survey respondent stakeholder groups' RS snake attitude scores.)

Michigan Stakeholder Groups								
Stakeholder Group	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
0 = No RS snakes	392	4.89	9.06	.46	3.99 – 5.79	3.089*	31.953**	99** < 0 < 1**
1 = Yes RS snakes	351	7.75	9.69	.52	6.73 – 8.77			1 > 0**, 99**
99 = Unsures	272	1.83	8.71	.53	.79 – 2.87			99 < 0**, 1**
Minnesota Stakeholder Groups								
Stakeholder Group	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
0 – No RS snakes	417	3.85	8.04	.39	3.07 – 4.62	8.374**	18.474**	99** < 0 < 1**
1 – Yes RS snakes	547	5.61	9.33	.40	4.82 – 6.39			1 > 0**, 99**
99 – Unsures	211	1.41	8.11	.56	.31 – 2.51			0 < 99**, 1**

** significant at the 0.01 level, * significant at the 0.05 level

Table 3.23. NV and RS attitude scores among MI and MN snake mail survey stakeholder groups (2005).

Non – venomous Attitude Scores								
RS snake Stakeholder Groups	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
0 = No RS snakes	811	11.90	8.17	.287	11.34 – 12.46	7.515**	66.463**	99** < 0 < 1**
1 = Yes RS snakes	905	13.49	8.09	.269	12.96 – 14.02			1 > 0**, 99**
99 = Unsures	488	8.10	9.05	.410	7.29 – 8.90			99 < 0**, 1**
Rattlesnake Attitude Scores								
RS snake Stakeholder Groups	*n*	Mean	Standard Deviation	Standard Error	95% Confidence Interval	Levene Statistic	F	Group Differences
0 = No RS snakes	809	4.35	8.56	.301	3.76 – 4.94	10.122**	45.830**	99** < 0 < 1**
1 = Yes RS snakes	898	6.45	9.53	.318	5.82 – 7.07			1 > 0**, 99**
99 = Unsures	483	1.64	8.44	.384	.89 – 2.40			0 < 99**, 1**

** significant at the 0.01 level, * significant at the 0.05 level

Table 3.24. Regression table for explanation of variation in the dependent variable, NV snake attitude score, for 2005 MI snake survey respondents ($n = 612$).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 Snake knowledge score	.487	580.589**	0.66	3.324	.138	.698	24.095	3.05 – 3.60
2 Snake knowledge score	.564	396.683**	0.60	2.681	.141	.563	18.983	2.40 – 2.96
Interest level in snakes			0.39	2.875	.275	.310	10.464	2.34 – 3.41
3. Snake knowledge score	.574	275.360**	0.60	2.633	.140	.553	18.780	2.36 – 2.91
Interest level in snakes			0.37	2.696	.276	.291	9.782	2.16 – 3.24
Manage habitat for wildlife			0.15	-1.817	.473	-.105	-3.844	-2.75 – (- 0.89)
4 Snake knowledge score	.578	210.570**	0.59	2.571	.141	.540	18.205	2.29 – 2.85
Interest in snakes			0.36	2.684	.274	.290	9.786	2.15 – 3.22
Manage habitat for snakes			0.14	-1.769	.470	-.102	-3.760	-2.69 – (-.85)
Gender			0.09	-1.331	.488	-.073	-2.728	-2.29 – (-.37)

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.25. Regression table for NV snake attitude scores of 2005 MN snake survey respondents (n = 943).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 Snake knowledge score	0.393	450.927**	0.61	3.106	.146	.627	21.235**	2.819 – 3.393
2 Snake knowledge score	0.526	387.708**	0.54	2.322	.140	.471	16.603**	2.056 – 2.607
Interest level in snakes			0.44	3.535	.252	.398	14.043**	3.041 – 4.030
3 Snake knowledge score	0.530	262.300**	0.53	2.296	.141	.464	16.322**	2.020 – 2.572
Interest level in snakes			0.44	3.487	.252	.393	13.854**	2.992 – 3.981
Educational level			0.09	0.284	.116	.064	2.440*	.055 - .513
4 Snake knowledge score	0.533	199.406**	0.51	2.235	.143	.451	15.665**	1.954 – 2.515
Interest level in snakes			0.43	3.431	.252	.387	13.618**	2.936 – 3.926
Educational level			0.10	0.299	.116	.068	2.572**	.071 - .527
Gender			0.11	-1.197	.508	-.063	-2.357*	-2.195 – (-.200)
5 Snake knowledge score	0.536	161.494**	0.52	2.251	.142	.455	15.808**	1.972 – 2.531
Interest level in snakes			0.44	3.513	.254	.396	13.842**	3.015 – 4.011
Educational level			0.10	0.294	.116	.067	2.540*	.067 - .522
Gender			0.11	-1.172	.507	-.062	-2.313*	-2.167 – (-.177)
See RS snake past year?			0.10	-1.656	.732	-.059	-2.260*	-3.094 – (-.218)

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.26. Regression table for RS snake attitude scores for 2005 MI snake survey respondents (n = 597).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% C.I. Beta
1 Snake knowledge score	0.446	481.375**	0.64	3.690	.168	.669	21.940**	3.360 – 4.020
2 Snake knowledge score	0.511	312.874**	0.57	2.959	.178	.536	16.647**	2.610 – 3.309
Interest in snakes			0.37	3.137	.350	.289	8.958**	2.449 – 3.825
3 Snake knowledge score	0.517	213.649**	0.56	2.875	.179	.521	16.041**	2.523 – 3.227
Interest in snakes			0.36	3.126	.348	.288	8.977**	2.442 – 3.809
Gender			0.10	-1.737	.617	-.082	-2.813**	-2.949 – (-.524)

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.27. Regression table for RS snake attitude scores of 2005 MN snake survey respondents (n = 282).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 Snake knowledge score	.349	151.451**	0.56	3.615	.294	.592	12.307**	3.037 – 4.193
2 Snake knowledge score	.429	106.540**	0.47	3.085	.287	.506	10.736**	2.520 – 3.651
Interest in snakes			0.37	3.488	.549	.299	6.352**	2.407 – 4.569
3 Snake knowledge score	.462	81.533**	0.47	2.949	.281	.483	10.504**	2.396 – 3.501
Interest in snakes			0.36	3.648	.534	.313	6.829**	2.596 – 4.699
RS snake pop. change			0.23	-2.309	.540	-.189	-4.278**	-3.371 – (-1.247)
4 Snake knowledge score	.472	63.842**	0.48	2.935	.278	.481	10.549**	2.387 – 3.482
Interest in snakes			0.38	3.946	.543	.338	7.272**	2.877 – 5.014
RS snake pop. change			0.21	-2.171	.538	-.177	-4.039**	-3.230 – (-1.113)
See RS snake in past year?			0.12	-2.972	1.194	-.111	-2.489*	-5.323 – (-.622)
5 Snake knowledge score	.485	53.876**	0.49	2.768	.281	.454	9.842**	2.215 – 3.322
Interest in snakes			0.38	3.586	.551	.308	6.503**	2.500 – 4.671
RS snake pop. change			0.21	-2.071	.532	-.169	-3.891**	-3.119 – (-1.023)
See RS snake in past year?			0.14	-3.544	1.197	-.133	-2.960**	-5.901 – (-1.187)
WL/Outdoor Activity score			0.20	-.194	.069	.131	2.787**	.057 - .330

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.28. Regression table for moving a NV snake regardless of its fate for 2005 MI survey respondents (n = 767).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 NV impersonal risk score	.286	307.207**	0.54	.164	.009	.535	17.527	.146 - .182
2 NV impersonal risk score	.303	167.135**	0.52	.152	.010	.497	15.814	.133 - .171
Seek wildlife information?			0.15	-.336	.076	-.139	-4.427	-.486 – (-.187)

Table 3.29. Regression table for moving a NV snake for 2005 MN snake survey respondents (n = 543).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 NV impersonal risk score	.285	216.595**	0.49	.162	.011	.535	14.717**	.141 - .184
2 NV impersonal risk score	.299	116.535**	0.46	.153	.011	.504	13.601**	.131 - .175
Seek wildlife information?			0.13	-.296	.085	-.129	-3.471**	-.463 – (-.128)
3 NV impersonal risk score	.309	81.822**	0.47	.150	.011	.496	13.435**	.128 - .172
Seek wildlife information?			0.16	-.284	.085	-.123	-3.351**	-.450 – (-.117)
NV snake population change			0.13	-.158	.053	-.107	-2.993**	-.262 – (-.054)

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.30. Regression table for moving a RS snake for 2005 MI snake survey respondents (n = 497).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 RS impersonal risk score	.273	187.413**	0.53	.147	.011	.524	13.690	.126 - .169
2 RS impersonal risk score	.280	97.241**	0.51	.143	.011	.507	13.0339	.121 - .164
Frequency of close contacts			010	- .107	.046	-.090	-2.324	-.198 - -.017
3 RS impersonal risk score	.286	67.211**	0.52	.142	.011	.503	12.996	.120 - .163
Frequency of close contacts			0.10	-.116	.046	-.098	-2.515	-.207 – (-.025)
See RS snake past year?			0.11	.414	.178	.089	2.327	.064 - .764

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

Table 3.31. Regression table for moving a RS snake for 2005 MN snake survey respondents ($n = 783$).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	Standardized Beta	t	95% C.I. Beta
1 RS impersonal risk score	.244	207.826**	0.45	.137	.010	.495	13.323**	.117 - .158
2 RS impersonal risk score	.310	132.676**	0.39	.108	.011	.389	10.169**	.087 - .129
Interest level in snakes			0.23	.386	.053	.281	7.340**	.283 - .489
3 RS impersonal risk score	0.329	94.129**	0.35	.093	.011	.337	8.429**	.072 - .115
Interest level in snakes			0.27	.413	.052	.301	7.899**	.310 - .515
Personal risk rating			0.18	-.280	.069	-.150	-4.050**	-.416 – (-.144)

** significant at the $p < 0.01$ level, * significant at the $p < 0.05$ level

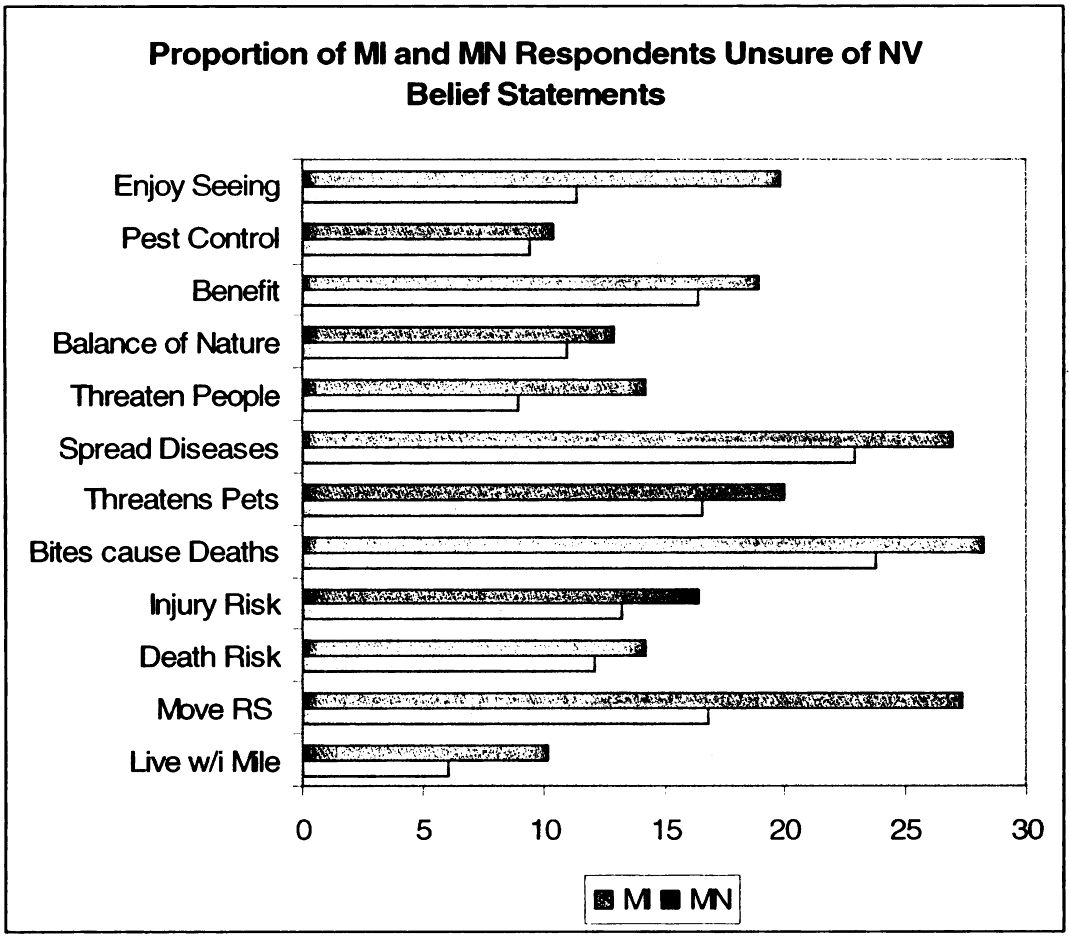

Figure 3.1 Proportion of MI and MN respondents who marked "unsure" to each of twelve belief statements constituting a NV attitude scale on snake mail questionnaires (2005).

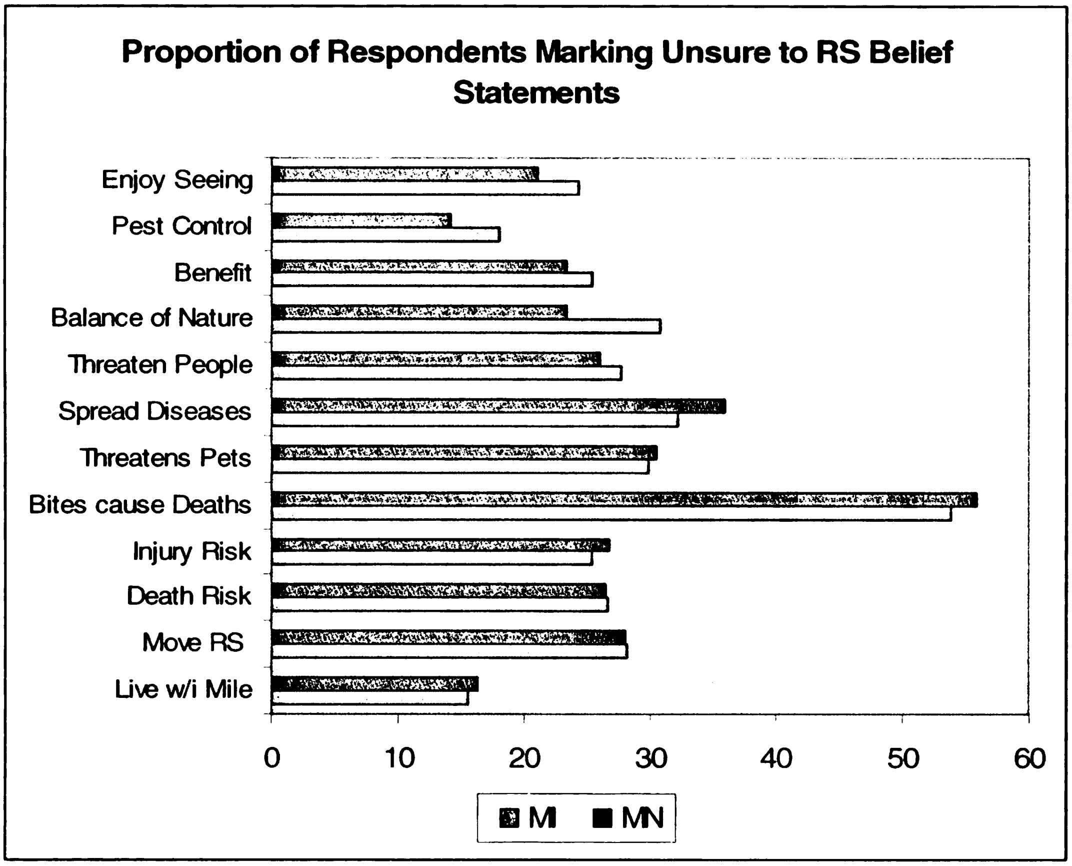

Figure 3.2. Proportion of MI and MN respondents who marked "unsure" to each of twelve belief statements constituting a RS snake attitude scale on mail questionnaires (2005).

CHAPTER 4

SOCIAL ACCEPTANCE CAPACITY: SUGGESTIONS FOR SNAKES

4.1. Introduction

Insights from human dimensions research increasingly are incorporated into natural resources management (Decker et al. 2001). However, little human dimensions research has included reptiles with the exception of one national survey assessing the public's attitudes toward particular wildlife species including turtles and snakes (Kellert 1980). Kellert (1980) examined public willingness to sacrifice a variety of benefits to assure the well-being of several endangered species. In the case of reptiles, respondents expressed little desire to make sacrifices to protect the eastern indigo snake, a species listed under the federal Endangered Species Act, yet were willing to sacrifice a considerable amount for other species (Kellert and Berry 1979). Furthermore, rattlesnakes (RS) were disliked by 78% of respondents, and ranked as the fifth most disliked animal of thirty-three included in the survey. Only wasps, rats, mosquitoes, and cockroaches were more disliked than RS.

Kellert's findings have been repeated in more current studies. In a survey of visitors to an eastern national park, strong support was indicated for all "wildlife." But respondents were not as supportive toward the existence of snakes as a group when asked whether snakes in the park should be killed (Greene 1997). In a separate study in southeastern Australia, people who had killed snakes in the Murrumbidgee Irrigation Area explained their actions as: 1) protecting their children and family pets (53%), 2) "hate" (16%), 3) fear (8%), and 4) no reason given (23%) (Whitaker and Shine 2000). Because of the negative attitudes toward and lethal human behaviors imposed on snakes, social acceptance capacity (SAC) is a theoretical framework that may be helpful in reptile conservation efforts by providing opportunities to reduce negative behaviors and build individual and community capacities to co-exist with snakes and other reptiles. Various models have been used to represent the SAC theoretical framework in wildlife management (Table 4.1). The SAC framework originated in the leisure sciences and was referred to as "social carrying capacity" (SCC) (Shelby and Heberlein 1986). SCC addressed the density of people participating in recreational opportunities in an area and its impact on user satisfaction. SCC is surpassed when impacts in an area exceed acceptable levels of a specified evaluative standard. The SCC framework was first applied in wildlife management for nuisance or perceived overabundant populations, and had its roots in biological carrying capacity (i.e., the maximum number of animals that a given area of habitat can sustain). Thus, human dimensions researchers first used numbers of animals rather than numbers or types of human-animal interactions as a determinant of SAC. More recently, researchers have started to examine frequencies and kinds of wildlife-human interactions as a determinant of SAC and as a framework for wildlife management under the label of adaptive impacts management (Riley et al. 2002).

The earliest work ascribing a SAC framework to wildlife management was conducted by Decker and Purdy (1988) for white-tailed deer. They defined wildlife acceptance capacity (WAC) as the maximum number of animals of a particular species that would be tolerated by humans in an area. An upper limit, but no lower limit, was identified as a target for a wildlife population. Decker and Purdy's early framework focused on one key stakeholder group rather than including multiple stakeholders. More recently, Decker et al. (1996) defined a stakeholder as an individual who will be affected by, or will affect, wildlife or wildlife management. Stakeholders may include diverse groups such as hunters, animal rights supporters, individuals that feed wildlife, individuals that observe wildlife, motorists that risk deer-vehicle collisions, among others. Because such groups are not mutually exclusive, individuals often belong concurrently to two or more of these groups. These groups are important in management of wildlife populations due to their increased investment (IAFWA 2002) and risk (Stout et al. 1993, Conover 1995) associated with such populations. Because of the abundance and diversity of stakeholder groups, wildlife managers need to decide whose interests they will address in a given situation (Riley et al. 2002). Stakes for each focal group can be determined in various ways, and are discussed in the next two described frameworks associated with SAC.

Using WAC as a starting point, Minnis and Peyton (1995) proposed a cultural carrying capacity (CCC) framework that incorporated social judgment theory (Sherif and Hovland 1961), in which three divisions to the evaluative continuum of an individual's attitude toward an object or issue are posited. The latitude of acceptance (LOA) contains beliefs about the object or issue that the individual considers acceptable while the latitude of rejection contains beliefs that are unacceptable. Finally, the latitude of non-commitment contains beliefs that are neither acceptable nor unacceptable. According to Minnis and Peyton (1995), multiple stakeholders have defined LOAs (i.e. lower and upper size limits for a particular wildlife population). By defining LOAs for key stakeholder groups, the area common to all is deemed the CCC for a species in a particular place and time, and eliminates the need for wildlife managers to choose among stakeholder priorities in making management decisions. Thus, CCC is defined as the wildlife population level in a defined area that produces the most manageable amount of issue activity at a given time. Rather than absolute numbers of animals considered the key determinant of cultural carrying capacity, numbers of human-animal interactions and public attitudes as they relate to the likelihood of issue activities were also included.

Social judgment theory (Sherif and Hovland 1961) predicts that when a communicator puts forward a persuasive message that reflects a receiver's own attitudinal position or a similar position, the receiver will assimilate the position toward his or her own attitude and persuasion is apt to be successful. However, when a communicator puts forward a persuasive message that does not reflect a receiver's attitudinal position or a similar position, the receiver is likely to contrast the position away from his or her own attitude and persuasion is unlikely to be successful (Eagly and Chaiken 1993). Thus wildlife managers can use such information to predict the acceptability or rejection of messages to influence CCC for a particular wildlife population by multiple stakeholder groups. Minnis and Peyton acknowledged the temporally and spatially dynamic nature of CCC, and defined an upper and lower limit to wildlife-human interactions.

Finally, Carpenter et al. (2000) proposed the wildlife stakeholder acceptance capacity (WSAC) framework, based on social efficiency theory (Shelby and Heberlein 1986). Shelby and Heberlein posited that social efficiency was maximized by putting a resource to its most highly valued use. Social efficiency theory predicts that managers will manipulate wildlife populations to provide its most highly valued use. Carpenter et al. (2000) generalized the concept of social efficiency to wildlife management decisions, and presented a mathematical formula by which wildlife managers could maximize the net social value of their decisions. Stakeholders are an explicitly stated part of the framework because of the inherent role they play in wildlife management (Decker et. al

1996), and as in the case of Minnis and Peyton, multiple stakeholders are considered. Stakes are weighted for each group and are determined by size of the group and the intensity of support or opposition that the group holds toward a particular management action (Table 4.1). The dynamic nature of WSAC is acknowledged, and upper and lower limits are defined in terms of desires for and tolerance of wildlife impacts, i.e., human-wildlife interactions recognized by a stakeholder and that serve as impetus for some sort of action by the stakeholder. WSAC is determined by a complex mix of variables: psychological variables, such as value orientations and specific beliefs; behavioral variables, such as past experience with wildlife; and situational specifics, such as wildlife encounter frequency and wildlife management actions (Zinn et al. 2000).

The frameworks for SAC that have been applied to wildlife management situations thus far have relied on well-defined and vocal stakeholder groups and have been applied to "huggable" (i.e., mammals and birds) wildlife populations, such as white-tailed deer *(Odocoileus virginianus)* (Minnis and Peyton 1995, Minnis 1997, West and Parkhurst 2002), black bear *(Ursus Americana)* (Peyton et al. 2001, Bowman et al. 2001, Organ and Ellingwood 2000, Miller et al. 1998, Grise 1995), timber wolf *(Canis lupus)* (Beyer et al. 2006, Pate et al. 1996, Schoenecker and Shaw 1997, Bjerke et al. 1998) mountain lion *(Puma concolor)* (Riley and Decker 2000a and b, Manfredo et al. 1998, Wolch et al. 1997), and Canada goose (*Branta candensis*) (Coluccy et al. 2001). Reasons for these species' importance to stakeholders include but are not limited to: 1) license revenues and excise taxes paid by the hunting public (Federal Aid 2006, International Association of Fish and Wildlife Agencies 2002); 2) damage to agricultural crops and livestock (Conover et. al 1995); and 3) threats to human health and safety, such as deer-vehicle collisions (Stout et al. 1993). These species have garnered considerable funding and management attention and thus, are relatively well-known. In contrast, no information exists pertaining to SAC for reptiles, and in particular, snakes. However, these frameworks can also be applied to snakes, turtles, or other non-game species, which do not have well-defined and cohesive stakeholder groups, and for which we have little information regarding population dynamics and relationships between numbers of animals and numbers of human-animal interactions in an area (Table 4.2).

The major goal of this study was to test two existing frameworks of SAC – cultural carrying capacity concept (CCC) and its associated latitudes of acceptance and wildlife stakeholder acceptance capacity concept (WSAC) and its proxy- desire for future populations –as used by Riley and Decker (2000b) and Lischka (2006). Based upon this goal, we sought to assess the utility of the frameworks and to compare and contrast results from MI and MN, where human and snake populations differed. We hypothesized that stakeholders who believed they were living in areas with extant RS populations would be more likely to demonstrate less tolerance of and desire for RS populations than stakeholders who believed that RS were absent or were unsure whether RS existed in their areas.

4.2 Study Areas

Two areas were selected for research, one in southeastern MI and the other in southeastern MN. Study areas allowed for a comparison of stakeholder SACs between two similar, but importantly different, RS species and states. Each study area consisted of four counties in which one of two RS species (i.e., the timber rattlesnake in MN, and the eastern massasauga rattlesnake in MI) existed. All county-level demographic information and ecoregion descriptions can be found in Chapter 1.

4.3 Methods

Mail surveys were conducted in MI and MN using a modified version of Dillman's Tailored Design Method (2000) that included six mailings (See Chapter 3 for details). MI and MN data were analyzed separately to account for differences between snake species and respondents in the two states (Table 3.2, Chapter 3, this ms).
In each state, stakeholder groups were defined post hoc, based on their responses to a questionnaire item that asked about the current RS population in their area. One group of stakeholders consisted of respondents who believed that they were living and recreating in an area with RS, a second group consisted of respondents who believed they were living and recreating in an area without RS, and a third group of respondents who were unsure of whether they shared their living and recreation area with RS. The assumption was made that these groups were not cohesive or unified in any way, such as working toward a common goal, though this was not formally tested. Rather, stakeholders were classified strictly based on their perceived geographic proximity to RS. Individuals that actually are living in close proximity have a greater probability of encounter(s) with RS and thus may derive greater direct benefits (i.e., rodent control, aesthetics) as well as facing greater direct risk (i.e., snakebite) from them. Such individuals are of particular interest because they have a greater likelihood of contact with RS, and therefore have a greater probability of engaging in some sort of behavior in response to such

interactions. Individuals living elsewhere do not have the opportunity to view RS as regularly in the wild but also are not presented with the potential risk from such encounters.

We hypothesized that stakeholders who believed they were living in areas with extant RS populations would be more likely to demonstrate less tolerance of and desire for RS populations than stakeholders who believed that RS were absent or were unsure whether RS existed in their areas. To test this hypothesis, data collected were used to determine (1) whether there were differences in latitudes of acceptance and desires for future RS populations among stakeholders who believed they lived in the presence of RS, stakeholders who believed they lived in areas without RS and stakeholders who were unsure of whether or not RS were present, (2) whether stakeholders' latitudes of acceptance and desire for future RS populations were inversely related to degree of risk perceived by individuals, (3) whether stakeholders' desire for future populations for non-venomous (NV) snakes exceeded that of RS, and (4) differences and similarities in results between MI and MN.

Measures of SAC were modeled after Riley and Decker (2000), Lischka (2006) and Beyer et al. (2006). Questionnaire respondents were queried regarding what change they would like to see in NV snake and RS populations in their neighborhoods. Potential responses included: (-1) Decrease a lot, (-1) Decrease somewhat, (0) Stay the same, (1) Increase somewhat, (1) Increase a lot, and (88) No opinion, which was coded as missing data. As a follow-up, respondents were further asked to indicate how important it was to them that the indicated population (i.e., NV snakes or RS) actually match their desired change. Responses included: *(1) Not at all important, (2) Somewhat important, (3) Very* *important and (99) Unsure*, which was coded as missing data. A respondent's desire for future snake populations then was defined as the product of their desire for a population's change multiplied by the importance that the population actually match the respondent's indicated preference (-3 – +3).

