ENFORCEMENT, PERSONAL GAINS, AND NORMATIVE FACTORS ASSOCIATED WITH HUNTER COMPLIANCE AND COOPERATION WITH MICHIGAN WHITE-TAILED DEER AND BOVINE TUBERCULOSIS MANAGEMENT INTERVENTIONS

By

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A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Fisheries and Wildlife

2012

ABSTRACT

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Management of game populations in North America is primarily approached through adoption and enforcement of hunting and trapping regulations. The level of compliance with these regulations is typically unknown. Utilizing enforcement to maintain compliance depends upon instrumental models of behavior that focus on "rational calculations of utility," through which individuals balance deterrence with their perceived potential for personal gains from illegal acts. Alternative approaches to gaining compliance may employ normative models of behavior that focus on an internal sense of duty arising from moral obligation, social norms, and "procedural justice" through adopting regulations using what are perceived to be fair processes. Research in diverse contexts has indicated agencies may strategically utilize procedural justice to build trust and create normative influence through a sense of responsibility to comply. Normative influence may also promote cooperative behavior that extends beyond basic compliance.

Bovine tuberculosis (bTB) eradication efforts in an area of Michigan where the disease is sustained within the white-tailed deer (*Odocoileus virginianus*) population required reduction in densities and concentrations of deer in order to decrease disease transmission. Eradication strategies included adoption of baiting regulations and liberalized hunting regulations to promote harvest of female (antlerless) deer. Hunters contested the need for these regulations, and prior assessments suggested the frequency of baiting violations and inadequate cooperation with reaching necessary harvest levels limited the effectiveness of eradication efforts.

I developed a conceptual framework that included instrumental and normative factors expected to have influenced hunter violations, cooperation with population management efforts, and trust in the agency. I conducted a mail survey of 3,500 bTB area deer hunters to quantify the rate of violations and used logit modeling to assess factors affecting violations, cooperation, and trust. Factor analysis validated the conceptual framework. I estimated the minimum baiting violation rate was 25%. Among instrumental influences, the perceived risk of punishment was not significant, but the expected severity (through belief that revocation of hunting privileges was a potential penalty) was significant. Personal gains via perceived enhanced opportunity to take at least 1 deer were associated with violations and with cooperation (purchasing antlerless licenses). Results indicated procedural justice may build trust, but the potential benefits for subsequent reduction of violations and improving cooperation were less clear.

This research presented an opportunity to examine how agency actions and policies contribute collectively to compliance, cooperation, and trust rather than studying these outcomes in isolation. Detailed assessment of individuals' trust, compliance, and cooperation with specific actors exercising specific authorities is a necessary approach for developing recommendations to enhance government performance. To meet their public trust responsibilities, I suggest state wildlife agencies should consider ways to affect both instrumental and normative factors to increase effectiveness of management and build trust. Authority to revoke hunting privileges for illegal use of bait should be pursued. Efforts should be considered to advise hunters regarding the best locations and methods of hunting that do not involve using bait, provide assistance through habitat management to increase deer sightings, or encourage hunters to harvest antlerless deer rather than bucks. Convincing hunters that the best available science is used to inform decisions may offer an opportunity to enhance trust and compliance.

To Niki Jo, my partner in everything.

ACKNOWLEDGEMENTS

Primary funding was provided by the Michigan Department of Natural Resources Wildlife Division, through the Federal Aid in Wildlife Restoration Act under Pittman-Robertson project W-147-R and the Game and Fish Protection Fund, and by the Michigan Department of Agriculture and Rural Development. Additional funding was provided by Michigan State University, the Safari Club International - Michigan Involvement Committee, and the Rocky Mountain Goats Foundation. All survey methodologies were approved by the Michigan State University Committee Involving Research on Human Subjects and the Institutional Review Board (IRB #08-419).

I am greatly indebted to Dr. Shawn Riley, my advisor in many ways throughout my doctoral program. His professional guidance and collaborations were critical, but I have looked up even more to his example in balancing many roles as a scholar, wildlife management professional, public servant, and devoted family man. My other committee members, Dr. Carole Gibbs, Dr. Michael Schechter, and Dr. Scott Winterstein provided valuable support to this project as well. Thanks especially to Dr. Gibbs and Dr. Schechter for their guidance as I have sought to understand the relevance and application of my work in a broader context. I still have farther to go in this regard, but would not have made it as far as I have without their patience and willingness to share their knowledge and perspectives.

Many past and present colleagues at both Michigan State University and the Michigan Department of Natural Resources provided moral and logistical support at some point during my doctoral program. Thanks especially to Bret Muter, Dr. Meredith Gore, Dr. Ben Peyton, and Peter Bull (Michigan State University); Steve Beyer, Elaine Carlson, Dr. Dwayne Etter, Brian

Frawley, Ashley Hippler, Lisa Jackson, Dr. Pat Lederle, Dr. Dave Luukkonen, Dr. Russ Mason, Glen Matthews, Dr. Dan O'Brien, Doug Reeves, Dr. Steve Schmitt, Mike Wegan, (Wildlife Division); and Debra Christensen, Tom Courchaine, Creig Grey, and Dan Hopkins (Law Enforcement Division). In particular, my Rose Lake Research Center Colleagues provided valuable pushes across the finish line, and Dr. Pat Lederle convinced me at the outset that I could succeed in the graduate program while continuing to function effectively as a full-time employee with Wildlife Division. I am grateful for that