Based on hypothetical scenarios used to measure tolerance for black bears (Peyton et al. 2001), we developed six hypothetical scenarios for RS populations and the number of human-RS, pet-RS, and livestock-RS interactions associated with each population level. As the numbers of RS increased in the hypothetical scenarios, the potential consequences for pets, livestock and humans became greater (Table 4.3). A partial "latitude of acceptance" (LOA) was constructed for each defined stakeholder group by using the average preferred population level (q27, Appendix A.3.) chosen by the group and the average maximum tolerable situation that would induce issue activity (q28, Appendix A.3.).

Factor analysis was used to identify two factors, RS stewardship and RS impersonal risk, underlying twelve belief statements that respondents were asked to consider and indicate their level of agreement or disagreement with each. A respondent's RS stewardship score was calculated using responses from six questionnaire items and a RS impersonal score was measured using six questionnaire items (Table 3.1, Chapter 3, this ms). Self-perceived personal risk was measured by one questionnaire item (question 21b, Appendix A.3.).

In addition to the a priori stakeholder groups, respondents were segmented post de facto into groups of interest to test for differences using t-tests, ANOVA and general linear models. We used a stepwise regression procedure to identify the variables that accounted for the greatest amount of variation in LOA measures and future snake population desires. Model selection was based on changes in adjusted R^2 values, $p \leq 0.05$. Demographic variables tested for inclusion in models were: (1) number of years living in state, (2) number of years living at current residence, (3) description of area in which you currently live, (4) description of area in which you lived as a child, (5) gender, (6) educational level, (7) whether or not a respondent had children living in their residence, (8) whether or not a respondent had dogs living at their residence, and the (8) age class to which a respondent belonged. Human trait variables that were tested for inclusion in models were: (1) wildlife and outdoor activities score, (2) information seeking behavior regarding wildlife, (3) interest in wildlife, (4) wildlife habitat management, (5) interest in snakes, (6) NV snake experience score, (7) RS experience score, (8) whether or not a respondent had observed a RS in their neighborhood in the past year, (9) how the NV snake population had changed in the neighborhood, (10) how the RS population had changed in the neighborhood, (11) how the frequency of close contacts between RS and people in MI or MN have changed, (12) perceived personal risk from RS, (13) post hoc stakeholder group, (14) snake knowledge score, (15) NV impersonal risk score, (16) RS impersonal risk score, (17) NV stewardship score, and (18) RS stewardship score. Not all variables were tested for inclusion due to collinearity concerns, but instead, the variables that made most logical sense in terms of hypothesis testing were included while others were excluded from consideration when applicable. SPSS 13.0 and 15.0 (SPSS, Inc., Chicago, IL) was used for all analyses.

4.4 Results

4.4.1 Cultural Carrying Capacity - Latitudes of Acceptance

In MI, the overall average preferred RS population and hypothetical associated impacts situation was 2.26 ± 1.26, which was truncated as Situation 2 (Situation B, prior to q27, A3). In this Situation, RS were described as existing but *rarely* sighted by anyone and as being at risk of extinction. Forty-one percent of MI respondents chose a preferred situation of no RS present in their neighborhoods. The overall average maximum tolerable RS population and hypothetical associated impacts situation was 3.99 ± 1.55 (rounded up to Situation 4, i.e. Situation D, prior to q27, A3). Under this scenario, RS are sighted *regularly*, pets or livestock are *rarely* bitten and RS populations are healthy but scattered. This partial LOA consisted of a preferred RS population that was at risk of extinction and an upper tolerance level of healthy but scattered RS populations.

MI stakeholder groups differed in their mean preferred and maximum tolerable situations. Respondents who believed that RS were present in their area chose a higher preferred situation (2.75 ± 1.19) and maximum tolerable score (4.39 ± 1.45) than respondents who believed that RS were absent (2.03 ± 1.26 and 3.83 ± 1.53) and respondents who were unsure (1.89 ± 1.15 and 3.71 ± 1.56) (n = 948, F = 45.86, df = 2, $p < 0.01$; and n = 915, F = 17.06, df = 2, $p < 0.01$, respectively) (Figure 4.1).

In MN, the overall average preferred situation was 2.27 ± 1.25 (n = 1,144), which was truncated to Situation 2. The overall mean maximum tolerable situation was 3.78 ± 1.57, which was rounded up to Situation 4. Forty percent of MN respondents indicated a preferred situation that consisted of no RS in the neighborhood. The mean preferred situation did not differ between MI and MN (means = 2.26 and 2.27 respectively; n =

2,135, $t = -0.16$, $df = 2,133$, $p = 0.88$). However, mean maximum tolerable situation was greater in MI than MN (means = 3.99 and 3.78, respectively; n =2,054, $t = 3.02$, $df = 2,052$, $p < 0.01$).

The three MN stakeholder groups differed in their mean preferred situations (n = 1,134, $F = 67.68$, $df = 2$, $p < 0.01$). Respondents who believed that RS were present scored highest (2.69 $\pm$ 1.15), followed by unsure respondents (2.08 $\pm$ 1.24, $p < 0.01$) and respondents who believed that RS were absent (1.81 $\pm$ 1.18, $p < 0.01$). Unsure respondents scored higher than respondents who believed that RS were absent ($p < 0.04$). Respondents who believed that RS were present chose a higher maximum tolerable situation (4.16 $\pm$ 1.41) than unsure respondents (3.55 $\pm$ 1.67, $p < 0.01$) and respondents who believed that RS were absent (3.42 $\pm$ 1.60, $p < 0.01$) (n = 1,089, F =28.63, $df = 2$, $p < 0.01$). Unsure respondents did not differ from respondents who believed that RS were absent ($p = 0.77$) (Figure 4.2).

4.4.2 Wildlife Stakeholder Acceptance Capacity – Desire for Future Rattlesnake Populations

In MI, respondents tended to desire somewhat of a decrease in future RS populations (avg. -0.63 $\pm$ 1.42). More than half (57.4%) of respondents indicated that they would like the RS population to remain at its current level. In MN, desires for future RS populations averaged (-0.49 $\pm$ 1.39). Greater than half (60.9%) of respondents indicated that they would like the RS population to remain at its current level. Mean desire for future RS populations was lower for MI than MN (n = 1,675, $t = -2.04$, $df = 1,602$, $p = 0.04$).

Mean desire for future RS populations differed among stakeholder groups in MI (n = 725, F = 8.40, df = 2, p < 0.01). Post hoc tests indicated that stakeholders who believed that they lived in the presence of RS had higher scores (-0.42 $\pm$ 1.38) than respondents who were unsure of whether RS were present (-0.98 $\pm$ 1.51) (Tamhane's T2 test, p < 0.01). Stakeholder groups also differed in MN (n = 908, F = 9.62, df = 2, p < 0.01). Stakeholders who were unsure of whether RS were present scored lower (-0.96 $\pm$ 1.50) than stakeholders who believed they lived in the presence of RS (-0.38 $\pm$ 1.45, p < 0.01) and stakeholders who believed that RS were absent (-0.42 $\pm$ 1.18, p = 0.01).

4.4.3 Wildlife Stakeholder Acceptance Capacity – Desire for Future Non-venomous Snake Populations

In MI, the average score for desire for future NV snake populations was 0.25 $\pm$ 1.34. The most commonly selected response indicated a desire for the NV snake population to remain as it is (60.8%). MI stakeholder groups differed in their desires for future NV snake populations (n = 814, F = 5.24, df = 2, p < 0.01). Respondents who lived and recreated in areas with RS scored higher (0.39 $\pm$ 1.36) than respondents who were unsure if RS were present (-0.01 $\pm$ 1.35, p < 0.01). Respondents who believed that RS were absent did not differ from the other two groups (0.23 $\pm$ 1.31, p = 0.39 (Yes RS) and p = 0.14 (Unsure)).

In MN, the average score for desire for future NV snake populations was 0.18 $\pm$ 1.23. The most commonly selected response suggested a desire for NV snake populations to remain at their current levels (64.8%). Stakeholder groups in MN differed in their desires for future NV snake populations (n = 940, F = 6.20, df = 2, p < 0.01). Stakeholders who were unsure whether RS were present scored lower (-0.12 $\pm$ 1.42) than respondents who believed that RS were present (0.29 ± 1.24, $p < 0.01$). Respondents who believed that RS were absent did not differ (0.16 ± 1.10, $p = 0.33$ (Yes RS) and $p = 0.11$ (Unsure)).

Desires for future NV snake populations did not differ between MI and MN respondents ($n = 1{,}801$, $t = 1.27$, $df = 1{,}736$, $p = 0.20$). Desires for NV snake populations and RS populations in MI were moderately correlated (Pearson's $r = 0.62$, $p < 0.01$), though a paired sample t-test indicated that desires for NV snake populations were greater than for RS (means = 0.25 and -0.63, respectively; $t = 18.48$, $df = 706$, $p < 0.01$). Results were similar in MN (Pearson's $r = 0.65$, $p < 0.01$; means = 0.18 and -0.49, respectively; $t = 16.66$, $df = 841$, $p < 0.01$). Changes in the NV snake population in a respondent's area were inversely related to desires for future NV snake populations in MI and MN (Pearson's $r = -0.23$, Adj. $R^2 = 0.05$, $F = 32.64$, $t = -5.71$, $p < 0.01$ and Pearson's $r = -0.26$, Adj. $R^2 = 0.07$, $F = 46.77$, $t = -6.84$, $p < 0.01$, respectively).

4.4.4 Comparison of Cultural Carrying Capacity and Wildlife Stakeholder Acceptance Capacity Measures

Correlations among measures of CCC and WSAC were positive and moderate to good (Fink 2003) in MI and MN. In MI, the Pearson's test statistic for correlations between desired future RS populations and preferred and maximum tolerable situations were $r = 0.52$ ($p < 0.01$, two-tailed test, $n = 716$) and $r = 0.39$ ($p < 0.01$, two-tailed test, $n = 691$) (Figure 4.3). Correlation between preferred and maximum tolerable situations was $r = 0.54$ ($p < 0.01$, two-tailed test, $n = 943$). Results were similar for MN measures. The Pearson's test statistic for correlations between desired future RS populations and preferred and maximum tolerable situations were $r = 0.49$ ($p < 0.01$, two-tailed test, $n =$

887) and $r = 0.32$ ($p < 0.01$, two-tailed test, $n = 859$) (Figure 4.4). Correlation between preferred and maximum tolerable situations was $r = 0.57$ ($p < 0.01$, two-tailed test, $n = 1{,}085$).

4.4.5 Explanatory Factors for Latitudes of Acceptance

In MI, the factors that explained the greatest amount of variability in preferred situation were RS stewardship score, educational level, description of the area in which the respondent lived (area description), and the age class to which the respondent belonged (Table 4.4). The factors that explained the greatest amount of variability in maximum tolerable situation in MI were RS stewardship score, whether or not the respondent managed habitat for wildlife, and age class (Table 4.5).

In MN, the factors that explained the greatest amount of variability in preferred situation were RS stewardship score, description of the area in which the respondent currently resided, number of years a respondent had resided in the state and degree of personal risk from a RS perceived by the respondent (Table 4.6). The factors that explained the greatest amount of variability in maximum tolerable situation in MN were RS stewardship score, description of the area in which the respondent lived, the number of years that a respondent had lived in MN and a respondent's level of interest in local wildlife issues (Table 4.7)

4.4.6 Explanatory Factors for Future Snake Population Desires

The factors that explained the greatest amount of variability in desire for future RS populations in MI were RS stewardship score, degree of personal risk perceived by an individual from a RS and age class (Table 4.8). The factors that explained the greatest amount of variability in desire for future RS populations in MN were RS stewardship score, degree of personal risk perceived from a RS, belief about how close contacts between people and RS are changing, and dog ownership (Table 4.9).

In MI, the independent factors included in regression models that explained variation in desires for NV snake populations were NV snake stewardship score and a measure of a respondent's belief in how the NV snake population had changed over time (Table 4.10). The same two independent factors were included in the model for future NV snake population desires in MN (Table 4.11).

4.4.7 Relationship of Risk to Capacity Measures

We examined the relationship between respondents' rating of personal risk posed by RS and our SAC measures (i.e., preferred situation, maximum tolerable situation and desire for future RS populations) (Table 4.12). An inverse relationship existed between respondents' ratings of personal risk posed by RS and their desires for future RS populations (Figure 4.5). Regression procedures were used to test whether SAC measures demonstrated an inverse relationship with ratings of personal risk from RS perceived by respondents (Table 4.13) and to examine the relationship between SAC measures and a respondent's RS impersonal risk score (Table 4.14). RS impersonal risk score accounted for a change in adjusted R^2 that ranged 0.14-0.21 for MI respondents and 0.10-0.36 for MN respondents.

Because of the importance of RS stewardship score in explaining variability in the various SAC measures, regression was used to examine its bivariate relationship with each of the SAC measures (Table 4.15). RS stewardship scores accounted for a change in adjusted R^2 that ranged 0.22-0.48 for MI respondents and 0.13-0.47 for MN respondents. The bivariate correlation was calculated for RS impersonal risk scores and RS stewardship scores for MI respondents ($r = 0.71$, $p < 0.01$) and MN respondents ($r = 0.67$, $p < 0.01$). Because of the high correlation between the two variables, only one was included in any regression model used to account for variability in SAC measures. RS stewardship score was chosen because of its greater contribution, i.e., adj. R^2, to variability in dependent measures.

4.5 Discussion

Few articles have been published that have actually attempted to operationalize the concepts of CCC (Peyton et al. 2001) and WSAC (Lischka 2006). Results of this study suggested the two frameworks result in highly correlated results and agreement among the variables that explain the greatest degree of variation in the dependent measures. Either framework may work equally well when attempting to gauge stakeholder tolerance of and desires for interactions with a wildlife species of interest.

Contrary to much of the previous research on stakeholder attitudes toward carnivores (Riley and Decker 2000b, Kellert 1985, Williams et al. 2002), this study indicates that respondents who recognize they live in the company of RS are more tolerant of RS than stakeholders who believe otherwise. This tolerance of landowners living with RS mirrors that of MI stakeholders' tolerance of another potentially risky species, the black bear (Peyton et al. 2001). Past experience with bears and awareness of bears coincided with a higher WAC, or maximum tolerable situation for bears. The authors concluded that living with bears had not produced more intolerance for bears. Similar to this study, Peyton et al. (2001) also found that respondents who lived in areas where no bears were currently present, were less tolerant of having black bear in their area than respondents who lived in areas where bears were present. Findings on black bears and RS in MI may reflect a lack of any lethal encounters with either of these species in that state or a lack of media attention. Although the eastern massasauga has been documented in almost half of the counties in the lower peninsula of MI, there does not appear to have been any documented fatalities from this species during the past fifty years. This may suggest that there are few negative impacts, damage or threats to human safety that stakeholders actually experience when they reside in an area with extant RS populations. Such stakeholders may acclimate to the RS over time, although this hypothesis was not tested.

A large proportion of respondents (>20%) were unsure whether they lived in an area with RS. As a result, such individuals might be unable to make well-informed decisions or provide relevant input to the snake management processes in their areas. This also suggests that human-snake encounters may be very rare, even when snakes are present (Whitaker and Shine 2000).

Surprisingly, level of personal risk that a respondent felt from a RS was not related to an individual's preferred or maximum tolerable situation, but a strong relationship was demonstrated for personal risk ratings and desire for future RS populations. There was a stronger relationship between impersonal risk scores and any of the SAC measures. The majority of respondents felt at no risk or only slight risk from RS. Riley and Decker (2000) and Stout et al. (1993) found similar patterns for SACs for mountain lions and deer.

As expected, respondents had a greater desire for an increase in NV snake populations than RS populations. What was unexpected was that the desire for an increase in NV snake populations was so slight (< 1 on a scale of 0-3). These data demonstrated, as expected, an inverse relationship between a respondent's perception of how the NV snake population had changed since the respondent had lived in an area and a respondent's desire for future NV snake populations. What was most similar for both groups of snakes (i.e. NV snakes and RS) was the great percentage of people who opted for a response which may have indicated desires for the current NV and RS populations to stay the same. It's unclear why stakeholders chose that response, though similar results have been obtained for white-tailed deer (Christoffel and Craven 2000, Decker and Gavin 1987), mountain lions (Riley and Decker 2000b) and black bear (Peyton et al. 2001), among others. Perhaps such responses are an indication of the sentiment, "If it's not broke, why fix it?" and just represent contentment with the status quo.

In comparing the utility of the two methods used to measure SAC to guide management actions for RS, there are problems with both. Desire for future populations as a proxy for WSAC, as measured in terms of Riley and Decker (2000) and Lischka (2006) only indicates stakeholders' desires for how they would like to see the wildlife population of interest change. Such desires seem irrelevant for management when a large segment of stakeholders has little idea of what the current wildlife population of interest is and/or is totally intolerant of the wildlife population of interest. As a result, such stated desires give managers little information regarding accurate identification of maximum tolerance levels for human-wildlife interactions when human experiences with the wildlife species of interest are so limited (i.e., no experience or perhaps sighting an individual animal out in the wild). LOAs seem at least partially irrelevant to snake management when stakeholders indicate a preferred situation of having no snakes present. Under such circumstances, only an intolerance level can be determined, and the management goal becomes one of not exceeding that tolerance level or managing for WAC (Decker and Purdy 1988). It is interesting to contemplate the implications of stakeholders' maximum tolerable situations in terms of managing RS populations, however, given the results of this research. The majority of stakeholders would tolerate situations up to and including #4, but there was a dramatic drop for situation #5 and #6. The latter were the only two situations in which bites to humans were mentioned as occurring, and even so, these would still be *rare* occurrences. It appears that the great majority of respondents to this survey were intolerant of any potential risk of RS bite to humans in their areas.

Though respondent populations differed between MN and MI, similar results were obtained regarding SACs for NV snakes and RS in both states. The factors that explained the greatest variability in SAC measures were the same in many cases. In particular, it was striking how important RS stewardship score was for SAC in both states, though human and rattlesnakes differed in various ways, including demographic characteristics in humans and size and potential for observation in RS species. This suggests that a measure of stewardship may also be the most important factor in determining SACs for RS elsewhere. Stakeholder groups and their associated SAC results demonstrated similar patterns in MI and MN, indicating that classification of stakeholder groups based on geographic proximity to RS was valid and potentially useful for classifying RS stakeholder groups in other areas.

4.6 Management Implications

The utility of measuring (or attempting to measure) SACs for snakes is in identifying the underlying beliefs and attitudes that stakeholders possess about wildlife and their influence on measures of SAC, and subsequently using such information to manage people's beliefs and attitudes toward, and associated tolerance of, the wildlife population of interest (Beyer et al. 2006). Both approaches, i.e. CCC and WSAC, used in this study emphasize the importance of communication and educational efforts in managing wildlife populations (Peyton et al. 2001, Beyer et al. 2006, Carpenter et al 2000), and both provide a mechanism whereby such efforts can be assessed – monitoring how stakeholder beliefs and attitudes change over time, and how such changes impact their tolerance of and desires for interactions with wildlife.

Clearly, RS stewardship score explained a great deal of the variation in measures of SAC for MI and MN stakeholders toward RS. This should be tested in other areas of the US where greater than one species of RS occurs and where stakeholders may differ from the present study. Study results suggest that a stewardship score may be used as an evaluative tool for monitoring SAC for RS, and that communication and education efforts may yield the greatest results if they are focused on influencing stakeholder stewardship scores.

Study results also suggested that there is an overlap in stakeholder LOAs, even if the LOAs are not complete. Results potentially may be used by wildlife managers to guide snake management decisions and to start monitoring SAC, particularly in areas where known RS populations exist. However, it's essential that managers start monitoring RS populations as well as human-rattlesnake interactions in MI and MN.

Few studies have been conducted that can be used to estimate RS population numbers in an area, and current monitoring for human-rattlesnake encounters appears to consist of a call for citizens to report sightings of eastern massasauga rattlesnakes in MI and timber rattlesnakes in MN. A more systematic approach will need to be taken if SACs and their implications for RS conservation and management are to be used in such efforts.

The identification of misconceptions regarding risks posed to humans by both NV snakes and RS through the process of formulating SACs for these groups can be used to produce written materials and programs aimed at correcting such misconceptions. Future work should evaluate the effectiveness of educational outreach efforts in correcting such misconceptions and their influence on SACs.

Table 4.1. Three existing frameworks used for incorporating social acceptance capacity in wildlife management decisions. (WAC = wildlife acceptance capacity, CCC = cultural carrying capacity, WSAC = wildlife stakeholder acceptance capacity).

	WAC (Decker and Purdy, 1988)	CCC (Minnis and Peyton, 1995)	WSAC (Carpenter et al., 2000)
Goals	Manage for maximum wildlife population level in an area for one key stakeholder group.	Manage for wildlife numbers that produce the most manageable amount of issue activity at a specific time and place.	Manage population to maximize net social value of decisions (minimizing conflicts is subordinate).
Limits	Upper only	Upper and Lower	Upper and Lower
Theoretical framework	Taken from biological carrying capacity in part	Social judgment theory – attitudinal responses are mediated by judgmental processes and effects. Where "latitude of acceptance" terminology comes from (Sherif and Hovland).	Social efficiency theory – social efficiency is maximized when a resource is allocated to its most highly valued use (Shelby and Heberlein 1986).
Key parameters of interest	Weighting mentioned. Account for social, economic and political factors. No specification.	CCC/ARM-includes many parameters, especially management, impact, relationships between impact and management, perceptions, behaviors. Calculation unclear.	N = stakeholder #s S=degree stakeholder group is impacted +/- P=group political power I=intensity of support or opposition
Considerations	Consider damage and appreciative interests and thresholds, perceived competition of the species w/another of interest, role of WL disease transmission to livestock, etc.	Behaviors to increase or decrease extent of wildlife-human interactions with species may involve personal efforts or trying to modify management agency's approach (when WL population becomes an issue for group).	Consider: a) constraints to benefits stakeholders receive from wildlife and b) detrimental impacts of wildlife on economic, social and environmental values of stakeholders.
Influencing capacity	Communication and education. Sizable discrepancies in WAC and management objectives for a key constituency represents a potential management problem	Education, resetting management goals, communication, providing technical or financial assistance. Stakeholders may solve impacts via personal efforts or through higher authority. Agency should respond prior to disruptive issue activity.	Communication and education. Authors state it is reasonable to expect that when understanding of an issue is high, intensity of support will be proportional to actual stake in issue.
Static/dynamic	Dynamic	Dynamic-adaptive management/monitoring.	Dynamic in time and space.

Table 4.2. A comparison of species and their characteristic traits for which social acceptance capacity frameworks have been applied (i.e. huggables) vs. those for which social acceptance capacity frameworks have not been applied (i.e., unhuggables). (+) = trait present, (-) = trait absent

Trait	**Huggables**	**Unhuggables**
Wildlife population estimate available	(+)	(-)
Relationship between wildlife population and human interaction frequencies known	(+)	(-)
Species awareness	(+)	(-)
Species appreciation	(+)	(-)
Knowledge of species' natural history and management needs	(+)	(-)
Well-defined stakeholder groups	(+)	(-)

Table 4.3. Six hypothetical scenarios and their associated characteristics and frequencies that were used to measure cultural carrying capacities for rattlesnakes in mail surveys about snakes conducted in Michigan and Minnesota (2005).

Situation	Snake Populations	Sightings	Bites Pets	Bites Livestock	Bites People
1	NA	NA	NA	NA	NA
2	Risk Extinction	Rare	NA	NA	NA
3	Small and Isolated	Occasional	Rare	Rare	NA
4	Healthy but Scattered	Regular	Rare	Rare	NA
5	Healthy & Connected	Regular	Occasional	Occasional	Rare
6	Abundant & Widespread	Frequent	Occasional	Occasional	Rare

Table 4.4. Regression table for explanation of variation in the dependent variable, preferred situation for rattlesnakes for 2005 Michigan snake mail survey respondents (*n* = 865). (** significant at the p=0.01 level, * significant at the p=0.05 level)

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Conf. Interval Beta	
1 Rattlesnake stewardship score	.364	495.963**	0.60	.136	.006	.604	22.270**	.124	.148
2 Rattlesnake stewardship score	.372	256.910**	0.60	.136		.603	22.356**	.124	.147
Educational level			0.10	.065	.019	.092	3.421**	.028	.102
3 Rattlesnake stewardship score	.380	177.692**	0.60	.133		.589	21.780**	.121	.144
Educational level			0.14	.079		.112	4.095**	.041	.116
Area description			0.13	-.105	.030	-.097	-3.527**	-.163	-.047
4 Rattlesnake stewardship score	.386	136.774**	0.59	.132		.585	21.700**	.120	.143
Educational level			0.12	.071		.101	3.657**	.033	.108
Area description			0.12	-.108		-.100	-3.637**	-.166	-.050
Age class			0.10	-.094	.031	-.081	-3.007**	-.155	-.033

Table 4.5. Regression table for explanation of variation in the dependent variable, maximum tolerable situation for rattlesnakes, for 2005 Michigan snake mail survey respondents ($n = 838$).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Conf. Interval Beta	
1 Rattlesnake stewardship score	.216	232.248**	0.46	.127	.008	.466	15.240**	.111	.144
2 Rattlesnake stewardship score	.221	119.981**	0.45	.124		.455	14.783**	.108	.141
Manage habitat			0.08	-.235	.094	-.077	-2.501*	-.420	-.051
3 Rattlesnake stewardship score	.225	82.021**	0.45	.123		.450	14.601**	.106	.139
Manage habitat			0.09	-.251		-.082	-2.670**	-.436	-.067
Age class			0.09	-.094	.042	-.068	-2.228*	-.176	-.011

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.6. Regression table for explanation of variation in the dependent variable, preferred situation for rattlesnakes, for 2005 Minnesota snake mail survey respondents (*n* = 821).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Conf. Interval Beta	
1 Rattlesnake stewardship score	.315	378.254**	0.55	.136	.007	.562	19.449**	.122	.150
2 Rattlesnake stewardship score	.341	213.446**	0.57	.136		.563	19.852**	.123	.150
Area description			0.18	-.224	.039	-.164	-5.795**	-.300	-.148
3 Rattlesnake stewardship score	.356	152.128**	0.56	.134		.555	19.782**	.121	.148
Area description			0.19	-.238		-.174	-6.200**	-.313	-.162
No. of years in state			0.14	-.098	.022	-.125	-4.441**	-.141	-.055
4 Rattlesnake stewardship score	.366	119.254**	0.58	.143		.590	20.077**	.129	.157
Area description			0.19	-.213		-.156	-5.521**	-.289	-.137
No. of years in state			0.14	-.092		-.117	-4.190**	-.135	-.049
Personal risk			0.16	.206	.056	.110	3.687**	.097	.316

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.7. Regression table for explanation of variation in the dependent variable, maximum tolerable situation for rattlesnakes, for 2005 Minnesota snake mail survey respondents (*n* = 444). (** significant at the p=0.01 level, * significant at the p=0.05 level)

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Conf. Interval Beta	
1 Rattlesnake stewardship score	.136	70.551**	0.37	.103	.012	.371	8.399**	.079	.126
2 Rattlesnake stewardship score	.154	41.362**	0.37	.105		.380	8.673**	.081	.129
Area description			0.17	-.225	.069	-.143	-3.261**	-.360	-.089
3 Rattlesnake stewardship score	.170	31.305**	0.37	.101		.366	8.411**	.078	.125
Area description			0.17	-.242		-.154	-3.532**	-.377	-.107
No. of years in state			0.10	-.134	.043	-.135	-3.095**	-.219	-.049
4 Rattlesnake stewardship score	.187	26.440**	0.35	.091		.330	7.400**	.067	.115
Area description			0.16	-.231		-.146	-3.396**	-.364	-.097
No. of years in state			0.10	-.143		-.144	-3.334**	-.227	-.059
Interest in local wildlife			0.12	.365	.116	.140	3.153**	.137	.593

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.8. Regression table for desire for future rattlesnake populations, for 2005 Michigan snake mail survey respondents (*n* = 613).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Conf. Interval Beta	
1 Rattlesnake stewardship score	.467	536.587**	0.69	.162	.007	.684	23.164**	.148	.176
2 Rattlesnake stewardship score	.490	294.821**	0.65	.152		.642	21.438**	.138	.166
Personal risk			0.21	-.345	.064	-.160	-5.359**	-.472	-.219
3 Rattlesnake stewardship score	.492	198.783**	0.65	.151		.636	21.184**	.137	.165
Personal risk			0.23	-.351		-.163	-5.461**	-.478	-.225
Age class			0.09	-.072	.036	-.057	-1.975*	-.143	.000

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.9. Regression table for explanation of variation in the dependent variable, desire for future rattlesnake populations, for Minnesota respondents (n = 565).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Conf. Interval Beta	
1 Rattlesnake stewardship score	.465	491.739**	0.69	.179	.008	.683	22.175**	.163	.195
2 Rattlesnake stewardship score	.505	288.778**	0.64	.161		.615	19.674**	.145	.177
Personal risk			0.26	-.421	.062	-.213	-6.803**	-.542	-.299
3 Rattlesnake stewardship score	.521	205.279**	0.63	.158		.602	19.465**	.142	.174
Personal risk			0.24	-.367		-.186	-5.926**	-.489	-.246
Close contacts			0.16	-.169	.038	-.133	-4.403**	-.244	-.094
4 Rattlesnake stewardship score	.524	156.520**	0.63	.154		.589	18.870**	.138	.170
Personal risk			0.24	-.375		-.189	-6.058**	-.496	-.253
Close contacts			0.19	-.173		-.136	-4.514**	-.248	-.098
Dog ownership			0.08	.185	.079	.069	2.325*	.029	.341

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.10. Regression table for desire for future NV snake populations, for 2005 Michigan snake mail survey respondents (n = 520).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Confidence Interval Beta	
1 Non-venomous (NV) snake stewardship score	.480	479.895**	0.68	.234	.011	.693	21.907**	.213	.255
2 NV snake stewardship score	.495	255.633**	0.70	.227	.011	.673	21.309**	.206	.248
NV snake population change			0.18	-.213	.052	-.129	-4.095**	-.316	-.111

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.11. Regression table for desire for future NV snake populations for MN mail questionnaire respondents (2005) ($n = 634$).

Model	Adj. R^2	F	*eta*	Beta	SE Beta	St. Beta	t	95% Confidence Interval Beta	
1 Non-venomous (NV) snake stewardship score	.368	369.536**	0.62	.189	.010	.607	19.223**	.169	.208
2 NV snake stewardship score	.393	204.307**	0.59	.179	.010	.576	18.197**	.159	.198
NV snake population change			0.19	-.261	.052	-.158	-5.003**	-.364	-.159

** significant at the p = 0.01 level, * significant at the p = 0.05 level

Table 4.12. Comparison of personal risk scores and mean capacity measures for Michigan and Minnesota snake mail survey respondents (2005).

Personal Risk	Mean *Preferred* Situation		Mean *Maximum* Tolerable Situation		Mean Desire for Future Rattlesnake Populations	
	MI	**MN**	**MI**	**MN**	**MI**	**MN**
1 – No risk at all	2.41	2.32	4.08	3.77	-0.16	0.06
2- Slight risk	2.34	2.38	4.08	3.92	-0.81	-0.54
3 – Somewhat at risk	1.95	2.10	3.82	3.60	-1.80	-1.89
4 – Great risk	2.80	2.75	3.80	3.50	-2.00	-1.50

Table 4.13. Relationships between Michigan and Minnesota mail survey respondents' ratings of personal risk posed by rattlesnakes and social acceptance capacity measures (2005).

	Change in Adj. R^2	F	Beta	*eta*	St. beta	t	95% Confidence Interval for Beta	
MI Preferred Situation	0.002	2.478	-0.111		-0.054	-1.574	-0.249	0.027
MI Maximum Tolerable Situation	-0.001	0.477	-0.060		-0.024	-0.691	-0.231	0.111
MI Desire for Future RS Populations	0.111	85.541**	-0.719	0.33	-0.335	-9.249**	-0.872	-0.567
MN Preferred Situation	0.000	0.554	-0.043		-0.023	-0.744	-0.155	0.070
MN Maximum Tolerable Situation	-0.001	0.026	-0.012		-0.005	-0.162	-0.153	0.130
MN Desire for Future RS Populations	0.174	183.893**	-0.842	0.42	-0.419	-13.561**	-0.964	-0.720

** significant at the $p = 0.01$ level, * significant at the $p = 0.05$ level

Table 4.14. Relationships between impersonal risk scores and capacity measures for Michigan and Minnesota 2005 mail survey respondents.

	Change in Adj. R^2	F	Beta	*eta*	St. beta	t	95% Confidence Interval for Beta	
MI Desire for Future RS populations	0.362	410.845**	0.185	0.60	0.460	14.043**	0.167	0.203
MI Preferred Situation	0.213	256.662**	0.129	0.46	0.463	16.021**	0.113	0.144
MI Maximum Tolerable Situation	0.140	149.843**	0.140	0.38	0.376	12.241**	0.109	0.150
MN Desire for Future RS Populations	0.356	488.570**	0.191	0.60	0.597	22.104**	0.174	0.208
MN Preferred Situation	0.183	245.632**	0.126	0.43	0.429	15.673**	0.110	0.141
MN Maximum Tolerable Situation	0.103	121.486**	0.119	0.32	0.322	11.022**	0.098	0.140

** significant at the $p = 0.01$ level, * significant at the $p = 0.05$ level

Table 4.15. Relationships between rattlesnake stewardship scores and capacity measures for Michigan and Minnesota 2005 snake mail survey respondents.

	Change in Adj. R^2	F	Beta	*eta*	St. beta	t	95% Confidence Interval for Beta	
MI Desire for Future RS populations	0.478	664.659**	0.167	0.69	0.692	25.781**	0.155	0.180
MI Preferred Situation	0.356	521.873**	0.136	0.60	0.597	22.845**	0.124	0.147
MI Maximum Tolerable Situation	0.215	249.969**	0.130	0.46	0.464	15.810**	0.114	0.146
MN Desire for Future RS Populations	0.471	783.018**	0.183	0.69	0.687	27.982**	0.170	0.196
MN Preferred Situation	0.303	473.601**	0.134	0.55	0.551	21.762**	0.122	0.146
MN Maximum Tolerable Situation	0.133	161.985**	0.112	0.37	0.366	12.727**	0.094	0.129

** significant at the $p = 0.01$ level

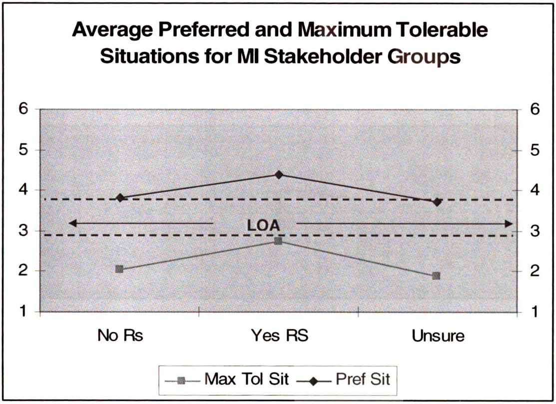

Figure 4.1. Latitude of acceptance (LOA) for three stakeholder groups in southeastern Michigan (No RS = stakeholders who believed rattlesnakes were absent from the areas in which they lived and recreated, Yes RS = respondents who believed that they lived and recreated in areas where rattlesnakes were present, and Unsure RS = respondents who were unsure whether rattlesnakes existed in areas where they lived and recreated) *n* = 915. The lower line represents the mean preferred situation and the upper line represents the mean maximum tolerable situation for each of the three stakeholder groups. The LOA consists of that area on the graph that is tolerable for all stakeholder groups (designated by dashed lines between 2.75 and 3.71).

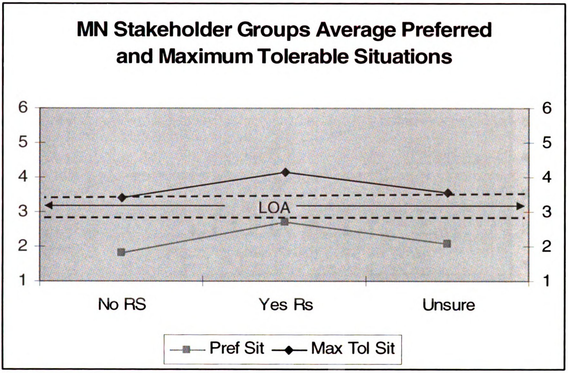

Figure 4.2. Latitude of acceptance (LOA) for three stakeholder groups in southeastern Minnesota (No RS = stakeholders who believed rattlesnakes were absent from the areas in which they lived and recreated, Yes RS = respondents who believed that they lived and recreated in areas where rattlesnakes were present, and Unsure = respondents who were unsure whether rattlesnakes existed in areas where they lived and recreated) *n* = 1,089. The lower line represents the mean preferred situation and the upper line represents the mean maximum tolerable situation for each of the three stakeholder groups. The LOA consists of that area on the graph that is tolerable for all stakeholder groups (designated by dashed lines between 2.69 and 3.42).

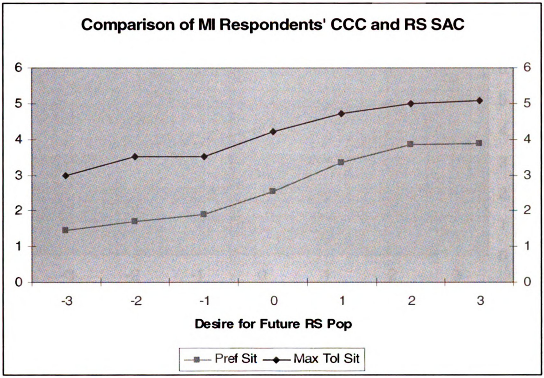

Figure 4.3. Relationship between mail survey respondents' desires for future rattlesnake populations (WSAC) and preferred and maximum tolerable situations for rattlesnakes in Michigan (2005).

*CCC = Cultural Carrying Capacity, RS SAC = Rattlesnake Social Acceptance Capacity

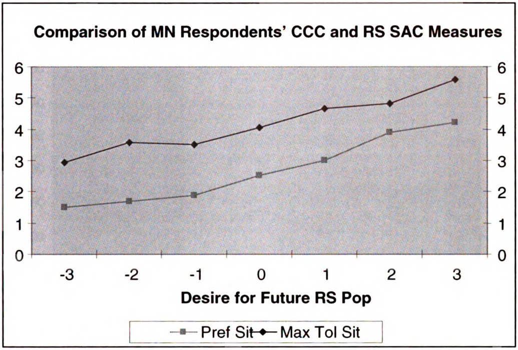

Figure 4.4. Relationship between mail survey respondents' desires for future rattlesnake population and preferred and maximum tolerable situations for rattlesnakes in Minnesota (2005).

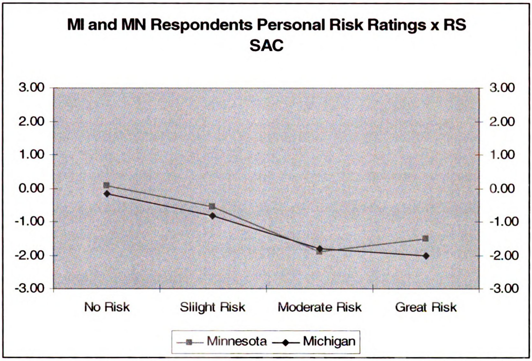

Figure 4.5. Relationship between Michigan and Minnesota snake mail survey respondents' personal risk ratings and desires for future rattlesnake populations, i.e., WSAC (2005).

CHAPTER 5

OUTREACH TO INCREASE KNOWLEDGE AND INFLUENCE STAKEHOLDER ACCEPTANCE CAPACITY FOR SNAKES

5.1 Introduction

Reptile populations are declining globally due to habitat degradation and loss, invasive species, environmental pollution, disease, unsustainable human use, and climate change (Gibbons et al. 2000). The International Union for the Conservation of Nature and Natural Resources (IUCN 2000) estimates that 25% of reptile species are threatened with extinction. Thirty-seven reptile species, including twenty-three snakes, are listed as threatened or endangered by at least one of six Midwestern Great Lakes states (Table 5.1, Table 5.2). Five snake species or subspecies are listed as Regional Conservation Priorities in USFWS Region 3, consisting of IL, IN, IA, MI, MN, MO, OH and WI (USFWS 2002). In addition to state and regional protection, the eastern massasauga rattlesnake (*Sistrurus catenatus catenatus,* Rafinesque 1818) is a candidate for listing under the federal Endangered Species Act (USFWS 1999).

In MI, the eastern massasauga is listed as a species of concern and is protected under a MI DNR Director's order (MI Natural Features Inventory 2006). The bulk of the remaining eastern massasauga populations exist in Michigan, where human tolerance and desire for rattlesnakes (RS) is low (See Chapters 3,4, this ms). The main conservation threats are habitat loss and degradation, fragmentation, and human persecution (Holman et al. 1999, Legge 1996). Thus, the need to reduce harmful human behaviors and increase stakeholder acceptance capacity (SAC) – or tolerance – for snakes is immediate in MI. One potential venue to fulfill this need is through outreach efforts aimed at reducing lethal human behaviors toward snakes and their subsequent assessment to identify optimal methods and delivery channels to improve and monitor the effectiveness of such efforts.

To use educational outreach as a wildlife management tool, it is important to understand the ways in which people receive and process information presented. The sub-discipline of human dimensions of wildlife management aims to do so through research regarding human behaviors. Such research has primarily relied on cognitive and motivational approaches (Decker et al. 2001). A cognitive approach – one that can be used to predict human behavior - entails the examination and study of concepts such as values and norms that underlie human behavior, while a motivational approach is used to explain reasons for human behavior (Decker et al. 2001). However, various factors can interfere with an individual's cognitive process when presented with information about a particular subject.

Prior knowledge or beliefs about an object or issue has been identified as one of the most important variables that can bias a person's information processing activity (Wyer and Srull 1984). Information may be processed in such a way that it reinforces an individual's existing schema, or mental model, e.g., forewarned audiences – of either the message content or of the fact that they would be presented with a persuasive message – were prone to biased information processing. The audience's initial attitudes tended to be reinforced, resulting in resistance to new arguments (Petty and Cacioppo 1986).

Fear is believed to be the most common emotional response to snakes (Shalev and Ben-Mordehai 1996), and has been identified as the major obstacle to snake conservation in India and as a contributing factor elsewhere (Seshadri 1984). Snakes have also been reported to be the most feared of animals listed in surveys (Davey 1994, Merkelbach et al. 1987). Fear, anxiety and stress can interfere with cognitive processing. Wright et al. (2002) found that individuals who were fearful of snakes tended to over-predict fear and subsequently over-predicted the danger of a snake, as well as under-predicted existing safety resources such as potential escape routes.

One way in which motivational and cognitive approaches have been used in concert to study how humans receive and process outreach information is through the elaboration-likelihood model (ELM) of persuasion (Petty and Caccioppo 1986). Two routes, a central and a peripheral, are identified by which persuasive messages are processed by recipients. Persuasion that occurs through central route processing is believed to result in enduring attitude and belief change while peripheral route processing is believed to likely result in attitude or belief changes of short duration. In wildlife education, the central route used to influence stakeholder attitudes includes a number of issue-relevant, information-based approaches, such as outreach publications (i.e., brochures, cards, booklets, etc.) and programs that use slides, videos and other inanimate props. Peripheral cues that may be important when influence is attempted include outreach programs that rely on mere exposure (Zajonc 1968), such as the presence of an animal in a tank at a nature center or classroom or in a cage or enclosure at a zoo, without a verbal or written message. Positive attitude changes have occurred using this technique (Litvak 1969, Zajonc 1968), though results have been variable (Kress 1975).

Behavioral modeling is an approach used to modify people's attitudes toward an object via observation, rather than directly experiencing, the consequences of another person's interactions with the object (Bandura 1969). Individuals fearful of snakes who observed a second individual behave without fear in the presence of a snake showed a tendency to reduce their fear behaviors (Gear and Turteltaub 1967). Fearful individuals have shown greater approach behavior toward snakes with behavioral modeling than without (Somervill et al. 1981). Behavioral modeling accounted for most (80%) of the attitude change toward snakes observed in adults by Blanchard (1969), though Kress (1975) found no attitude change in children toward snakes after observing an adult or another child interacting with a snake.

Morgan and Gramann (1989) attempted to test the ELM through a variety of snake outreach programs with middle school summer environmental camp participants. A combination of central and peripheral route strategies was expected to likely exist through behavioral modeling and direct contact opportunities. They evaluated the effectiveness of seven treatments with fifth - eighth grade children, based on increased knowledge and more positive attitudes toward snakes. The treatments consisted of: (1) an informational slide show and no involvement with snakes; (2) mere exposure to snakes but no information presented; (3) an informational slide show and mere exposure to snakes; (4) mere exposure and behavioral modeling of snakes but no information presented; (5) an informational slide show and mere exposure and behavioral modeling of snakes; (6) mere exposure, behavioral modeling, and direct contact with snakes but no information presented, and; (7) an informational slide show, mere exposure, behavioral modeling, and direct contact with snakes.

Morgan and Gramann (1989) found that individuals who viewed the slide program were nearly twice as knowledgeable as those who had not; this approach appeared to be effective in increasing participants' knowledge of snakes. However, the slide show in itself was not effective in changing attitudes. Mere exposure and behavioral modeling of snakes resulted in higher individual attitude scores than treatments that did not include any involvement with snakes. Direct contact with snakes in addition to behavioral modeling and mere exposure did not result in higher attitude scores. Attitude scores were highest for individuals who received an informational slide show, mere exposure, behavioral modeling, and direct contact opportunities. Although the goal of outreach is commonly to increase knowledge and influence attitudes toward wildlife, such as snakes, and the full-treatment approach appears to be the most effective with children, this approach remains untested on adults. Furthermore, Morgan and Gramann (1989) did not re-assess program participants at a later time; thus, retention of the changes that occurred due to their programs is unknown.

Current snake conservation efforts have aimed at influencing adult stakeholders' SACs for snakes, but no efforts appear to have been made to quantitatively evaluate results. For example, trained volunteers in Minnesota respond to residents who have concerns about timber rattlesnakes, but the effectiveness of such efforts has not been evaluated (Jaime Edwards, MN DNR, personal communication). The Toronto Zoo has conducted extensive eastern massasauga workshops for more than ten years with summer vacationers exposed to eastern massasaugas. An evaluation form was distributed, completed, and collected for 2-3 years, but resulting data have not been analyzed or utilized (Bob Johnson, Toronto Zoo, personal communication). Environment Canada hired an outside consultant to do a long-term retrospective assessment of comprehensive eastern massasauga conservation efforts around the Bruce Peninsula and Georgian Bay areas of Ontario. The consultant concluded that it was highly likely that the conservation efforts had resulted in positive attitude changes by stakeholders, but did not have empirical data to demonstrate this (Cathexis Consulting Inc. 2006).

The goal of this research was to evaluate use of different outreach methods to increase stakeholder knowledge and influence attitudes both in the immediate and longer (six months later) term toward snakes, and to offer suggestions for influencing SAC for snakes, particularly RS. The general hypothesis tested in this chapter stated that stakeholders would be more likely to gain knowledge from any of three treatments administered than from simply filling out a self-administered questionnaire on snakes and would be more likely to hold more positive attitudes toward snakes after attending a program with live snakes. This hypothesis was tested with data indicating 1) whether stakeholders attending any program and stakeholders receiving written materials as a part of this study had greater knowledge than those in the control group and 2) whether stakeholders who attended an outreach program that included behavioral modeling that utilized live snakes had more positive attitudes toward and SAC for snakes than stakeholders that received any of the other treatments or the control group.

5.2 Study Areas

The study area consisted of four counties in which a large block of habitat and extant populations of eastern massasauga rattlesnakes were found in southeastern Michigan. County-wide demographic information and ecoregion descriptions can be found in Chapter 1.

5.3 Methods

An experiment using adult ($\geq$ 18 years old) audiences was conducted to test the effectiveness of three outreach methods to increase knowledge about, and influence attitudes toward snakes. Data were collected to determine increases in knowledge and changes in attitudes about snakes immediately after treatments and again six months later (Appendix, A.10. and A.11.). Participants were drawn from mail survey respondents (see Chapter 3, this ms). Individuals who indicated on their mail questionnaires (Appendix, A.3.) that they were interested in attending a snake outreach program or participating in follow-up surveys were randomly assigned to one of three treatment groups or a control group. A control group was included to provide information regarding the potential changes of attitudes, beliefs, or behavioral intentions due to questionnaire completion without participation in outreach programs (Coover and Angell 1907). This sampling selection did preclude individuals who were not willing to attend an outreach program, non-respondents, and individuals who were not included in the survey sample, and so was subject to self-selection bias (Heinsman and Shadish 1996, Shadish et al. 2000). Participants in the experiment had indicated an interest in learning more about snakes on their mail questionnaires, and so results of this study are likely not applicable to individuals who are not interested in learning more about snakes. Nevertheless, insights can still be gained regarding the retention of knowledge gains and attitude changes.

The experimental treatment groups and control group were compared regarding their knowledge gains and attitude changes from the time they filled out their mail questionnaire to immediately after attending a program, receiving written educational materials, or receiving a second mail questionnaire and request to fill out the questionnaire and return it. Individuals who agreed to participate in the experiment were compared with respondents who refused to determine if there were characteristics that could be identified that explained a respondent's willingness to participate with those that were unwilling.

Treatments consisted of: (1) a 30-minute informational slide show about the human values associated with snakes and natural history of MI's snakes (Appendix, A.13.a) followed by a 30-minute informational slide show that provided in-depth information about five snake species residing in MI (Appendix, A.13.b); (2) a 30-minute informational slide show about the human values associated with snakes and natural history of MI's snakes (Appendix, A.13.a) followed by a 30-minute session in a separate room where five snakes were in tanks and each snake was handled by a naturalist who conveyed in-depth information about the five snake species (Appendix, A.13.b); (3) a mailing of a cover letter and packet of written educational publications about snakes in MI, and; (4) a control group. The control group was sent a second mail questionnaire identical to that which the program participants completed at the conclusion of the snake outreach programs (Appendix, A.10.). The written materials treatment group was sent a second mail questionnaire (Appendix, A.10.) and a packet of written outreach publications about MI snakes. All four groups were sent a long-term mail questionnaire the following spring to track knowledge and attitude change retention (Appendix, A.11.). Finally, individuals who did not reply to the long-term questionnaire were sent a second instrument approximately six weeks after the initial long-term mail questionnaire was sent in a final attempt to minimize participant attrition.

A pilot outreach program was conducted on 26 August 2005, followed by nine experimental outreach programs at Huron-Clinton Metropolitan Park Authority's Kensington Metropark nature center (Appendix, A.12.). This facility was chosen because of its location (within an approximately 30-minute drive for participants from three, i.e. Livingston, Oakland and Washtenaw, of the four study counties). Participants from the fourth county, Jackson, were reimbursed for their mileage to attend outreach programs. A protocol was developed for the outreach experiment and followed (Appendix, A.9.). All outreach program participants received a MI DNR non-game species patch as a "thank you" for participating in the experiment, and a participant chosen at random from each audience was presented with a $50 gift card to Meijer (a regional store similar to Walmart). Two female, Caucasian, part-time naturalists were trained to deliver prescribed treatment programs using scripts written by the author (Appendix, A.13.a and A.13.b) to minimize the effect of demographic and outreach delivery differences in presenters, i.e., procedural heterogeneity (Lipsey 1990). All presenters wore green Huron-Clinton Metroparks polo shirts to minimize the potential for perceived differences in presenter credibility by participants.

Initially, participants were mailed invitations to attend outreach programs on randomly selected dates. Due to low attendance at the first two workshops (n = 1, n = 2, respectively), phone contact was used to confirm invited participants' plans to attend the workshop that they had been assigned to or to reschedule their attendance on an alternate date when necessary. By contacting participants by phone, participants were able to air their concerns or questions regarding the experiment and to gain permission to bring their spouse and/or children along with them to the program so that they could participate.

Respondents were asked to assess how their attitudes had changed about snakes by participating in this study (q1, Appendix, A.13). Responses included: *Greatly*

Increase, Somewhat Increase, Has not Affected this, Somewhat Decrease and Greatly Decrease. Participants also provided standardized data by answering items that were identical on the original mail questionnaires (time 1), post-treatment assessment instruments (time 2) and long-term assessment instruments (time 3). A knowledge score was calculated from respondents' answers to four questionnaire items that used a Likert-type scale (*SA=Strongly agree, A = Agree, U = Unsure, D = Disagree, SD = Strongly Disagree)*: (1) NV snakes are likely to spread disease to humans in MI, (2) NV snakebites cause deaths to MI residents annually, (3) RS are likely to spread disease to humans in MI and (4) RS bites cause deaths to MI residents annually. Respondents' answers were recoded into 1 for responses that corresponded with agreement with factual information and 0 for unsure responses and responses that did not correspond with factual information. These scores were calculated at pre-treatment, immediately post-treatment and at the long-term assessment.

NV snake and RS attitudes were measured using twelve belief statements with a Likert type scale (*SA=Strongly agree, A = Agree, U = Unsure, D = Disagree, SD = Strongly Disagree)* (Appendix A.3). Reliability analyses were run for the NV snake and RS attitude scales, yielding Cronbach's alphas of (0.91) and (0.91), respectively. Factor analyses were run on each set of belief statements that composed the attitude scales. Two factors were identified for each of the attitude scales. The first factor for the NV attitude scale was identified as impersonal risk and consisted of six belief statements; the second factor was stewardship, consisting of five statements (Chapter 3, Table 3.1, this ms). The first factor for the RS attitude scale was stewardship and included six belief statements; the second was impersonal risk and also consisted of six belief statements

(Chapter 3, Table 3.1, this ms). Scale scores for NV impersonal risk, RS impersonal risk and RS stewardship ranged -12 - +12. Scores for NV stewardship ranged -10 - +10. Participants' scores on these four scales, i.e. NV Impersonal Risk, NV Stewardship, RS Impersonal Risk and RS Stewardship, were tested for differences over time and among treatment groups, between program (Treatments 1 and 2) and non-program (Treatments 3 and 4) participants, and between treatment (Treatments 1, 2, and 3) and control (Treatment 4) participants.

Measures of wildlife stakeholder acceptance capacity (WSAC) were modeled after Riley and Decker (2000b) and Lischka (2006). Participants were queried regarding the change they would like to see in NV snake and RS populations in their neighborhoods. Potential responses included: *(-1) Decrease a lot, (-1) Decrease somewhat, (0) Stay the same, (1) Increase somewhat, (1) Increase a lot, and (88) No opinion*, which was coded as missing data. As a follow-up, participants were asked to indicate how important it was to them that the indicated population (i.e., NV snakes or RS) actually match their desired change. Responses included: *(1) Not at all important, (2) Somewhat important, (3) Very important and (99) Unsure*, which was coded as missing data. A respondent's desire for future snake populations then was defined as the product of their desire for a population's change multiplied by the importance that the population actually match the respondent's indicated preference (-3 – +3).

Behavioral intentions were measured by means of a Rattlesnake Sensitivity Index (RSI) modeled after a black bear sensitivity index previously developed by Peyton and others (2001). The RSI consisted of seven hypothetical situations involving RS that participants were asked to imagine and indicate what, if any action, they would take in the given situation (q26, Appendix A.3). Responses included: *Do nothing (4), I would ask someone what I should do (3), I would tell someone that they need to remove the snake (2), I would kill the snake (1) or unsure (99),* but dropped from the analyses. RSI scores ranged 0 - 28, with a greater score indicating greater tolerance, i.e. less sensitivity to rattlesnakes.

ANOVA procedures were used to test for differences among treatment groups at pre-treatment, post-treatment and at the long-term assessment. ANOVA was also used to test for difference among treatment groups in terms of self-assessments regarding changes in how participants' attitudes and beliefs had changed due to participation in this study. Independent samples t-tests were used to test for differences between individuals who had attended a program and individuals who had not, and between treatment groups and the control group. Repeated measures were used to test for differences in parameters of interest within subjects (time 1 vs. time 2 vs. time 3) and among treatment groups. Scheffe and Tamhane's T2 post hoc tests were used to test for pairwise differences in treatments and times (George and Mallery 2006). The cutoff for alpha was set at $p = 0.10$ in order to give treatments, particularly programs "the benefit of the doubt about whether statistically modest effects represent treatment efficacy or merely sampling error" (Lipsey 1990). Effect sizes are reported for measures that demonstrate differences among treatment groups or between program and non-program participants or between treatment and control groups (Rosenthal 1994, Gliner et al. 2001). Power is reported for measures demonstrating differences to elucidate probabilities of Type II errors, as suggested in Lipsey (1990). All analyses were performed using SPSS, versions 13.0 and 15.0 (SPSS, Inc., Chicago, IL).

5.4 Results

One hundred fifty-eight of 1,092 MI mail questionnaire respondents indicated that they would be interested in attending an informational program about snakes, but only twenty-eight came to one of nine programs offered. Of the remaining participants (n = 130), half were mailed written educational materials and half were assigned as the control group. Approximately a third (22/65 = 33.8%) of each of these two groups continued their participation in the experiment, including the completion and return of the long-term assessment instrument. Participants who remained in the experiment for the duration include twelve who received a slide program but no live animals (Treatment 1), six who received a slide program and modeling of snakes (Treatment 2), twenty-two who received written materials but no program (Treatment 3) and twenty-two who answered questionnaires but received no treatment (Control Group 4).

5.4.1 Self-assessed Changes in Beliefs and Attitudes toward Snakes

Respondents provided information regarding their own assessment of changes they experienced in their beliefs or attitudes about snakes due to study participation (Appendix, A.13.). Respondents reported (a) increased interest in snakes, (b) reduced negative feelings toward snakes, (c) increased interest in seeking opportunities to learn more about snakes, (d) similar fear levels toward snakes, (e) similar feelings toward having a snake as a pet, (f) slightly decreased perceptions of personal risk from snakes (g) increased positive feelings about snakes, and (h) increased levels of attention to snakes since participating in this study. On average, respondents had spoken to two different groups of people about snakes since study participation. The increase in interest level about snakes differed among treatments (Table 5.3). Scheffe post hoc tests indicated a difference between the treatment consisting of two informational slide shows (Treatment 1) and the written materials group (Treatment 3). Reduction in negative feelings toward snakes did not differ among groups (Table 5.4). The belief that a participant had increased his or her time to seek opportunities to learn about snakes differed among treatments (Table 5.5). Scheffe post hoc tests indicated that Treatment group 2 (an informational slide show followed by a demonstration featuring live snakes) would spend more time seeking out opportunities to learn more about snakes than the written materials group (Treatment 3) or control group (Treatment 4). Level of fear that participants felt toward snakes did not differ among treatments (Table 5.6). Interest in having a snake as a pet did not differ among treatment participants (Table 5.7), nor did the slight reduction in levels of fear of personally being bitten by a RS (Table 5.8). The increase in positive feelings toward snakes differed among treatments (Table 5.9), but post hoc tests did not identify any pairwise differences between groups. Increase in the level of attention that participants indicated they would pay to snakes differed among treatments (Table 5.10). Scheffe post hoc tests indicated that the group who received two informational slide shows about snakes (Treatment 1) had increased their attention toward snakes more than the control group (Treatment 4).

Participants in either program treatment group (Treatment 1 and Treatment 2) reported (a) greater increases in interest to learn more about snakes, (b) increased time to seek opportunities to learn more about snakes, (c) increased positive feelings toward snakes and (d) increased attention to snakes, than did non-program groups (Treatments 3 and 4) (Table 5.11). Participants in any treatment group (Treatments 1, 2, and 3) expressed a greater increase in attention to snakes than the control group (Treatment 4) (Table 5.12).

5.4.2 Changes in Knowledge about Snakes

Mean knowledge scores among treatment groups did not differ at pre-test (mean = 3.29, n = 75, df = 3, F = 0.76, p = 0.52), but did at post-test (Table 5.13). Scores did not differ among treatment groups at the long-term assessment (mean = 3.54, n = 57, df = 3, F = 1.40, p = 0.25). Repeated measures analysis revealed a between-subjects effect due to treatment (Type III SS = 7.89, df = 3, F = 2.60, p = 0.06, eta = 0.37, power = 0.60).

Knowledge scores did not differ between program and non-program participants at pre-test (means = 3.46 $\pm$ 0.15 and 3.19 $\pm$ 0.16, respectively; n = 76, df = 74, t = 1.18, p = 0.24). Program participants scored higher (mean = 4.00 $\pm$ 0.00) than non-program participants at post-test (mean = 3.21 $\pm$ 0.14; n = 75, adj.df = 46, p < 0.01), and at the long-term assessment (means = 3.79 $\pm$ 0.10 and 3.44 $\pm$ 0.12, n = 58, adj.df = 54, t = 2.36, p = 0.02). Multivariate tests indicated a time * program/no program effect (Pillai's trace = 0.09; F = 2.59, p = 0.09, eta = 0.30, power = 0.49). Repeated measures analysis revealed a between-subjects effect due to program attendance (Type III SS = 7.73, df = 1, F = 8.06, p < 0.01, eta = 0.36, power = 0.80).

Knowledge scores did not differ between treatment and control participants at pre-test (means = 3.35 $\pm$ 0.12 and 3.17 $\pm$ 0.25, respectively; n = 75, df = 73, t = 0.75, p = 0.45) or post-test (means = 3.60 $\pm$ 0.11 and 3.29 $\pm$ 0.19, respectively; n = 74, df = 72, t = 1.48, p = 0.14). Treatment groups scored higher at the long-term assessment (mean = 3.65 $\pm$ 0.10) than the control group (mean = 3.35 $\pm$ 0.17; n = 57, df = 55, t = 1.67, p =

0.10). Repeated measures analysis revealed a between-subjects effect due to treatment (*n* = 54, Type III SS = 3.42, df = 1, F = 3.23, p = 0.08, eta = 0.24, power = 0.42).

5.4.3 Changes in Attitudes about Snakes

Interest in snakes did not differ among groups at pre-test (mean = 3.22, *n* = 67, df = 3, F = 0.47, p = 0.70) or post-test (mean = 3.33, *n* = 76, df = 3, F = 1.41, p = 0.25). Interest levels did differ at the long-term assessment (Table 5.14). Multivariate tests indicated a time * treatment effect (Pillai's trace = 0.23, F = 2.06, p = 0.07, eta = 0.34, power = 0.72). Repeated measures analysis revealed a between-subjects effect due to treatment (*n* = 52, Type III SS = 2.10, df = 3, F = 2.97, p = 0.04, eta = 0.39, power = 0.67).

Interest in snakes did not differ between program (mean = 3.28 ± 0.09) and non-program (mean = 3.19 ± 0.06) participants at pre-test (*n* =68, df = 66, t = 0.89, p = 0.38) or post-test (means = 3.46 ± 0.13 and 3.24 ± 0.06, respectively; *n* = 77, adj. df = 39, t = 1.51, p = 0.14). Mean interest levels were greater for program participants (mean = 3.47 ± 0.12) than non-program participants (mean = 3.08 ± 0.04) at the long-term assessment (*n* = 59, adj. df = 23, t = 3.19, p < 0.01). Multivariate tests indicated a time * program effect (*n* = 53, Pillai's trace = 0.16, df = 2, F = 4.90, p = 0.01, eta = 0.40, power = 0.78. Repeated measures analysis detected a within-subject effect due to time * program (Type III SS = 1.20, df = 1.7, F = 2.98, p = 0.06, eta = 0.23, power = 0.52) and a between-subjects effect due to program (Type III SS = 1.69, F = 7.32, p < 0.01, eta = 0.35, power = 0.76).

Snake interest did not differ between treatment and control groups (means = 3.24 ± 0.06 and 3.19 ± 0.09) at pre-test (*n* = 67, df = 65, t = 0.44, p = 0.66), post –treatment (means = 3.38 ± 0.08 and 3.21 ± 0.09, respectively; n = 76, adj. df = 62, t = 1.49, p = 0.14), or at the long-term assessment (means = 3.24 ± 007 and 3.10 ± 0.07, respectively; n = 58, adj. df = 51, t = 1.40, p = 0.17). No within-subject or between-subject effects were revealed through repeated measures analysis.

NV snake attitude scores did not differ among groups at pre-test (mean = 19.83 ± 0.49, n = 75, df = 3, F = 0.67, p = 0.57), but did differ at post-treatment (Table 5.15). Groups did not differ at the long-term assessment (mean = 19.93 ± 0.60, n = 57, df = 3, F = 1.19, p = 0.32). Multivariate tests indicated an effect due to time (Pillai's trace = 0.10, F = 2.51, p = 0.09, eta = 0.31, power = 0.48). Repeated measures analysis revealed a between-subjects effect due to pre-test scores (Type III SS = 291, F = 13.52, $p < 0.01$, eta = 0.48, power = 0.95).

Program and non-program participants' NV snake attitude scores did not differ at pre-test (means = 20.56 ± 0.61 and 19.54 ± 0.67) at pre-test (n =75, t = 1.12, adj. df = 70, p = 0.27), but did at post-test (means = 22.35 ± 0.49 and 19.89 ± 0.63, respectively; n = 71, t = 3.08, df = 69, $p < 0.01$). NV snake attitude scores were still greater for program participants at the long-term assessment (means = 21.56 ± 0.83 and 19.30 ± 0.75, respectively; n = 58, t = 2.02, adj. df = 44, p = 0.05). When I controlled for pre-test NV snake attitude scores, repeated measures analysis revealed between-subject effects due to the pre-test scores (Type III SS = 276, F = 13.44, $p < 0.01$, eta = 0.46, power = 0.95) and program effect (Type III SS = 99, F = 4.83, p = 0.03, eta = 0.3, power = 0.58).

Treatment groups and the control group did not differ at pre-test on NV snake attitude scores (means = 20.40 ± 0.58 and 18.96 ± 0.89, respectively; n = 74, t = 1.40, df = 72, p = 0.17). Treatment groups scored higher (mean = 21.59 ± 0.52) than the control group (mean = 19.38 ± 0.85) at post-test (n = 70, t = 2.34, df = 68, p = 0.02) but the groups did not differ at the long-term assessment (means = 19.97 ± 0.80 and 19.86 ± 0.87, respectively; n = 57, t = 0.09, df = 55, p = 0.93). When I controlled for pre-test NV snake attitude scores, repeated measures analysis revealed a within-subject effect due to time * treatment (n = 51, Type III SS = 27, F = 4.14, p = 0.05, eta = 0.28, power = 0.51) and a between-subjects effect due to pre-test NV snake attitude score (n = 51, Type III SS = 265, F = 11.58, p < 0.01, eta = 0.44, power = 0.92).

NV impersonal risk scores did not differ at pre-test (mean = 9.87 ± 0.32, n = 75, F = 0.56, p = 0.65), post-test (mean = 10.21 ± 0.28, n = 70, F = 1.35, p = 0.27), or at the long-term assessment (mean = 9.83 ± 0.37, n = 58, F = 0.80, p = 0.50). A repeated measures analysis revealed a between-subjects effect due to pre-test score when I controlled for NV impersonal risk pre-test score at pre-test (Type III SS = 62.14, F = 8.27, p < 0.01, eta = 0.38, power = 0.81).

Program and non-program participants did not differ on NV impersonal risk scores at pre-test (means = 10.22 ± 0.42 and 9.67 ± 0.44 respectively, n = 76, t = 0.82, df = 74, p = 0.41) but did at post-test (means = 10.92 ± 0.26 and 9.83 ± 0.38 respectively, n = 71, t = 2.35, adj. df = 69, p = 0.02). NV impersonal risk scores no longer differed at long-term assessment (means = 10.56 ± 0.61 and 9.56 ± 0.44 respectively, n = 59, t = 1.27, df = 57, p = 0.21). When I controlled for NV impersonal risk score at pre-test, repeated measures analysis revealed between-subjects effects due to pre-test (Type III SS = 58.21, F = 8.02, p < 0.01, eta = 0.37, power = 0.79) and program attendance (Type III SS = 21.31, F = 2.94, p = 0.09, eta = 0.23, power = 0.39).

Treatment and control groups did not differ on NV impersonal risk scores at pre-test (means = 10.14 ± 0.35 and 9.29 ± 0.69 respectively, *n* = 75, t = 1.10, adj. df = 35, p = 0.28), post-test (means = 10.35 ± 0.33 and 9.96 ± 0.50 respectively, *n* = 70, t = 0.67, df = 68, p = 0.51), or at the long-term assessment (means = 9.84 ± 0.47 and 9.81 ± 0.59 respectively, *n* = 58, t = 0.04, df = 56, p = 0.97). When I controlled for NV impersonal risk score at pre-test, repeated measures analysis revealed a between-subjects effect due to pre-test score (Type III SS = 58.41, F = 7.51, p < 0.01, eta = 0.36, power = 0.77).

NV stewardship scores did not differ among groups at pre-test (mean = 8.27 ± 0.22, *n* = 75, F = 1.05, p = 0.38) or the long-term assessment (mean = 8.32 ± 0.26, *n* = 59, F = 1.37, p = 0.26), but did at post-test (Table 5.16). When I controlled for NV stewardship score at pre-test, repeated measures analysis revealed a between-subjects effect due to pre-test score (Type III SS = 131.77, F = 28.81, p < 0.01, eta = 0.59, power = 1.00).

NV stewardship scores did not differ between program and non-program participants at pre-test (means = 8.57 ± 0.32 and 8.04 ± 0.30 respectively, *n* = 76, t = 1.16, df = 74, p = 0.25) but did at post-test (means = 9.21 ± 0.28 and 8.10 ± 0.31 respectively, t = 2.67, df = 73, p < 0.01) and the long-term assessment (means = 9.11 ± 0.32 and 8.00 ± 0.34 respectively, t = 2.36, adj. df = 51, p = 0.02). Repeated measures analysis indicated a between-subjects effect due to program attendance (Type III SS = 27.40, F = 3.21, p = 0.08, eta = 0.23, power = 0.42). When I controlled for NV stewardship score at pre-test, repeated measures analysis revealed between-subjects effects due to pre-test score (Type III SS = 130.47, F = 29.57, p < 0.01, eta = 0.59, power

= 1.00) and program attendance (Type III SS = 22.35, F = 5.07, p = 0.03, eta = 0.29, power = 0.60).

Treatment and control groups did not differ at pre-test (means = 8.45 ± 0.26 and 7.88 ± 0.42 respectively, *n* = 75, t = 1.22, df = 73, p = 0.23) or the long-term assessment (means = 8.38 ± 0.34 and 8.23 ± 0.42 respectively, *n* = 59, t = 0.28, df = 57, p = 0.78), but differed at post-test (means = 8.88 ± 0.28 and 7.79 ± 0.38 respectively, *n* = 76, t = 2.28, df = 74, p = 0.03). When I controlled for NV stewardship score at pre-test, repeated measures analysis revealed a between-subjects effect due to pre-test score (Type III SS = 136.09, F = 27.98, p < 0.01, eta = 0.58, power = 1.00).

RS attitude scores did not among treatment groups at pre-test (mean = 13.71 ± 0.83, *n* = 72, df = 3, F = 1.36, p = 0.26) but did at post-test (Table 5.17). Treatment groups 1 (two informational slide shows) and 3 (written materials group) scored higher than group 4 (control group). Treatment groups did not differ at the long-term assessment (mean = 15.81 ± 0.76, *n* = 54, F = 0.39, p = 0.76). Repeated measures analysis revealed a within-subjects effect due to time * treatment (Pillai's trace = 0.16, *n* = 45, F = 2.49, p = 0.07, eta = 0.40, power = 0.57), and between-subjects effect due to pre-test score (Type III SS = 969, F = 32.44, p < 0.01, eta = 0.67, power = 1.00).

RS attitude scores did not differ at pre-test between program (mean = 15.11 ± 7.25) and non-program (mean = 12.71 ± 6.83) participants (*n* = 73, t = 1.42, df = 71, p = 0.16). Program participants scored higher (mean = 18.52 ± 1.03) at post-test than non-program participants (mean = 14.22 ± 0.91; *n* = 69, t = 2.90, df = 67, p < 0.01), but scores did not differ at long-term assessment (means = 16.94 ± 1.34 and 15.39 ± 0.90, respectively; *n* = 55, t = 0.96, df = 53, p = 0.34). Repeated measures analysis revealed a time* treatment within-subject effect ($F = 3.59$, $p = 0.04$, eta = 0.28, power = 0.62). When I controlled for pre-test RS snake attitude scores, a between-subjects effect due to pre-test was revealed (Type III SS = 997, $F = 34.82$, $p < 0.01$, eta = 0.67, power = 1.00).

Treatment and control groups did not differ at pre-test on RS snake attitude scores (means = 14.35 $\pm$ 1.03 and 12.35 $\pm$ 1.39, respectively; *n* =72, $t = 1.12$, df = 70, $p = 0.27$) but did at post-test (means = 17.58 $\pm$ 0.83 and 12.09 $\pm$ 1.17, respectively; *n* = 68, $t = 3.83$, df = 66, $p < 0.01$). Scores no longer differed at long-term assessment (means = 15.94 $\pm$ 0.92 and 15.60 $\pm$ 1.34, respectively; *n* = 54, $t = 0.22$, df = 52, $p = 0.83$). Repeated measures indicated witin-subjects effects due to time ($F = 2.82$, $p = 0.07$, eta = 0.25, power = 0.51) and time * treat/control ($F = 2.91$, $p = 0.07$, eta = 0.25, power = 0.52). When I controlled for RS attitude scores at pre-test, repeated measures revealed a within-subjects effect due to time * treat/control (Pillai's trace = 0.12, $F = 5.87$, $p = 0.02$, eta = 0.35, power = 0.66), and between-subjects effect due to pre-test scores (Type III SS = 1006, $F = 34.59$, $p < 0.01$, eta = 0.67, power = 1.00).

RS impersonal risk scores did not differ among treatment groups at pre-test (mean = 7.00 $\pm$ 0.43, *n* = 75, $F = 2.10$, $p = 0.11$) or the long-term assessment (mean = 7.81 $\pm$ 0.42, *n* = 57, $F = 0.39$, $p = 0.76$) but did at post-test (Table 5.18). When I controlled for pre-test scores, repeated measures analysis revealed a between-subjects effect due to pre-test scores (Type III SS = 205.83, $F = 19.23$, $p < 0.01$, eta = 0.53, power = 0.99).

RS impersonal risk scores differed between program and non-program participants at pre-test (means = 8.07 $\pm$ 0.66 and 6.33 $\pm$ 0.53 respectively, *n* = 76, $t = 2.02$, df = 74, $p = 0.05$). Because of this, gain scores were compared at post-test and at long-term assessment. Gain scores did not differ at post-test (means = 1.23 $\pm$ 0.83 and

0.29 ± 0.56 respectively, $n = 74$, $t = 0.97$, $df = 72$, $p = 0.34$) or the long-term assessment (means = -0.61 ± 1.00 and 0.38 ± 0.58 respectively, $n = 57$, $t = -0.91$, $df = 55$, $p = 0.37$). When I controlled for RS impersonal risk scores at pre-test, repeated measures analysis revealed within-subjects effects due to time (Pillai's trace = 0.11, $F = 6.37$, $p = 0.02$, eta = 0.33, power = 0.70) and time * pretest scores (Pillai's trace = 0.09, $F = 5.33$, $p = 0.03$, eta = 0.30, power = 0.62). A between-subjects effect due to pre-test scores was also indicated (Type III SS = 159.31, $F = 34.98$, $p < 0.01$, eta = 0.63, power = 1.00).

Treatment and control groups did not differ at pre-test (means = 7.24 ± 0.52 and 6.50 ± 0.77 respectively, $n = 75$, $t = 0.80$, $df = 73$, $p = 0.43$) or the long-term assessment (means = 7.95 ± 0.53 and 7.55 ± 0.72 respectively, $n = 57$, $t = 0.44$, $df = 55$, $p = 0.66$), but did at post-test (means = 8.38 ± 0.52 and 5.79 ± 0.65 respectively, $n = 74$, $t = 2.98$, $df = 72$, $p < 0.01$). Repeated measures analysis indicated a between-subjects effect due to inclusion in a treatment group or not (Type III SS = 62.88, $F = 2.90$, $p = 0.09$, power = 0.39). When I controlled for pre-test scores, repeated measures analysis revealed a within-subjects effect due to time * treatment/control (Pillai's trace = 0.06, $F = 3.39$, $p = 0.07$, eta = 0.25, power = 0.44) and between-subjects effects due to pre-test scores (Type III SS = 225.19, $F = 21.75$, $p > 0.01$, eta = 0.54, power = 1.00) and inclusion in treatment or control group (Type III SS = 29.05, $F = 2.81$, $p = 0.10$, eta = 0.23, power = 0.38).

RS stewardship scores did not differ among treatment groups at pre-test (mean = 6.70 ± 0.46, $n = 73$, $F = 0.89$, $p = 0.45$) or the long-term assessment (mean = 8.07 ± 0.41, $n = 55$, $F = 0.21$, $p = 0.89$), but did at post-test (Table 5.19). Repeated measures analysis indicated a within-subjects effect due to time ($F = 2.60$, $p = 0.09$, eta = 0.24, power =

0.46). When I controlled for pre-test scores, a between-subjects effect due to pre-test score was revealed (Type III SS = 349.16, $F = 30.91$, $p < 0.01$, eta = 0.65, power = 1.00).

RS stewardship scores for program and non-program participants did not differ at pre-test (means = 7.04 ± 0.79 and 6.41 ± 0.56 respectively, $n = 74$, $t = 0.66$, df = 72, $p = 0.51$), post-test (means = 8.92 ± 0.64 and 7.78 ± 0.51 respectively, $n = 71$, $t = 1.36$, df = 69, $p = 0.18$), or the long-term assessment (means = 8.47 ± 0.61 and 7.87 ± 0.52 respectively, $n = 56$, $t = 0.67$, df = 54, $p = 0.50$). Repeated measures analysis indicated a within-subjects effect due to time ($F = 4.83$, $p = 0.01$, eta = 0.30, power = 0.74). When I controlled for pre-test scores, a between-subjects effect due to pre-test score was revealed (Type III SS = 371.12, $F = 34.40$, $p < 0.01$, eta = 0.65, power = 1.00).

Treatment and control groups did not differ on their RS stewardship scores at pre-test (means = 7.10 ± 0.57 and 5.83 ± 0.75 respectively, $n = 73$, $t = 1.29$, df = 71, $p = 0.20$) or the long-term assessment (means = 8.24 ± 0.46 and 7.81 ± 0.80 respectively, $n = 55$, $t = 0.50$, df = 53, $p = 0.62$) but did at post-test (means = 9.17 ± 0.44 and 6.30 ± 0.69 respectively, $n = 70$, $t = 3.60$, df = 68, $p < 0.01$). Multivariate tests indicated an effect due to time (Pillai's trace = 0.13, $F = 3.33$, $p = 0.05$, eta = 0.36, power = 0.60) and time * treatment/control (Pillai's trace = 0.10, $F = 2.50$, $p = 0.09$, eta = 0.32, power = 0.48). Repeated measures analysis indicated a within-subjects effect due to time ($F = 4.82$, $p = 0.02$, eta = 0.31, power = 0.74). When I controlled for pre-test scores, repeated measures analysis revealed a between-subjects effect due to pre-test scores (Type III SS = 346.90, $F = 31.71$, $p < 0.01$, eta = 0.64, power = 1.00).

5.4.4. Changes in Social Acceptance Capacity Measures for Snakes

NV SAC scores differed at pretest (Table 5.20). Because of this, gain scores at post-test and long-term assessment were examined for differences. There was no difference among gain scores at post-test (mean = 0.55 $\pm$ 0.23, n = 56, F = 1.56, p = 0.21) or long-term assessment (mean = -0.24 $\pm$ 0.23, n = 49, F = 0.62, p = 0.61). Repeated measures analysis detected a within-subjects effect due to time (F = 2.91, p = 0.10, eta = 0.27, power = 0.38), and a between-subjects effect due to pre-test score (Type III SS = 13, F = 21.27, p < 0.01, eta = 0.61, power = 0.99).

NV SAC scores did not differ between program (mean = 1.40 $\pm$ 0.29) and non-program (mean = 1.39 $\pm$ 0.18) at pre-test (n = 63, t = 0.02, df = 61, p = 0.99), but did at post-test (means = 2.35 $\pm$ 0.35 and 1.51 $\pm$ 0.27, respectively; n = 67, t = 1.92, df = 65, p = 0.06). NV SAC scores did not differ at long-term assessment (means = 1.59 $\pm$ 0.33 and 0.85 $\pm$ 0.32, respectively; n = 57, t = 1.38, df = 55, p = 0.17). When I controlled for pre-test scores, repeated measures analysis revealed a between-subjects effect due to pre-test score (Type III SS = 35, F = 10.52, p < 0.01, eta = 0.46, power = 0.89) and program attendance (Type III SS = 15, F = 4.49, p = 0.04, eta = 0.32, power = 0.54).

Treatment groups differed (mean = 1.63 $\pm$ 0.19) from the control group (mean = 0.95 $\pm$ 0.27) at pre-test. Because of this, gain scores were examined at post-test and long-term assessment. Gain scores did not differ at post-test (means = 0.59 $\pm$ 0.30 and 0.47 $\pm$ 0.29, n = 56, t = 0.29, adj. df = 47, p = 0.78) or long-term assessment (means = - 0.41 $\pm$ 0.30 and 0.06 $\pm$ 0.33, respectively; n = 49, t = -0.98m df = 47, p = 0.33).

RS SAC scores did not differ at pre-test among treatments (mean = 0.11 $\pm$ 0.18, F = 0.23, p = 0.88). Because raw data were not normally distributed (high kurtosis value for RS SAC T2), gain scores were used to test for differences due to treatment. Gain scores did not differ at post-test (mean = 0.63 ± 0.19, F = 0.10, p = 0.96) or long-term assessment (mean = 0.02 ± 0.19, F = 1.23, p = 0.31). When I controlled for pre-test scores, repeated measures analysis indicated a within-subjects effect due to time * pre-test score (Pillai's trace = 0.25, F = 10.42, p < 0.01, eta = 0.50, power = 0.88), and a between-subjects effect due to pre-test score (Type III SS = 17, F = 28.17, p < 0.01, eta = 0.69, power = 1.00).

Pre-test RS SAC scores did not differ between program and non-program participants (means = 0.13 ± 0.23 and 0.09 ± 0.25 respectively, *n* = 56, t = 0.11, df = 54, p = 0.91). Gain scores did not differ at post-test (means = 0.72 ± 0.29 and 0.55 ± 0.25, respectively, *n* = 49, t = 0.45, df = 47, p = 0.66) or the long-term assessment (means = 0.25 ± 0.39 and 0.15 ± 0.19 respectively, *n* = 49, t = -1.04, df = 47, p = 0.30). When I controlled for pre-test scores, repeated measures analysis revealed a within-subjects effect due to time * pre-test score (Pillai's trace = 0.04, F = 9.78, p < 0.01, eta = 0.47, power = 0.86) and between-subjects effect due to pre-test score (Type III SS = 17, F = 30.22, p < 0.01, eta = 0.69, power = 1.00).

Treatment and control groups did not differ at pre-test (means = 0.19 ± 0.22 and -0.06 ± 0.31, respectively, *n* = 55, t = -0.64, df = 53, p = 0.52). Gain scores did not differ at post-test (means = 0.67 ± 0.27 and 0.56 ± 0.23, respectively, *n* = 48, t = 0.28, df = 46, p = 0.78) or the long-term assessment (means = 0.03 ± 0.26 and 0.00 ± 0.24 respectively, *n* = 48, t = 0.08, df = 46, p = 0.94).

The preferred situation selected among treatment groups did not differ at pre-test (mean = 3.24 ± 0.12, *n* = 72, df = 3, F = 1.36, p = 0.26), post-test (mean = 3.55 ± 0.13, *n*

= 73, df = 3, F = 0.12, p = 0.95) or the long-term assessment (mean = 3.52 ± 0.13, *n* = 60, df = 3, F = 0.47, p = 0.70). When I controlled for pre-test (preferred situation) selection, repeated measures analysis revealed a between-subjects effect due to pre-test selection (Type III SS = 24, F = 21.32, p < 0.01, eta = 0.55, power = 1.00).

Program participants (mean = 3.52 ± 0.19) had a greater preferred situation than non-program participants at pre-test (mean = 3.11 ± 0.15) at pre-test (*n* = 73, t = 1.67, df = 71, p = 0.10), but gain scores did not differ at post-test (means = 0.08 ± 0.24 and 0.36 ± 0.16 respectively, *n* = 70, t = -1.04, df = 68, p = 0.30) or the long-term assessment (means = 0.26 ± 0.30 and -0.05 ± 0.15, respectively, *n* = 58, t = 1.06, df = 56, p = 0.30). When I controlled for pre-test selection, repeated measures analysis revealed a between-subjects effect due to pre-test selection (Type III SS = 9.85, F = 24.85, p < 0.01, eta = 0.57, power = 1.00).

Treatment and control groups did not differ at pre-test (means = 3.28 ± 0.15 and 3.17 ± 0.21, respectively, *n* = 72, t = 0.39, df = 70, p = 0.70), post-test (means = 3.55 ± 0.16 and 3.55 ± 0.21, respectively, *n* = 73, t = 0.01, df = 71, p = 0.99), or the long-term assessment (means = 3.53 ± 0.17 and 3.50 ± 0.18, respectively, *n* = 60, t = 0.10, df = 58, p = 0.92). Repeated measures analysis indicated a within-subjects effect due to time (Pillai's trace = 0.13, F = 3.80, p = 0.03, eta = 0.36, power = 0.67). When I controlled for pre-test selection, repeated measures analysis revealed a between-subjects effect due to pre-test selection (Type III SS = 25.61, F = 23.56, p < 0.01, eta = 0.57, power = 1.00).

The maximum tolerable situation for participants differed by treatment at pre-test (Table 5.21). Post hoc tests indicated no pairwise differences between treatment groups. Because of this, gain scores were examined at post-test and long-term assessment for differences. Gain scores differed among groups at post-test (Table 5.22), but not long-term assessment (mean = -0.16 ± 0.20, n = 51, df = 3, F = 1.47, p = 0.24). Repeated measures analysis, controlling for pre-test selection, revealed within-subject effects due to time (Pillai's trace = 0.24, F = 14.17, p < 0.01, eta = 0.49, power = 0.96) and time * pretest selection (Pillai's trace = 0.25, F = 14.92, p < 0.01, eta = 0.50, power = 0.97) and a between subjects effect due to pre-test selection (Type III SS = 7.81, F = 8.42, p < 0.01, eta = 0.40, power = 0.81).

Program participants selected a greater maximum tolerable situation (mean = 5.37 ± 0.17) than non-program participants (mean = 4.87 ± 0.16) at pretest (n = 73, t = 2.03, df = 71, p = 0.05). Non-program participants had greater gain scores at post-test (mean = 0.37 ± 0.17) than program participants (mean = -0.63 ± 0.34, n = 65, t = -2.65, adj. df = 38, p = 0.01), but program participants (mean = 0.39 ± 0.38) had greater long-term assessment gain scores than non-program participants (mean = -0.44 ± 0.22, n = 52, t = 2.05, df = 50, p = 0.05**). Repeated measures analysis, controlling for pre-test selection, revealed within-subject effects due to time (Pillai's trace = 0.24, F = 15.03, p < 0.01, eta = 0.49, power = 0.97), time * pretest selection (Pillai's trace = 0.25, F = 15.55, p < 0.01, eta = 0.49, power = 0.97), and time * program attendance (Pillai's trace = 0.09, F = 4.35, p = 0.04, eta = 0.29, power = 0.53). A between-subjects effect was revealed due to pre-test selection (Type III SS = 9.12, F = 10.39, p < 0.01, eta = 0.43, power = 0.88).

Treatment and control groups did not differ at pretest (means = 5.00 ± 0.16 and 5.13 ± 0.17, respectively, n = 72, t = -0.49, df = 70, p = 0.62), post-test (means = 4.98 ± 0.17 and 5.20 ± 0.20 respectively, n = 67, t = -0.76, df = 65, p = 0.45), or the long-term assessment (means = 4.86 ± 0.25 and 4.86 ± 0.32 respectively, n = 58, t = -0.01, df = 56, p =1.00). Repeated measures, controlling for pre-test selection, revealed within-subject effects due to time (Pillai's trace = 0.08, $F = 3.89$, $p = 0.06$, eta = 0.28, power = 0.49) and time * pretest selection (Pillai's trace = 0.06, $F = 3.12$, $p = 0.08$, eta = 0.25, power = 0.41), and a between-subjects effect due to pretest selection (Type III SS = 12.82, $F = 7.55$, $p < 0.01$, eta = 0.38, power = 0.77).

5.4.5 Changes in Behavioral Intentions toward Snakes

Treatment groups did not differ at pretest (mean = 0.53 $\pm$ 0.14, $n = 76$, df = 3, $F = 0.45$, $p = 0.72$) in their level of agreement/disagreement with the statement "I would be less likely to have a rattlesnake removed from my property if I knew that it was likely to die as a result." Treatment groups did differ at post-test (Table 5.23) but not at the long-term assessment (mean = 1.07 $\pm$ 0.12, $n = 58$, df = 3, $F = 0.49$, $p = 0.69$). Repeated measures analysis revealed a within-subjects effect due to time (Pillai's trace = 0.13, $F = 4.01$, $p = 0.02$, eta = 0.36, power = 0.69). When I controlled for the pretest level of agreement with the statement, a between-subjects effect was revealed due to pretest level of agreement (Type III SS = 14.44, $F = 10.69$, $p < 0.01$, eta = 0.41, power = 0.89).

Program and non-program participants did not differ at pre-test (means = 0.61 $\pm$ 0.22 and 0.45 $\pm$ 0.18 respectively, $n = 77$, $t = 0.54$, df = 75, $p = 0.59$) but did at post-test (means = 1.29 $\pm$ 0.14 and 0.88 $\pm$ 0.16 respectively, $n = 77$, $t = 1.92$, adj. df = 74, $p = 0.06$). Program and non-program participants did not differ at long-term assessment (means = 1.21 $\pm$ 0.16 and 0.98 $\pm$ 0.16 respectively, $n = 59$, $t = 0.92$, df = 57, $p = 0.36$). Repeated measures analysis indicated a within-subjects effect due to time (Pillai's trace = 0.17, $F = 5.59$, $p < 0.01$, eta = 0.41, power = 0.84). When I controlled for level of agreement or disagreement with the statement at pretest, repeated measures analysis revealed a between-subjects effect due to the pre-test level of agreement or disagreement with the statement (Type III SS = 15.75, F = 12.12, p < 0.01, eta = 0.42, power = 0.93).

Treatment and control groups did not differ in their level of agreement or disagreement with the statement regarding removal of a RS from their properties at pretest (means = 0.63 ± 0.17 and 0.29 ± 0.27 respectively, *n* = 76, t = 1.14, df = 74, p = 0.26) but program participants showed a greater degree of agreement with the statement at post-test (means = 1.25 ± 0.13 and 0.54 ± 0.23 respectively, *n* = 76, t = 2.68, adj. df = 37, p < 0.01). Treatment and control groups did not differ in their level of agreement at long-term assessment (means = 1.14 ± 0.15 and 0.95 ± 0.21 respectively, *n* = 58, t = 0.73, df = 56, p = 0.47). Repeated measures analysis indicated a within-subjects effect due to time (Pillai's trace = 0.17, F = 5.62, p < 0.01, eta = 0.41, power = 0.84). When I controlled for the level of agreement or disagreement with the statement at pretest, repeated measures analysis revealed a between-subjects effect due to pretest level of agreement (Type III SS = 15.03, F = 11.40, p < 0.01, eta = 0.41, power = 0.91).

Scores on the RSI did not differ among groups at pretest (mean = 20.64 ± 0.60, *n* = 56, F = 0.90, p = 0.45), post-test (mean = 21.46 ± 0.55, *n* = 59, F = 0.80, p = 0.50), or at long-term assessment (mean = 21.32 ± 0.59, *n* = 50, F = 0.31, p = 0.82). Repeated measures analysis indicated a within-subjects effect due to time (F = 3.40, df = 2, p = 0.04, eta = 0.35, power = 0.61). When I controlled for RSI pre-test score, repeated measures analysis revealed a between-subjects effect due to pretest score (Type III SS = 582.33, F = 34.38, p < 0.01, eta = 0.77, power = 1.00).

Program and non-program participant RSI scores did not differ at pre-test (means = 20.70 ± 0.70 and 20.62 ± 0.88 respectively, *n* = 57, t = 0.07, df = 55, p = 0.95), post-test (means = 22.00 ± 0.63 and 21.06 ± 0.82 respectively, *n* = 60, t = 0.91, adj. df = 57, p = 0.37), or the long-term assessment (means = 21.63 ± 0.76 and 21.20 ± 0.77 respectively, *n* = 51, t = 0.34, df = 49, p = 0.74). Repeated measures analysis indicated a within-subjects effect due to time (Pillai's trace = 0.17, F = 2.77, p = 0.08, eta = 0.42, power = 0.50). When I controlled for pretest RSI scores, repeated measures analysis revealed a between-subjects effect due to pretest (Type III SS = 695.58, F = 45.37, p < 0.01, eta = 0.80, power = 1.00).

Treatment and control groups did not differ on their RSI scores at pre-test (means = 20.15 ± 0.67 and 21.88 ± 1.26, *n* = 57, t = -1.30, df = 54, p = 0.20), post-test (means = 21.39 ± 0.66 and 21.67 ± 1.00 respectively, *n* = 59, t = -0.22, df = 57, p = 0.83), or the long-term assessment (means = 21.19 ± 0.74 and 21.53 ± 1.00 respectively, *n* = 50, t = -0.27, df = 48, p = 0.79). Repeated measures analysis indicated a within-subjects effect due to time * treatment/control (Pillai's trace = 0.25, F = 4.05, p = 0.03, eta = 0.49, power = 0.67) and between-subjects effect due to treatment/control (Type III SS = 180.04, F = 3.52, p = 0.07, eta = 0.34, power = 0.44). When I controlled for RSI pre-test scores, repeated measures revealed a within-subjects effect due to time * treatment/control (Pillai's trace = 0.09, F = 4.49, p = 0.04, eta = 0.30, power = 0.55) and a between-subjects effect due to pretest RSI score (Type III SS = 346.90, F = 31.71, p < 0.01, eta = 0.64, power = 1.00).

5.5 Discussion

Though sample sizes were small, this study demonstrates that information and education campaigns can change a participant's beliefs, attitudes, and behavioral intentions about wildlife, at least in the short-term. Participants felt that their involvement in this research had increased their interest in learning more about snakes and had increased their positive feelings toward snakes.

Knowledge results support the hypothesis that individuals who attended a snake program would have greater knowledge than individuals who did not attend such a program, and this greater knowledge was still apparent six months after the outreach intervention. Similar results were obtained immediately post-treatment by Morgan and Gramann (1989) for 5^{th} – 8^{th} grade participants.

Not surprisingly, all of the participants in this experiment, including the control group, were at least somewhat interested in snakes. Program participants expressed greater interest in snakes than non-program participants. This finding begs the question as to whether increased interest leads an individual to attend a program rather than just receive written materials to begin with, and has implication for stakeholder participation in just such communication and education efforts and thus their potential utility for management.

In terms of influencing attitudes, this experiment offers some evidence for face-to-face programs being more effective in doing so than written materials, and thus, support for the second hypothesis. NV snake attitudes were more positive for program participants immediately after the outreach intervention, and were still more positive at the long-term assessment than non-program participants. When the two factors underlying the NV snake attitude scale were examined in greater detail, this pattern was consistent for both NV impersonal risk and NV stewardship scores. RS attitudes were more positive for program participants at post-test but did not differ at the long-term assessment. These results are mixed, but the RS attitude scores at long-term assessment is congruent with prior research (Gomez et al. 2004) that focused on primary school children and the retention of attitude changes toward snakes. When the two factors underlying the RS attitude scale were examined separately, it was revealed that the level of impersonal risk perceived by program participants was less than that of non-program participants, and it raises the question as to whether perceived risk interfered with participation in programs for some individuals. RS stewardship scores did not differ at pretest for any of the groups, though Treatment groups 1 and 3 (program using slide shows and written materials groups) demonstrated greater scores immediately after the outreach intervention than Treatment groups 2 and 4 (program with modeling and control groups).

The results for changes in SACs are hard to interpret. No consistent patterns were evident in examining any of the data pertaining to SACs at pre-treatment, post-treatment or at the long-term assessment. Probably the most important finding from this examination of measures was that the pre-treatment score was the most important determinant in terms of post-treatment and long-term assessment measures. This was true for every SAC measure.

Program participants were less likely to have a RS removed from their properties if they knew it would likely die as a result at post-treatment time, but did not differ from non-program participants at the pre-test or long-term assessment. This finding had been expected prior to the experiment, but it was surprising given that RSI scores did not differ between groups at pre-test, post-test or at the long-term assessment.

The most consistent finding of this study was that pre-test scores for attitudes and behavioral intentions were by far the most important determinants of post-test and long-term assessment attitude and behavioral intention scores. This finding is consistent with social judgment theory (Sherif and Hovland 1961) which posits that information processing is affected by currently held attitudes and beliefs. Participants who desired an increase in the NV snake population at pre-test also desired an increase in it at post-test and long-term assessment. Likewise, if an individual desired a decrease in the NV or RS population at pre-test, they were apt to still desire a decrease at post-test and long-term assessment. The effect sizes were medium to large for the influence of pre-test scores in all cases. A second consistent finding had to do with a spike or increase in program participants' SACs immediately post-treatment but a tendency for this difference to dissipate at the long-term assessment, though the reason for this was not investigated.

5.6 Conclusions

This study was a first step in testing the effects of various educational outreach methods to increase stakeholder knowledge and influence stakeholder SACs for snakes, particularly RS. Future work should include larger sample sizes, perhaps by offering a monetary incentive for participation, or by targeting locations in which to conduct programs, and asking for voluntary compliance from people who attend such programs. Such an effort has the potential to greatly increase sample size without great additional financial costs. However, such an experimental design will be more susceptible to spurious effects due to differences in experimental setting and the associated changes in audience members' abilities to pay attention, among other factors (Shadish, Cook and Campbell 2002).

If wildlife managers are to use education and outreach efforts as wildlife management tools, it is important that such efforts are continually monitored and assessed, as with any other management intervention. This study provided one first small step in incorporating outreach as a part of the adaptive wildlife management process, and demonstrated that knowledge and attitudes can be influenced for long (at least six months) periods of time, especially when a face-to-face format is used. Such efforts should be expended when human-wildlife issues are first emerging so that the efficacy of such outreach and communication efforts can be assessed prior to issue activities and before negative attitudes and behavioral intentions toward wildlife are developed. Interventions can be adapted for various stakeholder audiences and can target specific human-wildlife interactions when managers have information regarding stakeholder beliefs and attitudes and the associated desires for human-wildlife interactions and tolerance of the wildlife population of interest.

Table 5.1. Midwestern Great Lakes states and numbers of reptiles listed as threatened, endangered or of special concern by each state.

State	Threatened	Endangered	Special Concern	Reference
Illinois	8	8	8	Illinois Endangered Species Protection Board
Indiana	0	15	4	Indiana Department of Natural Resources
Michigan	2	2	6	Michigan Natural Features Inventory
Minnesota	3	1	8	Minnesota Department of Natural Resources
Ohio	0	5	8	Ohio Department of Natural Resources
Wisconsin	3	6	8	Wisconsin Department of Natural Resources
Totals	16	37	42	

Table 5.2. Twenty-three snake species listed as endangered or threatened in six Midwestern Great Lakes states. (Scientific names from Ernst and Ernst 2003.)

State	Endangered Snakes	Threatened Snakes
Illinois[1]	Coachwhip (*Masticophis flagellum*, Shaw 1802)	Kirtland's snake (*Clonophis kirtlandii*, Kennicott 1856)
	Broad-banded water snake (*Nerodia fasciatus confluens*, Blanchard 1923a)	Timber rattlesnake (*Crotalus horridus*, Linnaeus 1758)
	Eastern massasauga (*Sistrurus catenatus catenatus*, Rafinesque 1818)	Western hognose snake (*Heterodon nasicus*, Baird and Girard 1852a)
	Ratsnake (*Elaphe obsolete*, Say, in James 1823)	Mississippi green water snake (*Nerodia cyclopion*, Dumeril, Bibron and Dumeril 1854)
		Flathead snake (*Tantilla gracilis*, Baird and Girard 1853)
		Eastern ribbon snake (*Thamnophis sauritus sauritus* Linnaeus 1766)
		Lined snake (*Tropidoclonion lineatum*, Hallowell 1857)
Indiana[2]	Butler's garter snake (*Thamnophis butleri*, Cope 1889)	
	Copperbelly water snake (*Nerodia erythrogaster neglecta*, Conant 1949)	
	Cottonmouth (*Agkistrodon piscivorus* Bonnaterre 1790)	
	Kirtland's snake	
	Eastern massasauga	
	Scarlet snake (*Cemophora coccinea*, Blumenbach 1788)	
	Smooth green snake (*Liochlorophis vernalis*, Harlan 1827)	

Table 5.2. (cont'd)

State	Endangered Snakes	Threatened Snakes
Indiana	Southeastern crowned snake (*Tantilla coronata*, Baird and Girard 1853)	
	Timber rattlesnake	
Michigan[3]	Kirtland's snake	Eastern fox snake (*Elaphe vulpine gloydi*, Conant 1940)
	Copperbelly water snake	
Minnesota[4]	**Eastern massasauga**	Timber rattlesnake
Ohio[5]	Copperbelly water snake	Kirtland's snake
	Plains garter snake (*Thamnophis radix*, Baird and Girard 1853)	
	Timber rattlesnake	
	Eastern massasauga	
	Lake Erie water snake (*Nerodia sipedon insularum*, Conant and Clay 1937)	
Wisconsin[6]	Queensnake (*Regina septemvittata*, Say 1825)	Butler's garter snake
	Eastern massasauga	
	Western ribbon snake (*Thamnophis proximus*, Say 1823)	
	Northern ribbon snake (*Thamnophis sauritus septentrionalis*, Rossman 1963b)	

Table 5.3. Mean scores for changes in interest levels toward learning about snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	4.25	0.13	3.96	4.54	0.38	2.86**	1 > 3*
2	7	4.14	0.14	3.79	4.49			
3	22	3.80	0.09	3.61	3.99			3 < 1*
4	18	3.95	0.11	3.73	4.18			

Table 5.4. Mean scores for reduction in negative feelings toward snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	2.25	0.22	1.77	2.73	0.54	0.16	
2	7	2.14	0.26	1.50	2.78			
3	22	2.35	0.17	2.00	2.70			
4	21	2.29	0.14	1.99	2.58			

*** significant at the $p = 0.01$ level, ** significant at the $p = 0.05$ level, * significant at the $p = 0.10$ level

Table 5.5. Mean scores for change in time spent looking for opportunities to learn more about snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	11	3.64	0.20	3.18	4.09	21.57	3.23**	
2	7	4.00	0.00	4.00	4.00			2 > 3*** 2 > 4***
3	20	3.35	0.11	3.12	3.58			3 < 2***
4	21	3.43	0.11	3.20	3.66			4 < 2***

Table 5.6. Mean scores for changes in levels of fear toward snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	2.67	0.19	2.25	3.08	2.68*	0.69	
2	7	2.29	0.36	1.41	3.17			
3	19	2.63	0.16	2.30	2.96			
4	19	2.68	0.11	2.45	2.91			

*** significant at the $p = 0.01$ level, ** significant at the $p = 0.05$ level, * significant at the $p = 0.10$ level

Table 5.7. Mean scores for changes in interest in having a snake as a pet for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	2.83	0.27	2.24	3.43	2.00	0.12	
2	7	3.00	0.00	3.00	3.00			
3	19	2.84	0.12	2.60	3.08			
4	21	2.86	0.14	2.56	3.16			

Table 5.8. Mean scores for changes in perceived personal risk from rattlesnakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	2.67	0.14	2.35	2.98	2.91**	0.94	
2	7	2.14	0.34	1.31	2.97			
3	20	2.35	0.18	1.97	2.73			
4	20	2.45	0.14	2.17	2.73			

*** significant at the p = 0.01 level, ** significant at the p = 0.05 level, * significant at the p = 0.10 level

Table 5.9. Mean scores for changes in positive feelings toward snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	4.42	0.19	3.99	4.84	0.34	2.80**	
2	7	4.29	0.18	3.83	4.74			
3	20	3.85	0.15	3.54	4.16			
4	21	3.86	0.14	3.56	4.16			

Table 5.10. Mean scores for changes in attention paid to snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	4.42	0.15	4.09	4.74	0.35	3.73**	1 > 4**
2	7	4.43	0.20	3.93	4.92			
3	20	4.05	0.15	3.73	4.37			
4	21	3.81	0.11	3.58	4.04			4 < 1**

*** significant at the p = 0.01 level, ** significant at the p = 0.05 level, * significant at the p = 0.10 level

Table 5.11. Mean changes in feelings for program (Treatments 1 and 2) and non-program (Treatments 3 and 4) participants in southeastern Michigan snake outreach experiment (2005).

Change in Feelings toward Snakes	*n*	Program mean $\pm$ Standard Error	Non-program mean $\pm$ Standard Error	t	Effect size (*eta*)	Power
Interest in learning more about snakes	60	4.21 ± 0.10 (19)	3.88 ± 0.10 (41)	2.69***	0.33	0.75
Negative feelings	60	2.21 ± 0.16 (19)	2.32 ± 0.11 (41)	-0.55		
Pursuing opportunities to learn about snakes	59	3.78 ± 0.13 (18)	3.39 ± 0.08 (41)	2.68***	0.33	0.75
Feelings of fear	57	2.53 ± 0.18 (19)	2.66 ± 0.09 (38)	-0.72		
Interest in snakes as pets	59	2.89 ± 0.17 (19)	2.85 ± 0.09 (40)	0.25		
Perceived personal risk from rattlesnakes	59	2.47 ± 0.16 (19)	2.40 ± 0.11 (40)	0.38		
Positive feelings	60	4.37 ± 0.14 (19)	3.85 ± 0.10 (41)	2.91***	0.36	0.82
Attention to snakes	60	4.42 ± 0.12 (19)	3.93 ± 0.10 (41)	3.08***	0.37	0.86

*** significant at $p = 0.01$ level, ** significant at $p = 0.05$ level, * significant at the $p = 0.10$ level

Table 5.12. Mean changes in feelings for treatment (Treatments 1, 2 and 3) and non-treatment (Control Group 4) participants in southeastern Michigan snake outreach experiment (2005).

Change in Feelings toward Snakes	*n*	Treatment mean ± Standard Error & *n*	Control group mean ± Standard Error & *n*	t	Effect size (*eta*)	Power
Interest in learning more about snakes	60	4.00 ± 0.07 (39)	3.95 ± 0.11 (21)	0.37		
Negative feelings	60	2.28 ± 0.12 (39)	2.29 ± 0.14 (21)	-0.02		
Pursuing opportunities to learn about snakes	59	3.55 ± 0.09 (38)	3.43 ± 0.11 (21)	0.85		
Feelings of fear	57	2.58 ± 0.12 (38)	2.68 ± 0.11 (19)	-0.58		
Interest in snakes as pets	59	2.87 ± 0.10 (38)	2.86 ± 0.14 (21)	0.07		
Perceived personal risk from rattlesnakes	59	2.41 ± 0.12 (39)	2.45 ± 0.14 (20)	-0.21		
Positive feelings	60	4.10 ± 0.11 (39)	3.86 ± 0.14 (21)	1.35		
Attention to snakes	60	4.23 ± 0.10 (39)	3.81 ± 0.11 (21)	2.64***	0.33	0.74

*** significant at p = 0.01 level, ** significant at p = 0.05 level, * significant at the p = 0.10 level

Table 5.13. Mean post-treatment knowledge scores about snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	***n***	**Mean**	**Standard Error**	**95% C.I.**		**Levene Statistic**	**F**	**Group Differences**
1	17	4.00	0.00	4.00	4.00	22.26***	6.14***	1 > 3*** 1 > 4***
2	10	4.00	0.00	4.00	4.00			2 > 3*** 2 > 4***
3	23	3.13	0.21	2.69	3.57			3 < 1*** 3 < 2***
4	24	3.29	0.19	2.91	3.68			4 < 1*** 4 < 2***

**** significant at the p = 0.01 level, ** significant at the p = 0.05 level, * significant at the p = 0.10 level

Table 5.14. Mean long-term interest scores about snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	12	3.50	0.15	3.17	3.83	13.51***	4.65***	1 > 3*
2	6	3.33	0.21	2.79	3.88			
3	20	3.05	0.05	2.95	3.15			3 < 1*
4	20	3.10	0.07	2.96	3.24			

Table 5.15. Mean post-treatment scores for knowledge about snakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	16	22.56	0.65	21.19	23.94	1.88	3.02**	1 > 4*
2	9	22.44	0.71	20.81	24.08			
3	21	20.48	0.95	18.50	22.45			
4	24	19.38	0.85	17.62	21.13			4 < 1*

*** significant at the p = 0.01 level, ** significant at the p = 0.05 level, * significant at the p = 0.10 level

Table 5.16. Mean post-treatment scores for NV stewardship for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	17	9.35	0.34	8.63	10.08	3.20**	2.77**	1 > 4**
2	10	9.30	0.42	8.34	10.26			2 > 4*
3	25	8.40	0.49	7.40	9.40			
4	24	7.79	0.38	7.01	8.57			4 < 1** 4 < 2*

Table 5.17. Mean post-treatment scores for RS snake attitudes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	14	19.71	1.41	16.67	22.76	1.12	6.06***	1 > 4***
2	8	17.38	1.27	14.38	20.37			
3	23	16.35	1.28	13.70	19.00			3 > 4*
4	23	12.09	1.17	9.67	14.50			4 < 1*** 4 < 3*

***significant at the p = 0.01 level, ** significant at the p = 0.05 level, *significant at the p = 0.10 level

Table 5.18. Mean post-treatment scores for RS impersonal risk for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Difference
1	16	9.50	0.79	7.83	11.17	1.67	4.40***	1 > 4**
2	9	9.11	0.74	7.42	10.81			
3	25	7.40	0.84	5.68	9.12			
4	24	5.79	0.65	4.46	7.13			4 < 1**

Table 5.19. Mean post-treatment scores for RS stewardship for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Difference
1	15	9.53	0.88	7.64	11.43	0.34	4.52***	1 > 4**
2	9	8.33	0.90	6.26	10.40			
3	23	9.26	0.62	7.98	10.55			3 > 4**
4	23	6.30	0.69	4.87	7.74			4 < 1** 4 < 3**

***significant at the p = 0.01 level, ** significant at the p = 0.05 level, *significant at the p = 0.10 level

Table 5.20. Mean pre-treatment scores for NV SAC for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	14	1.71	0.44	0.77	2.66	2.93**	2.19*	
2	10	1.10	0.38	0.24	1.96			
3	19	1.84	0.21	1.41	2.28			3 > 4*
4	19	0.95	0.27	0.38	1.51			4 < 3*

Table 5.21. Mean pre-treatment selections for maximum tolerable situations involving rattlesnakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	16	5.31	0.24	4.81	5.82	1.74	2.25*	
2	10	5.40	0.27	4.80	6.00			
3	23	4.61	0.27	4.06	5.16			
4	23	5.13	0.17	4.78	5.48			

***significant at the p = 0.01 level, ** significant at the p = 0.05 level, *significant at the p = 0.10 level

Table 5.22. Mean post-treatment gain scores for maximum tolerable situation involving rattlesnakes for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	16	-0.19	0.39	-1.02	0.64	3.37**	4.49***	
2	10	-1.30	0.63	-2.73	0.13			2 < 3*** 2 < 4*
3	18	0.61	0.24	0.10	1.13			3 > 2***
4	20	0.15	0.22	-0.31	0.61			4 > 2*

Table 5.23. Mean post-treatment scores for level of agreement with the statement "I would be *less* likely to have a rattlesnake removed from my property if I knew that it would likely die as a result" for three treatment groups and a control group as part of an outreach experiment conducted in Michigan in 2005.

Treatment	*n*	Mean	Standard Error	95% C.I.		Levene Statistic	F	Group Differences
1	17	1.41	0.19	1.00	1.82	2.84**	3.03**	1 > 4*
2	10	1.10	0.18	0.69	1.51			
3	25	1.20	0.22	0.75	1.65			
4	24	0.54	0.23	0.06	1.02			4 < 1*

***significant at the p = 0.01 level, ** significant at the p = 0.05 level, *significant at the p = 0.10 level

CHAPTER 6

SUMMARY AND RECOMMENDATIONS

6.1 Summary of Findings

The purpose of this dissertation research was to enhance reptile conservation and management efforts through the incorporation of human dimensions insights. Pertinent results can be used in this manner. In Chapter 2, two conceptual models for human behaviors during a rattlesnake encounter were developed. One model is applicable when the encounter is planned and the other is applicable when such an encounter is unplanned. In chapters 3-5, data and results are presented that inform the conceptual models and that test relationships among model components. Data collections were conducted via semi-structured and in-depth interviews (Christoffel, unpublished data), mail questionnaires (Chapters 3,4,5, this ms) and post-treatment and long-term assessment instruments used in an outreach experiment (Chapter 5, this ms).

People appear to be as interested in snakes as a questionnaire topic as any other currently studied wildlife species (MN response rate of 66%, MI response rate of 57%). For example, Riley and Decker (2000a) obtained a 58% response rate to their work on acceptance capacities and cougars in Montana. Many, if not most, recent questionnaire-type surveys have received less than 50% (Riley 2007).

Congruent with past research on people's specific knowledge of wildlife (Kellert and Berry 1980), questionnaire respondents appeared to have little factual knowledge about local snakes, such as identities, species richness and policies that may protect snakes. An alarming implication associated with the lack of knowledge is that if stakeholders are unaware of regulations protecting snakes, it is unlikely that they will comply with such regulations. However, knowledge or awareness of existing regulations does not always appear to stop people from killing snakes (Whitaker and Shine 2000).

Stakeholder knowledge about snakes explained the greatest degree of variation and was the most important determinant of NV snake and RS attitude scores in MI and MN. These findings offer strong support for the human behavior models presented in Chapter 2, but Kellert (1993) posits that knowledge is used more often as a basis for reinforcing and rationalizing attitudes rather than as an agent of attitude change.

Despite mistaken beliefs that people often hold about snakes, they do appear to have more positive than negative attitudes, especially toward NV snakes. People generally held moderate to very positive attitudes toward NV snakes and were neutral or slightly positive toward RS. Rural respondents held more positive attitudes than urban respondents toward NV snakes and RS. Prior research on wildlife attitudes and value orientations suggested that rural residents were more likely to hold utilitarian value orientations and less likely to hold humanistic and moralistic value orientations toward wildlife than urban residents (Kellert and Berry 1982). More recently, studies that examined rural and urban respondents' attitudes toward prairie dogs in the Great Plains (Reading et al. 1999; Zinn and Andelt 1999; Wyoming Agricultural Statistics Service 2001) suggested that urban respondents held more positive attitudes than rural respondents toward these rodents. Given that interviewees provided few recognized utilitarian benefits of snakes in MI and MN when queried in semi-structured interviews (Christoffel, unpub. data), it was expected that rural respondents would have less positive attitudes than urban respondents.

People who currently believe they live in the presence of RS have more positive attitudes toward snakes and have greater SACs for snakes. Peyton et al. (2001) found similar results for black bears in MI, but this finding differs from past research on cougars (Riley and Decker 2000b) and wolves (Williams et al. 2002), where individuals who believed that they did not live in proximity to potentially dangerous wildlife held more positive attitudes than respondents who believed otherwise. It may be that individuals who live in close proximity to RS acclimate to RS presence over time, or that individuals living in close proximity to RS so seldom have recognized encounters that risk perceptions are reduced over time. This latter explanation has some support provided by respondents' snake experience reports. Snakes are cryptically colored, and can often be within inches of a human but not detected (Whitaker and Shine 2000). Thus respondents may be out in their neighborhoods in the presence of snakes without knowing it. Perhaps encounters with at least some snake species native to respondents' areas are not very memorable because of the small size of some snakes (Hohlman et al. 1999, Oldfield and Moriarty 1994) or other features of the encounter. Less than 10% of respondents reported having observed a RS in their neighborhoods during the past year.

There is evidence for elevated risk perceptions regarding snakes, given that 55% of respondents were unsure whether RS bites caused annual deaths to local residents, and 32% believed that RS bites caused annual deaths to residents. This is particularly important as it pertains to the associated SACs for snakes. In semi-structured interviews (Christoffel, unpublished data), interviewees demonstrated a strong (r = -0.98) inverse relationship between levels of fear and like for amphibian and reptile groups. Similarly, mail questionnaire respondents' level of perceived personal risk from RS and RS SACs demonstrated an inverse relationship, though of lesser strength.

People are more likely to engage in potentially lethal behaviors toward RS than NV snakes. Questionnaire respondents were more than twice as likely to have RS removed from their properties regardless of the consequences for such animals as to have NV snakes removed. Heightened risk perceptions may be responsible for this result, as indicated by the importance of RS impersonal risk scores in explaining variability regarding whether a respondent would be less likely to have a RS removed from their properties if the snake probably would die as a result. Respondents may simply feel that they put themselves at undue risk to RS bite and potentially catastrophic consequences associated with such bites, similar to other forms of wildlife attacks (Slovic et al. 1979, Riley and Decker 2000), by allowing a RS to remain on their properties. NV impersonal risk scores also explained the greatest degree of variability in whether a respondent would be less likely to have a NV snake removed from his or her property if the snake would likely die as a result. Clearly risk perceptions were the most important determinants in respondents' consideration of having a NV snake or RS moved from their properties. When queried, interviewees had indicated that they would not want to kill a RS but would want to have it removed from their properties for safety reasons, especially targeted toward children and older adults who might be visiting (Christoffel, unpublished data). A large portion of respondents were unsure of whether or not they would be less likely to move either a NV snake (22%) or a RS (28%) if it was likely to die as a result of their actions. Regardless, such statements suggest elevated risk perceptions that motivate people to remove snakes from their properties regardless of the consequences.

The concept of SAC, in any form, may currently have limited utility in terms of snake management because of the lack of knowledge regarding most snake population impacts perceived by people, lack of knowledge regarding the relationship between snake populations and levels of associated human-wildlife interactions or effects, and lack of funding with which to investigate and address such issues. Perhaps the greatest contribution of these conceptual frameworks at this time is the opportunity to start understanding key human beliefs and attitudes that are antecedents to SACs. Knowledge of such beliefs and attitudes can be used to address knowledge gaps, correct mistaken beliefs, and in some cases, attempt to influence SACs.

Interestingly, none of the traditional demographic parameters measured were useful in predicting attitudes, beliefs, experiences, or SACs for snakes. Risk scores, knowledge, attitude scores and level of interest in snakes had greater predictive power.

Little research has attempted to operationalize the concepts of CCC (Peyton et al. 2001) and SAC (Lischka 2006). In this study, results of CCC and WSAC measures were highly correlated and there was general agreement among the variables that explained the greatest degree of variation in the dependent measures. Either conceptual framework may work equally well when attempting to gauge stakeholder tolerance of and desires for interactions with a wildlife species of interest.

Contrary to much of the previous research on stakeholder attitudes toward carnivores (Riley and Decker 2000, Kellert 1985, Williams et al. 2002), this study indicates that respondents who recognize that they live in the company of RS are more tolerant of RS than stakeholders who believe otherwise. Peyton et al. (2001) found similar results in a statewide survey of MI stakeholder attitudes toward black bears. Past experience with bears and awareness of bears coincided with a higher WAC, or maximum tolerable situation for bears. Findings on black bears and RS may reflect a lack of any lethal encounters with either of these species in MI. Although RS have been documented in almost half of the counties in the lower peninsula of MI, there appears to have been no documented fatalities from RS during the past fifty years. This may suggest that there are few negative impacts, damage or threats to human safety that stakeholders actually experience when they reside in an area with RS populations. Such stakeholders may acclimate to the RS over time or not perceive impacts from RS, although these hypotheses were not tested.

More than one in five respondents were unsure whether they lived in an area with RS. As a result, such individuals may be unable to make well-informed decisions or provide relevant input to the RS management processes in their areas. But this also suggests that human-RS encounters may be very rare, even when RS are present (Whitaker and Shine 2000).

Surprisingly, the level of personal risk that a respondent felt from a RS was not related to an individual's preferred or maximum tolerable situation, but a strong relationship was demonstrated for personal risk ratings and desire for future RS populations. There was a stronger relationship between RS impersonal risk scores and SAC measures. Fortunately, the majority of respondents felt at no risk or only slight risk from RS. Riley and Decker (2000) and Stout et al. (1993) found similar patterns for SACs for mountain lions and deer.

Questionnaire respondents had a greater desire for an increase in NV snake populations than RS populations. However, even desire for an increase in NV snake populations was only slight (<1 on a scale of 0-3). The data demonstrated an inverse relationship between a respondent's perception of how the NV snake population had changed since the respondent had lived in an area and a respondent's desire for future NV snake populations. What was most similar for NV snakes and RS, was the great percentage of people who opted for a response indicating desires for the current NV snake and RS populations to stay the same (63% and 59%, respectively). Unfortunately, it's unclear why stakeholders chose that response, although similar results have been obtained for white-tailed deer (Christoffel and Craven 2000), mountain lions (Riley and Decker 2000) and black bear (Peyton et al. 2001), among others. Perhaps such responses are an indication of the sentiment, "If it's not broke, why fix it?" and just represent contentment with the current situation.

There are problems with both methods used in this study to measure SAC to guide management actions for RS. Desire for future populations, as a proxy for WSAC, as measured in terms of Riley and Decker (2000b) and Lischka (2006), only indicates stakeholders' desires for how they would like to see the wildlife population of interest or the associated positive or negative interactions with the wildlife population, to change. Such desires seem irrelevant for management when a large segment of stakeholders have little idea of what the current wildlife population of interest is or is totally intolerant of the wildlife population of interest. As a result, such stated desires give managers little information regarding accurate identification of maximum tolerance levels for human-wildlife interactions when human experiences with the wildlife species of interest are so limited (i.e., no experience or perhaps sighting an individual animal out in the wild). LOAs seem at least partially irrelevant to snake management when stakeholders indicate a preferred situation of having no RS present. Under such circumstances, only an intolerance level can be determined, and the management goal becomes one of not exceeding that tolerance level or managing for WAC (Decker and Purdy 1988). It is interesting to contemplate the implications of stakeholders' maximum tolerable situations in terms of managing RS populations, however, given the results of this research. The majority of stakeholders would tolerate situations up to and including #4 (i.e. 58%), but there was a dramatic drop for situation #5 and #6. The latter were the only two situations in which bites to humans were mentioned as occurring, and even so, these would still be *rare* occurrences (Table 4.6). It appears that the majority of respondents to this survey were intolerant of any potential risk of RS bite to humans.

Though respondent populations differed in MN and MI, similar results were obtained regarding SACs for NV snakes and RS. Factors that explained the greatest variability in SAC measures were the same in many cases. In particular, it was striking how important RS stewardship score was for SAC in both states, though human and RS populations differed in various ways. In the case of RS, this included size and potential for observing the animal. These results suggest that a measure of stewardship may also be the most important factor in determining SACs for RS elsewhere. Stakeholder groups and their associated SAC results demonstrated similar patterns in MI and MN, indicating that classification of stakeholder groups based on geographic proximity to RS was valid and potentially useful for classifying RS stakeholder group elsewhere.

Participants in the outreach experiment (Chapter 5) had higher knowledge scores and more positive attitudes toward RS after attending programs than individuals who had received written materials or a control group. This suggests that educational outreach efforts can be used to increase knowledge and influence attitudes toward wildlife.

6.2 Recommendations for Future Research

As is commonly the case, this research has raised more questions than it has answered. There are many opportunities to build upon this research.

One important area for future research concerns further model testing, particularly of human behavior during an unplanned RS encounter. This model was not investigated empirically as a part of this study, but such work may help to elucidate mechanisms by which individuals engage in lethal behaviors toward RS, and means by which to reduce such behaviors, not only for the RS's sake, but also for human safety reasons.

Self-efficacy, i.e. a person's belief in his ability to engage successfully in a behavior with desired outcomes, is a component that was not explicitly addressed in this research. Low knowledge about snakes, particularly in terms of snake identification and high percentages of respondents who indicated that they would kill a RS, indicate that self-efficacy needs to be addressed. If respondents were able to differentiate NV snakes from RS, it is likely that great numbers of NV snakes would no longer be killed due to misidentification as RS. Secondly, if respondents understood the great risk they put themselves at in trying to kill a RS rather than leaving it alone, fewer RS bites would occur and fewer RS would be killed.

D.J. Case and Associates (2002) interviewed prominent experts on eastern massasauga rattlesnakes regarding utility of different outreach methods to address stakeholder concerns. Experts posited that face-to-face contact was the best method of communication regarding eastern massasauga rattlesnake-human issues. I attempted to assess the efficacy of face-to-face contact using slide shows, face-to-face contact and behavioral modeling, and a mailing of written materials to increase knowledge and influence attitudes toward eastern massasaugas in MI. However, further research that achieves larger sample sizes is needed to assess methods adequately (see Chapter 5, this ms).

Another aspect of research to be pursued pertains to the frequency of educational outreach in terms of influencing SAC and RS attitudes, particularly in new residential developments in current RS habitat. How often must such efforts be conducted in order to address the influx of humans who are first experiencing life in the presence of RS and to address the 'decay' function, or the loss of attitude change that occurs post-outreach intervention? In many cases, participants in the outreach experiment experienced an immediate positive attitude change after attending a program, but attitude scores at the long-term assessment more often reflected pre-program rather than post-program scores. This recommendation is pertinent in both states and study areas, where increasing residential development is an ongoing issue, particularly on the bluffs overlooking the Mississippi River in MN and the sprawl associated with the metropolitan areas of Ann Arbor and Detroit in MI, but is also relevant elsewhere in the US.

Future work should include a larger experiment to determine whether modeling a positive encounter with a snake provides greater and more enduring attitude changes in adults than a program without modeling. Sample sizes in the current study were really insufficient to answer those questions. It's important to investigate, given the much greater costs involved in keeping live animals for educational outreach programs, the long-standing belief held by many naturalists and environmental educators of the importance of direct experiences with animals in attitude formation toward wildlife, and prior research (Kellert 1976) which indicates the importance of direct experiences in childhood with wildlife in the development of adult attitudes toward wildlife. Most previous research has focused primarily on children (Kidd, Kidd and Zasloff 1995, Reames and Rajecki 1988, among others) but outreach programs featuring live animals at zoos have demonstrated more positive feelings, increased interest and increased engagement in conservation behaviors toward wildlife by adults who attended such programs as compared to adults who attended traditional exhibits (Povey and Rios 2004, Swanagan 2000). Associated with such direct experiences and educational interventions with children, is the potential for intergenerational learning and attitude changes associated with that learning (Vaughan et al. 2003).

Another interesting direction of research pertains to management implications associated with increased positive attitudes toward RS but similar fear levels in stakeholders after an outreach effort. Results from pilot outreach efforts conducted in 2004 indicated that a one-time educational outreach effort did not affect participants' levels of fear toward RS, though positive feelings toward RS were increased. It is important to determine if participants' behaviors will differ from pre-program expectations if they have a planned or an unplanned rattlesnake encounter following an outreach intervention. Only then can we determine if educational outreach can be used to change lethal human behaviors toward RS.

Another area of management concern that needs to be addressed regards the weighting of stakes of stakeholder groups, particularly in terms of managing wildlife species with few, if any, vocal stakeholder groups. For example, in this study, how do we weight the stakes of people who live in the presence of RS against people who live in the absence of RS? What are the stakes for people who are unsure of whether RS are present? Do people who have lived in an area for a longer period of time have a greater stake in local wildlife? If so, what is that worth?

6.3 Management Recommendations

Results of this study can be used to enhance snake conservation and management efforts, particularly in MI and MN. This can be accomplished, in part, by attempting to build stakeholder capacity to co-exist with snakes. Low levels of knowledge and incorrect knowledge about snakes result in less-informed decision-making by stakeholders and wildlife agency personnel. This study is beginning to address gaps in the knowledge of wildlife agency personnel by increasing awareness of the issues surrounding NV snake and RS conservation and management, and by providing an overview of current experiences, beliefs, attitudes and behavioral intentions by stakeholders for the MI DNR and MN DNR. Such a first step has been identified as necessary to the development of an educational outreach effort aimed at various stakeholders (Johnson et al. 2000).

Basic knowledge of local NV and RS snakes and the regulations associated with these groups is currently very low for stakeholders, i.e. > 80% of stakeholders in each state were unaware of existing regulations that protect snakes. Educational outreach efforts may be used to inform residents of existing state regulations that protect snakes, to raise awareness of local snake species, promote interest in snakes, and to reduce risk perceptions pertaining to snakes and snakebites. This need is urgent given the percentages of respondents who indicated that they would kill a rattlesnake, even with a very mild interaction, such as seeing one once near their home (10% in MI, 17% in MN).

Educational outreach efforts began as a part of this dissertation research (see Chapter 5, this ms) but need to be expanded. Outreach materials should include information regarding local snake species richness, descriptions and identifying field characteristics of local species, characteristic behaviors, and distributions for native snake species and directions on behaving safely around snakes, particularly RS. Stakeholders should also be provided with information regarding how presence of snakes may positively impact their quality of life, because this is one of the characteristics of the most successful symbols of environmental concern (Greenberg Quinlin Research Inc. 2000), and would perhaps make snake conservation and management a more salient issue for stakeholders.

To address stakeholders' uncertainty and the mistaken belief that RS bites cause deaths annually to residents, I recommend that state agencies develop accurate outreach materials concerning (1) RS bites in their states, (2) actions people can take to reduce risk of snakebites, and (3) appropriate actions to take should a person be bitten by a RS. The most commonly asked questions during this study's outreach experiment concerned RS bite, how to avoid being bitten and what to do if one were bitten. To develop accurate outreach materials for stakeholders, managers should work with their respective state poison control centers to track RS bite cases and their outcomes. Such information could then be used to provide stakeholders with accurate, detailed information regarding the incidence and circumstances of RS bites that do occur. Keyler (2005) presents this information for MN, but no such publication exists for MI. Such information may help to correct misgivings that some stakeholders have about living in the presence of RS. This is especially relevant given interviewees' voiced concerns about small children and older visiting adults. Nationally, it has been documented that adult white males are the most frequent RS bite victims (Morgan et al. 2004), and in MN specifically, a large percentage of cases involved the purposeful handling of RS and alcohol (Keyler 2005). Stakeholders living in areas with RS should be alerted to the appropriate measures to take to reduce the likelihood of bites to pets and livestock. In addition, they should be provided with information for actions to take in case of a bite to a pet or livestock, and where to go to receive medical care for their animals. Improper treatment of RS bite may make a life or death difference, particularly for small-bodied dogs or cats.

Low-cost or free identification charts should be made available to stakeholders. Although there are 17 snake species in MN and 18 in MI, very few respondents answered correctly when queried regarding the numbers of kinds of snakes that live in their states. It can be safely assumed that because stakeholders don't know the variety of snakes that live in their states, they also don't know how to identify snakes. Misidentification has led to the demise of many NV snakes in both states, where they are often turned into nature centers or DNR offices as RS, though in fact, they are far more likely to be eastern milk snakes in MI, bullsnakes in MN, or a hognose snake in either state. Because species richness is so low in these states, learning fieldmarks for local snakes would be fairly easy to do.

Efforts need to be made to substantiate the level of human-snake interactions with different snake population levels. Currently, there are no credible data regarding this relationship. Survey results indicated that a majority of respondents preferred either non-existent RS populations (41%) or populations that were at risk of extinction (15%), given the suite of consequences listed under each hypothetical situation. More than half of respondents (58%) indicated maximum tolerable situations in which no RS bites to humans would occur, and it is unclear how stakeholders would respond if such a bite occurred in their neighborhoods. Hypothetical scenarios were used in this research, but the levels of human-snake interactions are not known, and RS population information is lacking, particularly as it pertains to distribution and numbers of animals on the landscape.

Educational outreach may be used in attempts to change stakeholders' behaviors toward snakes. Elevated risk perceptions, particularly as they pertain to RS, may lead to potentially lethal human behaviors toward snakes. Stakeholders put themselves at greater risk when they attempt to kill snakes rather than leave them alone, particularly RS. Such human behaviors toward snakes, in addition to purposeful handling, account for a large number of venomous snakebites reported annually to the Center for Disease Control and Arizona Poison Control Center. It is important to reduce such human behaviors not only to discourage hostile behavior toward snakes, but to protect humans as well.

The utility of measuring (or attempting to measure) SACs for snakes is in identifying the underlying beliefs and attitudes that stakeholders possess about wildlife and their influence on measures of SAC, and using such information to manage people's beliefs and attitudes toward, and associated tolerance of, the wildlife population of interest (Beyer et al. 2006). Both approaches used in this study emphasize the importance of communication and educational efforts in managing wildlife populations (Peyton et al. 2001, Beyer et al. 2006, Carpenter et al 2000), and both provide a mechanism whereby such efforts can be assessed – monitoring how stakeholder beliefs and attitudes change over time, and how such changes impact their tolerance of and desires for interactions with wildlife. This needs to be done for many more species of wildlife than we currently have collected data.

RS stewardship score explained a great deal of the variation in measures of SAC for MI and MN stakeholders toward RS. This should be tested in other areas of the US where greater than one species of rattlesnake occurs in an area and stakeholders may differ from the present study. Results of this study suggest that a stewardship score may be used as an evaluative tool for monitoring SAC for RS, and that communication and education efforts may yield the greatest results if they are focused on influencing stakeholder stewardship scores.

Study results suggested that there is an overlap in stakeholder LOAs, even if the LOAs are not complete. Results potentially may be used by wildlife managers to guide snake management decisions and to start monitoring SAC, particularly in areas where known RS populations exist. However, it's essential that managers start tracking RS populations as well as human-RS interactions in MI and MN. Few studies have been conducted that can be used to estimate RS population numbers in an area, and current tracking for human-RS encounters appears to consist of a call for citizens to report sightings of eastern massasaugas in MI and timber rattlesnakes in MN. A more systematic approach will need to be taken if SACs and their implications for RS conservation and management are to be used in such efforts.

Managing snake habitat and snake populations are challenging tasks, particularly as a result of our current incomplete knowledge of these species and their needs. However, as a result of this study, we now have greater capacity to address the management of human beliefs, attitudes and resultant behaviors toward snakes.

APPENDIX

A.1.SURVEY PRENOTICE

The prenotice was printed on Michigan State University Department of Fisheries and Wildlife letterhead

March 17, 2005

Dear

In a few days, Ms. Rebecca Christoffel, a researcher in my lab, will ask your help to improve decisions about Michigan's natural resources. This research will assure human values are adequately considered in management of wildlife.

The Department of Fisheries and Wildlife at Michigan State University is sponsoring Ms. Christoffel's survey efforts. Her work is specifically assisting managers of Michigan's non-game wildlife species, but may be applied to similar management issues in other states. Ms. Christoffel will further explain the goals of her research and the importance of your participation in a letter accompanying the questionnaire.

Your household is one of a small number in which people are being asked for their beliefs and opinions about Michigan's snake populations. **Your thoughts are very important and will contribute to wildlife management**. For the study results to truly represent the thinking of people in your community, it is important that each questionnaire be completed and returned.

You may be assured of confidentiality in responding. Your privacy will be protected to the maximum extent allowable by law. The questionnaire has an identification number for mailing purposes only. This is so that I may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire itself. Questionnaire completion is voluntary. You indicate your voluntary agreement to participate by completing and returning the questionnaire. You may choose not to participate at all, or to refuse to answer certain questions without any penalty or loss of the included gift of postage stamps.

Please do not hesitate to contact me if you have questions at 1-888-290-0413. I would greatly appreciate your help with this important survey.

Sincerely,

Shawn J. Riley, Assistant Professor
Wildlife Ecology and Management
Michigan State University

A.2. SURVEY MAILING #1 COVER LETTER

The coverletter was printed on Michigan State University Department of Fisheries and Wildlife letterhead

Date

Dear :

As a resident of southeastern Michigan, you are likely aware of the area's increase in residential and commercial development. Such a situation leads to an increase in human-wildlife interactions. Knowing people's beliefs, attitudes, and behaviors toward wildlife can aid in wildlife management decision-making. The goal of our research is to enhance rare reptile conservation using insights from people who use and value Michigan's resources.

Your household is one of a small number in which people are being asked for their beliefs and opinions about Michigan's snake populations. Your thoughts are very important to us and will contribute to wildlife management. For study results to truly represent the thinking of people in your community, it is important to complete and return the questionnaire.

You may be assured of confidentiality in responding. Your privacy will be protected to the maximum extent allowable by law. The questionnaire has an identification number for mailing purposes only. This is so that I may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire itself. Questionnaire completion is voluntary. You indicate your voluntary agreement to participate by completing and returning the questionnaire. You may choose not to participate at all, or to refuse to answer certain questions without any penalty or loss of the included gift of postage stamps.

Would you please have the adult ($\geq$ 18 years) residing in the household who will next celebrate a birthday complete the questionnaire? The survey has 14 pages and should take about 15 minutes to complete.

I would be happy to answer any questions or concerns you may have about this study. Please write me or call me toll free at (888) 290-0413. If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 432-4503, e-mail: ucrihs@msu.edu, or regular mail: 202 Olds Hall, East Lansing, MI 48824-1047.

Thank you very much for your participation in this research!
Sincerely,

Rebecca Christoffel, Project Director

A.3 SURVEY INSTRUMENT

Michigan's Snakes:

A Survey of your Beliefs and Attitudes

Michigan State University
Dept. Fisheries & Wildlife
13 Natural Resources Bldg
East Lansing, MI 48824

Rebecca Christoffel
Michigan State University
Dept. Fisheries & Wildlife
13 Natural Resources Bldg
East Lansing, MI 48824

***Michigan's Snakes:* a survey of your beliefs and attitudes**

A survey conducted by:
Michigan State University
Department of Fisheries and Wildlife
13 Natural Resources Building
East Lansing, Michigan 48824

This questionnaire is part of a study to assist Michigan Department of Natural Resources with managing Michigan's snakes, one part of Michigan's non-game wildlife. Your thoughts on this topic are very important to us and <u>will</u> contribute to snake conservation in Michigan.

Please complete this questionnaire at your earliest convenience, seal it, and drop it in any mailbox. No envelope is needed and return postage has been provided for your convenience. The questionnaire should take about 15 minutes to complete.

Your responses will remain confidential to the greatest extent allowable by law, and your responses will never be associated with your name.

As a token of our appreciation for your participation in this study, a gift of three first-class stamps has been enclosed for your future use. These are for you to keep and are NOT needed to mail the survey back. Please check the box(es) on the inside back cover if you would also like to receive a summary of our study results and if you would be willing to attend an educational program about Michigan's snakes.

If you have any questions or concerns regarding this survey, please write **Rebecca Christoffel, Project Coordinator**, at the above address, or call her toll-free at **(888) 290-0413**.

Thank you for your participation!

If you choose not to complete the questionnaire, please return it with a note on the inside back cover. Simply seal it and drop it in a mailbox. Return postage is provided.

Please use this page for any additional comments or questions that you would like to share:

Please check this box ☐ if you would like to receive a summary of the <u>survey results</u>.

Please check this box ☐ if you would like to attend an <u>informational program</u> about Michigan's snakes.

<u>TO RETURN THE SURVEY</u>:

Simply seal it and drop in any mailbox. Return postage has been affixed for your convenience.

33. How would you describe the area you spent all or most of your childhood? (Please mark an "X" in one box.)

☐ Rural, farm
☐ Urban area (25,000 -100,000)
☐ Rural, non-farm
☐ Metropolitan area (>100,000 people)
☐ Small town-<25,000 people

34. How many children under the age of 12 currently live in your household? (If none, please write "0" in the space.)

__________ Children

35. How many dogs and cats currently live in your household? (If none, please write "0" in each space.)

__________ Dogs __________ Cats

36. Are you male or female? ☐ Male ☐ Female

37. In what year were you born? 19______

38. What is the highest level of formal education that you have completed? (Please mark an "X" in one box.)

☐ Attended elementary school
☐ Some college but no degree
☐ Attended high school
☐ Associate's Degree
☐ High school graduate or GED
☐ Bachelor's Degree
☐ Vocational or trade school
☐ Graduate or Professional Degree

A. Wildlife Activities

This section asks about your experiences with wildlife. For this survey, wildlife includes mammals (such as deer), fish, birds, reptiles, and amphibians. Reptiles are lizards, snakes and turtles. Amphibians are frogs, toads and salamanders.

1. About how often in a typical year do you engage in the following activities? (Please mark an "X" in one box for each activity).

Activity	*Frequently*	*Occasionally*	*Rarely*	*Never*
View wildlife				
Feed birds				
Garden				
Hike/bike in natural or recreational areas				
Visit zoos or nature centers				
Camp				
View wildlife TV programs				
Read about wildlife				
Watch wildlife movies				
Feed wildlife				
Photograph wildlife				
Use wildlife in artwork				
Hunt				
Trap				

2. How interested would you say that you are in local wildlife issues? (Please mark an "X" in one box.)

Very interested	Somewhat interested	No opinion	Somewhat disinterested	Very disinterested

3. Do you seek out information about local wildlife and related issues? (Please mark an "X" in one box.)

☐ Yes, *go to Question 4.* ☐ No, *please **skip** to Q6.* ⟶

4. How important are each of the following sources to you in learning about local wildlife and related issues? (Please mark an "X" in one box for each source.)

Source	Very important	Somewhat important	Not at all important
A. Local newspapers			
B. Family members /friends/ neighbors			
C. MI Department of Natural Resources (MDNR) publications			
D. MDNR meetings			
E. TV news or wildlife shows			
F. Wildlife videos/DVDs			
G. My own observations			
H. Programs at nature centers, zoos, state parks, etc.			
I. World wide web (Internet)			
J. Radio			
K. Sporting group publications			
L. Environmental publications			
M. Other (please specify) ________			

5. If you checked more than one source for question 4, which source is most important to you for information about local wildlife? (Please write one letter from the list in Question 4.) ____

☐
(>

27. Which of the possible Situations would you *prefer* for your neighborhood? (Please mark an "X" in one box.)

A	B	C	D	E	F	Unsure

28. What is the lowest level of rattlesnakes (which Situation) that would cause you to express concerns to an authority and request that they do something to reduce the number of rattlesnakes in your neighborhood? (Please mark an "X" in one box.)

A	B	C	D	E	F	Unsure

G. Background Information

We'd like to ask you a few questions about yourself to better understand your responses to previous questions. Your answers are confidential and will in no way be associated with your name or address.

29. How many years have you lived in Michigan? ____ years

30. How long have you lived at your current address? ______ years

31. Do you own the property where you live? ☐ Yes ☐ No

32. How would you describe the area where you currently live? (Please mark an "X" in one box.)

☐ Rural, farm
☐ Rural, non-farm
☐ Small town- <25,000 people
☐ Urban area (25,000- 100,000 people)
☐ Metropolitan area 100,000 people)

Six situations are described below that might be associated with increasing numbers of rattlesnakes in your neighborhood. *Use these to answer the questions that follow (Questions 27 and 28).*

	Possible Situation in your neighborhood
Increasing Rattlesnake Numbers ↑	**Situation F** *frequent* sightings of rattlesnakes bites to pets or livestock *occasionally* reported bites to humans *rarely* occur *residents* must take precautions with pets, livestock, children rattlesnake populations are abundant and widespread
	Situation E regular sightings of rattlesnakes bites to pets or livestock occasionally reported bites to humans are rare but do occur rattlesnake populations are healthy and connected
	Situation D regular sightings of rattlesnakes pets or livestock are rarely bitten rattlesnake populations are healthy but scattered
	Situation C rattlesnakes occasionally sighted by people pets or livestock are rarely bitten rattlesnake populations are small and isolated
	Situation B rattlesnakes exist but rarely sighted by anyone rattlesnake populations are at risk of extinction
	Situation A no rattlesnakes exist in your neighborhood

6. Do you do anything to manage habitat for wildlife on property <u>where you live or which you own</u>? (Please mark an "X" in one box.)

☐ Yes, *go to Question 7* ☐ No (*please **skip** to **Q8.***

7. If yes, what types of wildlife are you interested in having on your property? (Please mark an "X" for all that apply.)

Mammals (such as deer, rabbits, etc.)	
Birds	
Fish	
Amphibians	
Reptiles	
Other (please specify)________	

B. Michigan's Snakes

Now we would like to ask your perceptions of Michigan's snakes. In this survey, the term <u>non-venomous</u> (non-poisonous) snake refers to a snake that does not use venom to kill its food item. A <u>rattlesnake</u> (poisonous) is a snake that does use venom (poison) to kill food items.

8. How would you describe your level of personal interest in Michigan's snake(s)? (Please mark an "X" in one box.)

Very interested	Somewhat interested	No opinion	Somewhat disinterested	Very disinterested

9. Prior to receiving this survey, how many kinds of <u>non-venomous snake(s)</u> did you think live in Michigan? (Mark an "X" in one box).

None	1-4	5-10	11-15	16-20	More than 20	Unsure

10. Prior to receiving this survey, how many kinds of rattlesnake(s) did you think live in Michigan? (Please mark an "X" in one box.)

None	1	2	3	More than 3	Unsure

11. Do you think Michigan's non-venomous snake(s) need protection from human killing and collecting? (Please mark an "X" in one box.)
☐ Yes ☐ No ☐ No opinion

12. Do you think Michigan's rattlesnake(s) need protection from human killing and collecting? (Please mark an "X" in one box.)
☐ Yes ☐ No ☐ No opinion

13. Are you aware of any specific laws that protect Michigan's snake(s)? (Please mark an "X" in one box.)
☐ Yes ☐ No ☐ No opinion

14. How many rattlesnakes do you think currently live in your neighborhood? (Please mark an "X" in one box).

A lot	Some	Few	None	Unsure

Experiences with Snakes

Next, we'd like to find out what personal experiences you may have had with Michigan's snakes.

15. During the past year, how many times do you believe you have seen a rattlesnake in your neighborhood? (If none, write "0".)

_________ times

16. During the past year, how many people do you know, other than yourself, who have reportedly seen a rattlesnake(s) in your neighborhood? (If none, write "0".)

_________ people

24. How would you like to see the number of rattlesnakes in your neighborhood change? (Please mark an "X" in one box.)

Increase a lot	Increase somewhat	Stay the same	Decrease somewhat	Decrease a lot	No opinion

25. How important is it to you that the rattlesnake population match your preference in question 24? (Please mark an "X" in one box.)

Very important	Somewhat important	Not at all important	Unsure

26. For each event below indicate which of the four choices you would most likely make by placing an "X" in the appropriate box.

Event	*I would **not** do anything.*	*I would **ask** someone what I should do.*	*I would **tell** some one to remove the rattlesnake*	*I would **kill** the rattlesnake.*	*Unsure*
You see a rattlesnake near your home *once*.					
You hear about *one* time when a rattlesnake strikes at a neighbor's dog or cat.					
You see a rattlesnake near your home *more than once* in a week.					
Pets near your home are *repeatedly* threatened by a rattlesnake.					
A rattlesnake bites a pet near your home *once.*					
A rattlesnake bites *several* pets *over a summer* near your home.					
You see a rattlesnake on your porch *once.*					

b) To what extent do you believe that you personally are at risk from rattlesnakes in the areas that you live and recreate?

I am at great risk	I am at some risk	I am at a slight risk	I am at no risk	Unsure

c) How well do you think the Michigan Department of Natural Resources understands the risks to the public associated with having rattlesnakes in Michigan?

Very well	Somewhat well	Not very well	Not at all well	Unsure

d) To what degree are people that benefit from rattlesnakes the same as those who are exposed to any risks from them?

Very similar	Somewhat similar	Somewhat dissimilar	Very dissimilar	Unsure

F. Desires for Future Snake Populations

22. How would you like to see the number of non-venomous snakes in your neighborhood change? (Please mark an "X" in one box.)

Increase a lot	Increase somewhat	Stay the same	Decrease somewhat	Decrease a lot	No opinion

23. How important is it to you that the non-venomous snake population match your preference in question 22? (Please mark an "X" in one box.)

Very important	Somewhat important	Not at all important	Unsure

17. For each snake group, please mark an "X" for all statements that apply.

	Non – venomous snake	Rattle-snake
I have observed at least one in the wild.		
I have a friend or neighbor who observed at least one in the wild.		
I personally had or have one as a pet.		
I have a friend or neighbor who keeps or has kept one as a pet.		
I have witnessed one being killed by authorities, such as police.		
I have read or heard of one being killed by authorities, such as police.		
I had a pet threatened or bitten by one.		
I have read or heard of pets being threatened or bitten by one.		
I have personally been threatened or bitten by one.		
I have a friend or neighbor that has been threatened or bitten by one.		
Other (please specify)_________		

18. During the time you have lived at your current address, do you think that the population of non-venomous snakes in your neighborhood has: (Please mark an "X" in one box.)

Increased a lot	Increased somewhat	Stayed the same	Decreased somewhat	Decreased a lot	Unsure

19. During the time you have lived at your current address, do you think that the population of rattlesnakes in your neighborhood has: (Please mark an "X" in one box.)

Increased a lot	Increased somewhat	Stayed the same	Decreased somewhat	Decreased a lot	Unsure

20. Please mark an "X" in the box that most closely agrees with your opinion for each statement. (*SA=Strongly agree, A=Agree, U=Unsure, D=Disagree, SD=Strongly disagree*)

a. Non-venomous snakes

	SA	A	U	D	SD
I enjoy seeing non-venomous snakes in the wild in Michigan.					
Non-venomous snakes help to control mice, rats and other pests in Michigan.					
Whether or not I see one, I get some benefit from just knowing that non-venomous snakes live in Michigan.					
Non-venomous snakes are important to the balance of nature in Michigan.					
Non-venomous snakes pose a threat to people by their presence in Michigan.					
Non-venomous snakes are likely to spread disease to humans in Michigan.					
In Michigan, non-venomous snakes pose an unacceptable threat to dogs and cats.					
Non-venomous snakebites cause deaths to Michigan residents each year.					
In Michigan, the risk of a person being *injured* by a non-venomous snake is acceptably low.					
In Michigan, the risk of a person being *killed* by a non-venomous snake is acceptably low.					
I would be *less* likely to have a non-venomous snake moved off my property if I knew that it probably would not survive as a result.					
If I knew a non-venomous snake lived within a mile of my home, it would decrease my enjoyment of living there.					

b. Rattlesnakes

	SA	A	U	D	SD
I enjoy seeing rattlesnakes in the wild in Michigan.					
Rattlesnakes help to control mice, rats and other pests in Michigan.					
Whether or not I see one, I get some benefit from just knowing that rattlesnakes live in Michigan.					
Rattlesnakes are important to maintain the balance of nature in Michigan.					
Rattlesnakes pose a threat to people by their presence in Michigan.					
Rattlesnakes are likely to spread disease to humans in Michigan.					
In Michigan, rattlesnakes pose an unacceptable threat to pet dogs and cats.					
Rattlesnake bites in Michigan cause deaths to residents each year.					
In Michigan, the risk of being *injured* by a rattlesnake is acceptably low.					
In Michigan, the risk of a person being *killed* by a rattlesnake is acceptably low.					
I would be *less* likely to have a rattlesnake moved off my property if I knew that it probably would not survive as a result.					
If I knew a rattlesnake lived within a mile of my home, it would decrease my enjoyment of living there.					

E. Risks from Rattlesnakes

21. Please read the following questions and mark an "X" in the box that most closely represents your opinion.

a) Do you believe close contacts between rattlesnakes and humans are increasing or decreasing in Michigan?

Increasing a lot	Increasing somewhat	Staying the same	Decreasing somewhat	Decreasing a lot	Unsure

A.4 MICHIGAN MAIL SURVEY "THANK YOU!" POSTCARD

Last week a questionnaire seeking your beliefs and attitudes about Michigan's snakes was mailed to you. Your name was randomly chosen from a list of people living in southeastern Michigan.

If you have already completed and returned the questionnaire, thank you very much! If not, please do so today. I am greatly in need of your help because it is only by asking people like you to share your beliefs and attitudes about snakes that I can provide recommendations to the Michigan Department of Natural Resources regarding their management.

If you did not receive a questionnaire or if it was misplaced, please call me toll free at 1-888-290-0413 and I will get another one in the mail to you today.

Rebecca Christoffel, Graduate Student
Michigan State University, Department of Fisheries and Wildlife
13 Natural Resources Building
East Lansing, Michigan 48824

Last week a questionnaire seeking your beliefs and attitudes about Michigan's snakes was mailed to you. Your name was randomly chosen from a list of people living in southeastern Michigan.

If you have already completed and returned the questionnaire, thank you very much! If not, please do so today. I am greatly in need of your help because it is only by asking people like you to share your beliefs and attitudes about snakes that I can provide recommendations to the Michigan Department of Natural Resources regarding their management.

If you did not receive a questionnaire or if it was misplaced, please call me toll free at 1-888-290-0413 and I will get another one in the mail to you today.

Rebecca Christoffel, Graduate Student
Michigan State University, Department of Fisheries and Wildlife
13 Natural Resources Building
East Lansing, Michigan 48824

A.5. SURVEY MAILING #2 COVER LETTER

The coverletter was printed on Michigan State University Department of Fisheries and Wildlife letterhead
April 18, 2005

About three weeks ago, I sent a questionnaire to you that asked about your beliefs and attitudes toward snakes. To the best of my knowledge, it's not yet been returned.

Comments of people who have responded include a wide variety of beliefs and attitudes about snakes. Many people have described firsthand experiences with snakes, both good and bad. The survey results are going to be very useful to wildlife managers and others.

I am writing again because of the importance your response has for helping to obtain a true picture of people's attitudes and beliefs about snakes in southeastern Michigan. Although 500 questionnaires were sent to people living in each of the four counties in my study area, it's only by hearing from nearly everyone in the sample that I can be sure that the results are truly representative.

You may be assured of confidentiality in responding. Your privacy will be protected to the maximum extent allowable by law. The questionnaire has an identification number for mailing purposes only, so that I may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire itself. Questionnaire completion is voluntary. You indicate your voluntary agreement to participate by completing and returning the questionnaire. You may choose not to participate at all, or to refuse to answer certain questions.

Would you please have the adult (≥ 18 years) residing in the household who will next celebrate a birthday complete the questionnaire? The survey has 14 pages and should take about 15 minutes to complete.

A few people have called 1-888-290-0413 with specific questions or to state that they know very little about snakes and wonder if they should still participate. I do want your participation and I'm very happy to answer any questions or concerns that you might have about the survey. What I'm most interested in is people's feelings toward snakes and in their desires for current and future snake populations in their areas.

If you have questions or concerns regarding your rights as a study participant, or are dissatisfied at any time with any aspect of this study, you may contact – anonymously, if you wish – Peter Vasilenko, Ph.D., Chair of the University Committee on Research Involving Human Subjects (UCRIHS) by phone: (517) 432-4503, mail: 202 Olds Hall, East Lansing, MI 48824-1047, or email: ucrihs@msu.edu.

I hope that you will fill out and return the questionnaire soon, but if for any reason you prefer not to answer it, please let me know by returning the survey with a brief note on the inside back cover. Postage has been affixed to the survey for your convenience.

Sincerely,
Rebecca Christoffel, Project Manager

A.6. SURVEY MAILING #3 COVER LETTER

The coverletter was printed on Michigan State University Department of Fisheries and Wildlife letterhead

June 14, 2005

Address Block

Dear First Name Last Name:

During the last two months, I have sent you several mailings about an important research study I am conducting in southeastern Michigan.

Its purpose is to help Michigan Department of Natural Resources (MDNR) understand how people feel about wildlife, particularly snakes, in their area. This information will be used to better inform wildlife management decisions made by the MDNR, particularly as they relate to snake populations.

The study is drawing to a close, and this will be the last contact that will be made with the random sample of people chosen to provide their views on wildlife management in southeastern Michigan.

I am sending this final contact because of my concern that people who have not responded may have different beliefs or attitudes about snakes from those individuals that have responded. Hearing from everyone in this sample helps assure that the survey results are as accurate as possible, and that they provide a solid foundation for the MDNR to use to guide future wildlife management decisions.

I want to assure you that your response to this study is voluntary, and if you prefer not to respond that's fine. **If you do not wish to participate, will you please write a short note on the inside back cover of the enclosed survey and drop it in the mail?** This would be very helpful.

Finally, I appreciate your willingness to consider my request as I conclude this effort. Even if you know nothing about snakes or you have no interest or do not care at all about snakes, that input would be useful for me to receive. Thank you very much!

Sincerely,

Rebecca Christoffel
Project Director

A.7. SURVEY NON-RESPONSE INSTRUMENT

Rebecca Christoffel
Michigan State University
Department Fisheries & Wildlife
13 Natural Resources Building
East Lansing, MI 48824-1222

Rebecca Christoffel
Michigan State University
Department of Fisheries & Wildlife
13 Natural Resources Building
East Lansing, Michigan 48824-1222

Dear Sir or Madam: *August 25, 2005*

We recently sent you a questionnaire asking about your attitudes toward snakes in Michigan. Our records show that we did not receive a response from you. I have prepared a very simple, convenient set of 8 questions for those who were not able to respond to the longer survey.

Please take 5 minutes to answer those questions and return this survey so that we can provide a scientifically valid analysis of our study.

I have attached a stamped, addressed postcard that I hope you will fill out, detach, and drop in the mail. It should take no more than a few minutes to fill out the postcard. We would very much appreciate it if you would take the time to return this to us as soon as possible.

Your participation is voluntary, but we would not be asking you for this information if we did not consider it important to this research and the interpretation of our results. You may be assured of complete confidentiality. The postcard has an identification number for mailing purposes only. Your name will never be linked to your responses.

Thank you very much for your help!

Rebecca Christoffel, Project Manager

1. Was there a specific reason that you chose not to respond to our survey on beliefs and attitudes about Michigan's snakes? *(Please mark an "x" in front of all that apply).*
   [ ] I do not have time to answer surveys [ ] I know very little about snakes
   [ ] I never received the survey [ ] I am not interested in the issues in the survey
   [ ] I do not like answering surveys [ ] I would prefer being contacted by telephone
   [ ] The survey looked too long and/or complicated [ ] I am unhappy with Michigan Dept. of Natural Resources and/or its programs
   [ ] Another reason *(please specify)*______________________
2. In a typical year, do you engage in the following activities? *(Please mark an "x" in front of all that apply).*
   [ ] View wildlife [ ] Hike/bike in natural areas [ ] Camp [ ] Hunt [ ] Trap
3. How would you describe your level of personal interest in Michigan's snake(s)? *(Please mark an "x" in front of one response.)*
   [ ] Very interested [ ] Somewhat interested [ ] No opinion [ ] Somewhat disinterested [ ] Very disinterested
4. Do you think Michigan's rattlesnake(s) need protection from human killing and collecting? *(Please mark an "x" in front of one response.)*
   [ ] Yes [ ] No [ ] No opinion
5. To what extent do you believe that you personally are at risk from rattlesnakes in the areas that you live and recreate? *(Please mark an "x" in front of one response).*
   [ ] I am at great risk [ ] I am at some risk [ ] I am at a slight risk [ ] I am at no risk [ ] Unsure
6. Are you male or female? [ ] Male [ ] Female
7. Do you have a college degree? [ ] Yes [ ] No
8. How old are you? *(Please mark an "x" in front of one response).*

[ ] 18-30 [ ] 31-40 [ ] 41-50 [ ] 51-65 [ ] >65

Rebecca Christoffel
MSU, Dept. Fisheries & Wildlife
13 Natural Resources Building
East Lansing, Michigan 48824-1222

A.8. MICHIGAN AND MINNESOTA MAIL SURVEY CHRONOLOGIES

Michigan

Pre-notice letter with PI's signature	March 19, 2005
Cover letter, questionnaire, incentive	March 23, 2005
Postcard	March 30, 2005
Second cover letter and questionnaire	April 19, 2005
Third cover letter and questionnaire	June 14, 2005
Non-response mail instrument	August 25, 2005

Minnesota

Pre-notice letter with MN DNR signature	April 18, 2005
Cover letter, questionnaire, incentive	April 21, 2005
Postcard	April 29, 2005
Second cover letter and questionnaire	May 18, 2005
Third cover letter and questionnaire	June 13, 2005
Non-response mail instrument	August 25, 2005

A.9. OUTREACH EXPERIMENT PROTOCOL

1.) Each participant was considered a unit of analysis. All participants were a subset of a randomly selected sample provided by Survey Sampling International for the author's mail questionnaire about snakes administered in Jackson, Livingston, Oakland and Washtenaw counties, Michigan. Potential participants had marked a box on the inside back cover of the mail questionnaire indicating that they were interested in attending an informational program about Michigan's snakes. A random numbers generator was used to assign respondents to snake program dates. A coin toss was used to determine whether the right side or left side of the audience would be assigned to live snakes or to the Powerpoint slide presentation for the second half of the program each evening.

2.) Workshops lasted for approximately 1 hour, and participants were asked to fill out a post-workshop assessment instrument prior to departure. The first 30 minutes of the workshop was the same for all participants and consisted of a Powerpoint presentation given by the author that included basic reptile information, basic snake information, values of snakes, natural history, and snake conservation threats and remedial actions (A12).

3.) At the end of the "general" presentation, the audience was divided down the middle and half of the audience was presented with a 30-minute Powerpoint slide presentation featuring several Michigan snakes. The other half of the audience was presented with a lecture in a room in which four featured snakes were present in glass fronted tanks and the speaker handled the snakes in turn as they were being discussed. This activity, "behavioral modeling" (Bandura 1977), has been found to be useful in changing attitudes toward snakes (Morgan and Gramann 1989).

4.) The author and a second person (one of two part-time naturalists from Kensington Metroparks) presented all programs. All programs were held on weeknight evenings at 7:00 p.m. Kensington Metroparks Nature Center was offered as a place to hold the programs. This park was selected because of its location on the Washtenaw-Oakland County border - no more than a 30-minute commute for participants in 3 of 4 study counties. Jackson County participants were reimbursed for their mileage to participate in the program.

5.) An informed consent form and invitation letter was sent to each potential participant. The letter contained information regarding the location, time, and duration of program and a brief explanation of the experiment. Participants were asked to bring the consent form to their program and informed that it could be shown to the gate person to gain free entry into the park on the evening of their program. Jackson County residents were also informed about mileage reimbursement. All participants were informed that by participating, they would be entered into a drawing for a $50 Meijer gift certificate. One certificate was awarded to a participant at each of eight programs.

6.) The post-program assessment instrument was piloted, along with the program on 26 August 2005 with a "general public" audience at Kensington Park Nature Center. A question regarding whether participants knew the first names of others at the talk prior to its presentation was added to the instrument. As a follow up, people who responded that they did know first names were asked how many people they had known the first name of prior to the program.

7.) A "canned" talk was used for the experiment. The author and two part-time naturalists presented the same information and were consistent in their presentations. They also attempted to be consistent among themselves, though not to the point that it interfered with program delivery. Presenters only answered short questions at the end of the programs.

8.) Participants were screened prior to the start of the second half of the program regarding their comfort level with snakes. Anyone that was SO uncomfortable that they feel they would not be able to focus on content were excluded from the snake experiment.

9.) The author and two part-time naturalists wore green Kensington Metropark t-shirts and khakis to present each program in an attempt to control for variability due to different garb and credibility (as implied by the green Metroparks t-shirts).

A.10. POST-PROGRAM ASSESSMENT INSTRUMENT

\# ____________ *DATE*____________

1. How would you describe your level of personal interest in Michigan's snake(s)? (Please mark an "X" in one box.)

Very interested	Somewhat interested	No opinion	Somewhat disinterested	Very disinterested

2. Do you think Michigan's <u>non-venomous snake(s)</u> need protection from human killing and collecting? (Please mark an "X" in one box.)

Yes No No opinion

3. Do you think Michigan's <u>rattlesnake(s)</u> need protection from human killing and collecting? (Please mark an "X" in one box.)

Yes No No opinion

4. Please read the following questions and mark an "X" in the box that most closely represents your opinion.

a) Do you believe close contacts between rattlesnakes and humans are increasing or decreasing in Michigan?

Increasing a lot	Increasing somewhat	Staying the same	Decreasing somewhat	Decreasing a lot	Unsure

b) To what extent do you believe that you personally are at risk from rattlesnakes in the areas that you live and recreate?

I am at great risk	I am at some risk	I am at a slight risk	I am at no risk	Unsure

c) How well do you think the Michigan Department of Natural Resources understands the risks to the public associated with having rattlesnakes in Michigan?

Very well	Somewhat well	Not very well	Not at all well	Unsure

d) To what degree are people that benefit from rattlesnakes the same as those who are exposed to any risks from them?

Very similar	Somewhat similar	Somewhat dissimilar	Very dissimilar	Unsure

5. Please mark an "X" in the box that most closely agrees with your opinion for each statement.
(SA=Strongly agree, A=Agree, U=Unsure, D=Disagree, SD=Strongly disagree)

Non-venomous snakes	SA	A	U	D	SD
I enjoy seeing non-venomous snakes in the wild in Michigan.					
Non-venomous snakes help to control mice, rats and other pests in Michigan.					
Whether or not I see one, I get some benefit from just knowing that non-venomous snakes live in Michigan.					
Non-venomous snakes are important to the balance of nature in Michigan.					
Non-venomous snakes pose a threat to people by their presence in Michigan.					
Non-venomous snakes are likely to spread disease to humans in Michigan.					
In Michigan, non-venomous snakes pose an unacceptable threat to dogs and cats.					
Non-venomous snakebites cause deaths to Michigan residents each year.					
In Michigan, the risk of a person being *injured* by a non-venomous snake is acceptably low.					
In Michigan, the risk of a person being *killed* by a non-venomous snake is acceptably low.					
I would be *less* likely to have a non-venomous snake moved off my property if I knew that it probably would not survive as a result.					
If I knew a non-venomous snake lived within a mile of my home, it would decrease my enjoyment of living there.					

6. Please mark an "X" in the box that most closely agrees with your opinion for each statement.
(SA=Strongly agree, A=Agree, U=Unsure, D=Disagree, SD=Strongly disagree)

Rattlesnakes	SA	A	U	D	SD
I enjoy seeing rattlesnakes in the wild in Michigan.					
Rattlesnakes help to control mice, rats and other pests in Michigan.					
Whether or not I see one, I get some benefit from just knowing that rattlesnakes live in Michigan.					
Rattlesnakes are important to the balance of nature in Michigan.					
Rattlesnakes pose a threat to people by their presence in Michigan.					
Rattlesnakes are likely to spread disease to humans in Michigan.					
In Michigan, rattlesnakes pose an unacceptable threat to dogs and cats.					
Rattlesnake bites cause deaths to Michigan residents each year.					
In Michigan, the risk of a person being <u>*injured*</u> by a rattlesnake is acceptably low.					
In Michigan, the risk of a person being <u>*killed*</u> by a rattlesnake is acceptably low.					
I would be <u>*less*</u> likely to have a rattlesnake moved off my property if I knew that it probably would not survive as a result.					
If I knew a rattlesnake lived within a mile of my home, it would decrease my enjoyment of living there.					

7. How would you like to see the number of <u>non-venomous snakes in your neighborhood</u> change? (Please mark an "X" in one box.)

Increase a lot	Increase somewhat	Stay the same	Decrease somewhat	Decrease a lot	No opinion

8. How important is it to you that the <u>non-venomous snake</u> population match your preference in question 7? (Please mark an "X" in one box.)

Very important	Somewhat important	Not at all important	Unsure

9. How would you like to see the number of rattlesnakes in your neighborhood change? (Please mark an "X" in one box.)

Increase a lot	Increase somewhat	Stay the same	Decrease somewhat	Decrease a lot	No opinion

10. How important is it to you that the rattlesnake population match your preference in question 9? (Please mark an "X" in one box.)

Very important	Somewhat important	Not at all important	Unsure

11. For each event below indicate which of the four choices you would most likely make by placing an "X" in the appropriate box.

Event	*I would **not** do anything.*	*I would **ask** someone what I should do.*	*I would **tell** some one to remove the rattlesnake.*	*I would **kill** the rattlesnake.*	*Unsure*
You see a rattlesnake near your home *once.*					
You hear about *one* time when a rattlesnake strikes at a neighbor's dog or cat.					
You see a rattlesnake near your home *more than once* in a week.					
Pets near your home are *repeatedly* threatened by a rattlesnake.					
A rattlesnake bits a pet near your home *once.*					
A rattlesnake bites *several* pets *over a summer* near your home.					
You see a rattlesnake on your porch *once.*					

Six situations are described below that might be associated with increasing numbers of rattlesnakes in your neighborhood. *Use these to answer the questions that follow (Questions 12 and 13).*

Possible Situation in your neighborhood	
Increasing Rattlesnake Numbers ↑	**Situation F** *frequent* sightings of rattlesnakes bites to pets or livestock *occasionally* reported bites to humans *rarely* occur *residents* must take precautions with pets, livestock, children rattlesnake populations are abundant and widespread
	Situation E *regular* sightings of rattlesnakes bites to pets or livestock *occasionally* reported bites to humans are *rare* but do occurrattlesnake populations are healthy and connected
	Situation D *regular* sightings of rattlesnakes pets or livestock are *rarely* bitten rattlesnake populations are healthy but scattered
	Situation C rattlesnakes *occasionally* sighted by people pets or livestock are *rarely* bitten rattlesnake populations are small and isolated
	Situation B rattlesnakes exist but *rarely* sighted by anyone rattlesnake populations are at risk of extinction
	Situation A no rattlesnakes exist in your neighborhood

12. Which of the possible Situations would you *prefer* for your neighborhood? (Please mark an "X" in one box.)

A	B	C	D	E	F	Unsure

13. What is the lowest level of rattlesnakes (which Situation) that would cause you to express concerns to an authority and request that they do something to reduce the number of rattlesnakes in your neighborhood? (Please mark an "X" in one box.)

A	B	C	D	E	F	Unsure

14. On a scale from –5 to +5, please place an "X" over the number that most closely reflects the amount of like that you have for each group.
(-5 = Totally dislike [the only good one is a dead one], -4=Very strongly dislike, -3 = Strongly dislike, -2=Moderately dislike, -1=Slightly dislike, 0=Neutral [I can take them or leave them], +1=Slightly like, +2=Moderately like, +3=Strongly like, +4=Very strongly like, and +5=Totally like [I would do whatever I could for this group of animals]).

Non-venomous snakes

-5- 4 -3 -2 - 1 0 1 2 3 4 5

Rattlesnakes

-5 -4 3 -2 - 1 0 1 2 3 4 5

15. On a scale from 0 to 5, please mark an "X" on the number that most closely reflects the amount of fear that you feel around each group.
(0=Phobic [If a TV program is on in the other room about them, I can't sit in that room], 1=Very strongly fearful, 2=Strongly fearful, 3=Moderately fearful, 4=Slightly fearful [I can't touch them], 5=No fear at all [I feel comfortable picking them up and moving them if needed].)

Non-venomous snakes

0 1 2 3 4 5

Rattlesnakes

0 1 2 3 4 5

16. Did you know the first name of any individual at this program prior to its start?

Yes No

If you answered "Yes" to question 16, please indicate how many people you knew the first name of in the audience prior to the program's start.

____

Thank you very much for your participation in this research!

A.11. LONG-TERM ASSESSMENT INSTRUMENT

#______________ **Date** ________________

1. Please place an "X" in the box to the right of each statement that most closely reflects your feelings since participating in this study.

Participating in this study about snakes has caused...	**Greatly Increase**	**Somewhat Increase**	**Has not Affected This**	**Somewhat Decrease**	**Greatly Decrease**
...my interest in learning about snakes to ...					
...my negative feelings toward snakes to...					
...the time I spend looking for opportunities to learn about snakes to...					
...my fear of snakes to...					
...my interest in having a snake as a pet to...					
...my feelings of being at personal risk of being bitten by a rattlesnake to...					
...my positive feelings toward snakes to...					
...the attention I pay to information about snakes to...					

2. Have you had any personal observations or encounters with snakes since the last time you filled out a survey as part of this study?

No

Yes

If **yes**, please describe: ____

____

____

3. How would you describe your current level of personal interest in Michigan's snake(s)? (Please mark an "X" in one box.)

Very interested	Somewhat interested	No opinion	Somewhat disinterested	Very disinterested

4. Have you talked with anyone about snakes since participating in this study? Please place an "X" in the box to the left of all that apply.

Family
Friends
Neighbors
Co-workers
Others (please specify) ______________________________

5. Please place an "X" in the box to the left of each source that has provided you with information about snakes since you last completed a questionnaire for this study. For each source you marked, how would you rate most of the information that you received about snakes? Mark each as (+) snake friendly, (0) snake neutral or (-) snake unfriendly in the appropriate columns to the right of each source that you have marked with an "X".

	Source of information	**Snake Friendly (+)**	**Snake Neutral (0)**	**Snake Unfriendly (-)**
	A. Local newspapers			
	B. Family members/friends/neighbors			
	C. MI Department of Natural Resources publications			
	D. MI Department of Natural Resources meetings			
	E. TV news or wildlife shows			
	F. Wildlife videos or DVDs			
	G. Programs at nature centers, state parks, etc.			
	H. World wide web (Internet)			
	I. Radio			
	J. Sporting			
	K. Environmental publications			
	L. Other (please specify) ____________			
	M. None (I have not been provided with any further information about snakes)			

6. Do you think Michigan's non-venomous snake(s) need protection from human killing and collecting? (Please mark an "X" in one box.)

Yes No No opinion

7. Do you think Michigan's <u>rattlesnake(s)</u> need protection from human killing and collecting? (Please mark an "X" in one box.)

Yes No No opinion

8. Please mark an "X" in the box that most closely reflects your opinion for each statement.
(SA=Strongly agree, A=Agree, U=Unsure, D=Disagree, SD=Strongly disagree)

<u>Non-venomous snakes</u>	SA	A	U	D	SD
I enjoy seeing non-venomous snakes in the wild in Michigan.					
Non-venomous snakes help to control mice, rats and other pests in Michigan.					
Whether or not I see one, I get some benefit from just knowing that non-venomous snakes live in Michigan.					
Non-venomous snakes are important to the balance of nature in Michigan.					
Non-venomous snakes pose a threat to people by their presence in Michigan					
Non-venomous snakes are likely to spread disease to humans in Michigan.					
In Michigan, non-venomous snakes pose an unacceptable threat to dogs and cats.					
Non-venomous snakebites cause deaths to Michigan residents each year.					
In Michigan, the risk of a person being *<u>injured</u>* by a non-venomous snake is acceptably low.					
In Michigan, the risk of a person being *<u>killed</u>* by a non-venomous snake is acceptably low.					
I would be *<u>less</u>* likely to have a non-venomous snake moved off my property if I knew that it probably would not survive as a result.					
If I knew a non-venomous snake lived within a mile of my home, it would decrease my enjoyment of living there.					

9. How would you like to see the number of <u>non-venomous snakes in your neighborhood</u> change? (Please mark an "X" in one box.)

Increase a lot	Increase somewhat	Stay the same	Decrease somewhat	Decrease a lot	No opinion

10. How important is it to you that the <u>non-venomous snake</u> population match your preference in question 9? (Please mark an "X" in one box.)

Very important	Somewhat important	Not at all important	Unsure

11. Please mark an "X" in the box that most closely reflects your opinion for each statement.
(SA=Strongly agree, A=Agree, U=Unsure, D=Disagree, SD=Strongly disagree)

Rattlesnakes	SA	A	U	D	SD
I enjoy seeing rattlesnakes in the wild in Michigan.					
Rattlesnakes help to control mice, rats and other pests in Michigan.					
Whether or not I see one, I get some benefit from just knowing that rattlesnakes live in Michigan.					
Rattlesnakes are important to the balance of nature in Michigan.					
Rattlesnakes pose a threat to people by their presence in Michigan.					
Rattlesnakes are likely to spread disease to humans in Michigan.					
In Michigan, rattlesnakes pose an unacceptable threat to dogs and cats.					
Rattlesnake bites cause deaths to Michigan residents each year.					
In Michigan, the risk of a person being *injured* by a rattlesnake is acceptably low.					
In Michigan, the risk of a person being *killed* by a rattlesnake is acceptably low.					
I would be *less* likely to have a rattlesnake moved off my property if I knew that it probably would not survive as a result.					
If I knew a rattlesnake lived within a mile of my home, it would decrease my enjoyment of living there.					

12. How would you like to see the number of rattlesnakes in your neighborhood change? (Please mark an "X" in one box.)

Increase a lot	Increase somewhat	Stay the same	Decrease somewhat	Decrease a lot	No opinion

13. How important is it to you that the rattlesnake population match your preference in question 12? (Please mark an "X" in one box.)

Very important	Somewhat important	Not at all important	Unsure

14. For each event below indicate which of the four choices you would most likely make by placing an "X" in the appropriate box.

Event	*I would **not** do anything.*	*I would **ask** someone what I should do.*	*I would **tell** some one to remove the rattlesnake.*	*I would **kill** the rattlesnake.*	***Unsure***
You see a rattlesnake near your home once.					
You hear about *one* time when a rattlesnake strikes at a neighbor's dog or cat.					
You see a rattlesnake near your home *more than once* in a week.					
Pets near your home are *repeatedly* threatened by a rattlesnake.					
A rattlesnake bites a pet near your home *once.*					
A rattlesnake bites *several* pets *over a summer* near your home.					
You see a rattlesnake on your porch *once.*					

15. Please read the following questions and mark an "X" in the box that most closely represents your opinion.

a) From your experiences and awareness of encounters other people are having, do you believe close contacts between rattlesnakes and humans are increasing or decreasing in Michigan?

Increasing a lot	Increasing somewhat	Staying the same	Decreasing somewhat	Decreasing a lot	Unsure

b) To what extent do you believe that you personally are at risk from rattlesnakes in the areas that you live and recreate?

I am at great risk	I am at some risk	I am at a slight risk	I am at no risk	Unsure

c) How well do you think the Michigan Department of Natural Resources understands the risks to the public associated with having rattlesnakes in Michigan?

Very well	Somewhat well	Not very well	Not at all well	Unsure

Six situations are described below that might be associated with increasing numbers of rattlesnakes in your neighborhood. *Use these to answer Questions 16 and 17.*

Possible Situation in your neighborhood	
↑ Increasing Rattlesnake Numbers	**Situation F** *frequent* sightings of rattlesnakes bites to pets or livestock *occasionally* reported bites to humans *rarely* occur *residents* must take precautions with pets, livestock, children rattlesnake populations are abundant and widespread
	Situation E *regular* sightings of rattlesnakes bites to pets or livestock *occasionally* reported bites to humans are *rare* but do not occur rattlesnake populations are healthy and connected
	Situation D *regular* sightings of rattlesnakes pets or livestock are *rarely* bitten rattlesnake populations are healthy but scattered
	Situation C rattlesnakes are *occasionally* sighted by people pets or livestock are *rarely* bitten rattlesnake populations are small and isolated
	Situation B rattlesnakes exist but *rarely* sighted by anyone rattlesnake populations are at risk of extinction
	Situation A no rattlesnakes exist in your neighborhood

16. Which of the possible Situations would you *prefer* for your neighborhood? (Please mark an "X" in one box.)

A	B	C	D	E	F	Unsure

17. What is the lowest level of rattlesnakes (which Situation) that would cause you to express concerns to an authority and request that they do something to reduce the number of rattlesnakes in your neighborhood? (Mark an "X" in one box.)

A	B	C	D	E	F	Unsure

Thank you very much for your participation in this research!

A.12. SNAKE OUTREACH EXPERIMENT CHRONOLOGY

Pilot program conducted	26 August 2005
Invitation letter sent to participants	3 September 2005
Conducted experimental programs	6,7,12,14,15,19,20 September and 8 October 2005
Letter and survey sent to control group	3 November 2005
Outreach publications, letter and survey sent to written materials treatment group	4 November 2005
Long-term questionnaires mailed	7 April 2006
Second long-term questionnaires mailed	May 31, 2006

A13.a. SCRIPT FOR FIRST HALF OF SNAKE OUTREACH PROGRAM

I. So, why learn about snakes anyway? (values of snakes in society)
  A. Ecological
    1. predator
    2. prey
    3. indicators of habitat quality
  B. Spiritual or religious
    1. Christians
    2. Hindus
    3. Snake-handling sects in SE USA
    4. Fertility deities in many cultures around globe
  C. Cultural
    1. Lucky house cobras in India
  D. Economic
    1. Fashion
    2. Pet trade
    3. Meat
  E. Aesthetic
    1. Snakes used in art and jewelry-making
    2. Diversity of colors, patterns
    3. Diversity of forms, movements
  F. Pharmaceutical
    1. Rattlesnake venoms used for plethora of human medicinal purposes (heart problems, high blood pressure, hemophilia, etc.)
    2. Saliva from non-venomous snakes, such as northern water snakes for use in developing anti-coagulants or blood thinners, etc.

II. What makes a snake a reptile? (Brief intro to reptile characteristics)
  A. Scales
  B. Ectothermic
  C. Little to no parental care
  D. Claws on limbs
  E. Amniotic eggs

III. Snake Myths
  A. Snakes are NOT slimy
  B. Where you find one snake, you may find another but no guarantees
  C. A snake will not chase a person, though a blue racer may try to scare you off
  D. Having one kind of snake on your property DOES NOT preclude other species from being there (e.g., rattlesnakes not around where you have things such as fox snakes, etc.)
  E. No humans have been bitten in Michigan and died from eastern massasauga rattlesnake bite for AT LEAST 50 years.
  F. The two best ways to get bitten by a snake are to purposely handle a snake or to try and kill a snake.

IV. What makes a snake a snake? (Special characters of snakes)
   A. No eyelids or external ears
   B. No or only vestigial limbs
   C. Jaws and teeth for swallowing prey
   D. Movement – rectilinear, concertina, sidewinding, ?
   E. Size – smallest to largest (???? = smallest, Indian python longest, anaconda heaviest)
   F. Ecdysis

V. A year in the life of a Michigan snake
   A. Hibernation or brumation
   B. Emergence/migration
   C. Thermoregulation and associated behaviors and micro-habitats
   D. Eating and hunting
   E. Mating
   F. Reproduction
   G. Migration/hibernation

VI. Conservation threats to Michigan snakes
   A. Loss and degradation of habitat
   B. Roads
   C. Accidental or intentional killing
   D. Collection for the pet trade, especially of rare snakes
   E. Lack of knowledge regarding specific macro and micro habitat needs, population status, minimum number of individuals for a viable population, effects of toxicants on snakes, etc.

VII. Actions that will help conserve Michigan snakes
   A. Habitat protection.
   B. Fewer killings due to misidentification when people learn to recognize the 18 different kinds of snakes that live in Michigan.
   C. Additional funding for non-game management and research to learn about snakes' management needs, etc.
   D. Smaller roads and culverts, etc. to assist animals in moving from point A to point B.
   E. Regulations that are strictly enforced regarding the take and possession of Michigan's snakes.
   F. Incentives and direction to private landowners in managing their properties to benefit snakes (or at least to not wipe out snakes while managing to benefit some other favored species/group).
   G. Fewer snakes may be killed by landowners if they are trained in the correct response when they "hear" or see a rattlesnake. Most bites occur when individuals purposefully handle rattlesnakes or try to kill them.

A.13.b. SCRIPT FOR SECOND HALF OF SNAKE OUTREACH PROGRAMS

During the second half of the program, we're going to spend a little time acquainting you with several species of snakes found in Michigan.

I. Eastern milk snake (*Lampropeltis triangulum*)

A. Description: The eastern milk snake is a slender, medium-sized snake reaching lengths of 24 to 52 inches. Its scales are smooth, without a ridge or keel running down the middle of them, and so the snake is very smooth to the touch, like paten leather. At hatching, youngsters have a white background color with bright orange-red blotches outlined in black and are from 6 to 11 inches long. This is aposematic coloring that affords these small individuals some protection from potential predators. As the snake matures, the background color fades to gray or tan and the blotches turn a sort of brick-red, maroon or brown. A field mark that can help in identifying this snake is the light "V" or "Y" shaped marking that is usually present on the back of its head. The belly has a checkerboard pattern on it, but may just appear as dark in older individuals.

B. Distribution: Eastern milk snakes are found throughout the lower peninsula of Michigan and are rarely found in some localized areas of the upper peninsula.

C. Habitat(s): This is a habitat generalist. Milk snakes are found in a wide variety of habitats including open woodlands, bogs, swamps, woods edges, marshes, lakeshores, old fields, pastures, farmyards, and suburban parks and gardens. They are also found in and around human habitations, and are attracted to piles of rocks, logs, firewood or building materials. In fact, the eastern milk snake got its name from the commonly held misconception that these snakes, often found in dairy barns, were suckling milk from farmers' cows. Actually, the snakes were much more interested in the rodents that were found in the barns.

D. Diet: As I just mentioned, adult milk snakes feed primarily on rodents, but also consume snakes, lizards, birds and eggs. Milk snakes are constrictors; they bite their prey and then wrap their bodies around their prey items to hinder them helpless. For prey that are helpless, such as eggs, the snake simply seizes and swallows. As a youngster, a milk snake will prey on other snakes. This species is a member of the kingsnake family, which is known for its propensity to feed on other snakes. The animal switches over to warm-blooded prey as it matures.

E. Habits: Milk snakes are secretive and remain underground or under cover much of the time. They are most often active at night rather than during the day. The best time to observe adults is in the spring when they can be found basking to raise their body temperatures. Youngsters are most often observed in September and October, prior to hibernation.

F. Reproduction: Milk snakes lay 5-24 eggs in late June or early July in rotted stumps or logs, piles of vegetation or manure, shallow burrows in soil or sand, or cavities under rocks, bark or other surface litter. The eggs often stick, or adhere, to one another. Hatching occurs in August or September. Youngsters reach maturity in 3-4 years, and can live for 7-10 years in the wild.

G. Hibernation: Milk snakes can often be found using old stone foundations or wells for overwintering or hibernation, though old burrows, cavities under rotted stumps, rock or soil crevices, and rock-filled road embankments are also used. They may be found in the company of other species such as fox snakes, garter snakes, and brown snakes.

H. Factoids: As youngsters, milk snakes are sometimes thought to be coral snakes. No coral snakes are found in Michigan, other than in a zoo, and the coloring is actually quite different. Coral snakes are striped, rather than blotched. Milk snakes are also often mistaken for rattlesnakes. This has to do with their blotched coloring and their defensive behavior. When a milk snake feels threatened, it will vibrate its tail rapidly in dry grass or leaf litter, mimicking a rattlesnake. However, this snake is a benefit rather than a risk to people, with its propensity for eating rodents.

II. Eastern fox snake (*Elaphe gloydi*)

A. Description: The eastern fox snake is a robust, medium-sized snake with an average total length of about 3.5 feet, but it ranges from 3 – 5.5 feet. It has a background color that varies from yellow to light brown. A row of black or dark chocolate brown blotches run along the back, alternating with smaller dark blotches along the sides. The belly has irregular rows of dark squarish spots on a yellowish background. Fox snakes have a spinelike tip on their tail, and their scales are weakly keeled; there is a slight ridge running along the center of each scale.
The fox snake got its name from the musky-smelling secretion that it often emits when handled in the wild. Not only the snake but you, too, will smell foxy after such an encounter. Fox snakes are often called "copperheads" due to their solid copper-colored heads, but they aren't even closely related to a true copperhead. Fox snakes are not venomous, or poisonous. Youngsters have a gray or tan background color with gray or brownish blotches outlined in black, and achieve their adult coloration when about 3 years old. Field marks to look for in identifying the fox snake is its rather flat brown or copper-colored head and its blunt tail.

B. Distribution: The Eastern fox snake is found only within the Great Lakes basin and it inhabits coastal marshes and other near-shore habitats along Lakes Huron and Erie. This snake is listed as threatened in the state of Michigan, and is protected by law.

C. Habitat(s): Eastern fox snakes are primarily found in marshy areas and vegetated dunes and beaches, but they can sometimes be found in nearby farm fields, pastures, and woodlots. Fox snakes can sometimes be spotted basking on muskrat houses, dikes, and road embankments.

D. Diet: The diet of these snakes consists primarily of small mammals, such as meadow voles and deer mice. They will also eat nestling birds and eggs. Youngster may eat earthworms and frogs. When consuming helpless prey, the fox snake simply seizes and swallows. For larger prey, the snake uses constriction like the milk snake.

E. Habits:

F. Reproduction: Females lay 7-29 eggs during late June and July in rotted stumps or shallow burrows, or under logs, boards, or mats of decaying vegetation. Sometimes several females will lay their eggs at one nest site. Like the milk snake, fox snakes have adherent eggs. Most hatching occurs in late August or September. Fox snakes mature in 3-4 years.

G. Hibernation: Eastern fox snakes hibernate in mammal burrows or other frost-free shelters. They are typically active from mid-April until late October, and are most often observed in the spring. They become more night-active during the warmer summer months.

H. Factoids: Fox snakes are excellent climbers. They are often mistaken by people for rattlesnakes because of their coloration and a certain defensive behavior they engage in. Like the milk snake, fox snakes will often vibrate their tails rapidly when feeling threatened. Not only their blotches but their solid copper-colored heads have led some people to believe that they are rattlesnakes. This is a harmless snake that benefits people by its rodent-eating habits.

III. Northern water snake (*Nerodia sipedon*)

A. Description: The northern water snake is medium-sized snake. Females are larger than males and although old females may attain lengths greater than four feet, the average range for adults is 2 – 4 feet. Water snakes generally have a tan, brown or gray background color with a variable pattern of black, dark brown or reddish brown crossbands and blotches on the back and sides. Some older specimens lose their blotched patterning and appear very dark brown or black in color, especially when dry. The white, yellowish or orangish belly is usually marked with reddish brown half-moon shaped spots. The scales on the northern water snake are keeled, having a raised ridge running along their centers. Northern water snakes are often referred to as "water moccasins" and mistakenly believed to be poisonous, or venomous. True water moccasins, or cottonmouths, do not occur in this area.

B. Distribution: Northern water snakes are found throughout Michigan in appropriate habitat.

C. Habitat(s): This is a snake that is normally found in or around water bodies, though dispersing individuals may be found some distance from any standing water. Water snakes prefer fairly open and sunny locations with ample cover and basking sites. People often encounter this species on docks, in boathouses, near piers, bridge supports, dams, causeways, and flowing culverts.

D. Diet: Northern water snakes are opportunistic feeders, with a diet made up primarily of cold-blooded prey such as minnows, tadpoles, frogs, crayfish and aquatic salamanders, though carrion is also taken. They are grab and swallow predators, not bothering to engage in constriction. Youngsters include insects and earthworms in their diets. The saliva of this snake has compounds in it that inhibit blood clotting; if bitten, though it won't hurt much, you will bleed quite a bit.

E. Habits: Northern water snakes are mostly active during the day in spring and fall, but become primarily night-active during the warmer summer months.

F. Reproduction: Courtship and mating occurs in the spring for this species. Northern water snakes give birth to "live" young in August or September rather than laying eggs. Newborn snakes are 7.5 – 10.5 inches long. A litter may number from 4-99, but average litter size is 15-40. Larger females give birth to proportionally larger litters. Youngsters reach maturity in 2-3 years.

G. Hibernation: Northern water snakes hibernate from October to April. The colder months are spent in mammal or crayfish burrows, rock crevices, overbank root systems or other sheltered sites near their summer habitat. This species often hibernates in the company of others of its kind and other snake species.

H. Factoids: All snakes swim; it's just a matter of how willing they are to do so. So anytime you see a snake in water, you must not assume that it is a northern water snake. However, northern water snakes are tied to aquatic habitats. Northern water snakes are sometimes mistaken for Michigan's only venomous snake, the eastern massasauga. It's pretty easy to differentiate by behavior alone. Unlike the massasauga, a northern water snake will approach people rather than flee. If you are fishing and leave a bait bucket unattended nearby and there is a northern water snake in the area, do not be surprised if the snake comes and helps itself to a meal at your expense. If you try to handle the snake, don't be surprised if it bites. Northern water snakes are quick to defend themselves from potential threats – like you. Like the fox snake, the northern water snake can emit a very noxious smelling secretion when threatened.

IV. Eastern hognose snake (*Heterodon platirhinos*)

A. Description: The eastern hognose snake is a rather small but thick-bodied snake with a short tail and a flattened upturned snout. It can be brightly patterned with brown spots on a yellow background, or it may be a solid gray-green color. However, it will always have two big black eyespots on the back of its head. The belly may be yellow, cream, gray or even pinkish, often mottled with a darker color. The chin and throat are usually lighter than the rest of the underside. Eastern hognose snakes range from

20-45 inches, but are typically 2.5 – 3 feet long. Youngsters have dark blotches along their light gray or brown backs, and are 5-10 inches long at hatching.

B. Distribution: Eastern hognose snakes are found throughout the lower peninsula of Michigan and in Menominee County in the upper Peninsula. This species has become an uncommon to rare snake in many places where it was reasonably common only 10-20 years ago.

C. Habitat(s): Eastern hognose snakes are found nearly all types of terrestrial habitats, from open pine or deciduous woodlands to old fields, meadows and pastures.

D. Diet: Eastern hognose snakes are toad-eating specialists. They are immune to the poisons found in the paratoid glands at the back of the toads' heads. When the toad pumps itself up with air to appear larger to the snake, the snake is able to bite the toad and "deflate" it with fangs found at the back of the snake's mouth. This enables the snake to be able to swallow its prey item. Other prey items include frogs, salamanders, small reptiles, eggs, small mammals, birds, and insects.

E. Habits: Hognose snakes are largely day active but tend to be most active in the morning and early evening during the warm summer months. When they aren't foraging or basking, they spend most of their time underground.

F. Reproduction: Most mating occurs in the spring but it has been reported as late as September. Females lay their eggs in June or July in a shallow burrow in sand or soil, or under a log or rock. Clutch size ranges from 4-61 eggs. Hatching occurs in late August or September, and youngsters reach maturity in 2-3 years.

G. Hibernation: Eastern hognose snakes hibernate in deep, self-excavated or abandoned burrows or under a rotted stump or similar shelter.

H. Factoids: The eastern hognose snake is sometimes called the Michigan cobra or "puff adder." This is due to the defensive behaviors displayed by this species. If the animal is approached by what is perceived to be a predator, the animal will first lift the front portion of its body up off the ground and flare out the skin at the back of its head, showing off its two big eyespots that make it appear larger than the snake really is. If that doesn't work, the snake will "play possum" rolling over on its back, lolling out its tongue, and often exuding foul-smelling secretions and feces from its cloaca. If you turn the snake right side up, it will immediately flip over again on its back, until the danger has passed – you! It should be mentioned here that the eastern hognose snake is a harmless snake that seldom, if ever, bites when approached. Unfortunately, it is often mistakenly believed to be venomous or poisonous, and so is often mistakenly killed by people.

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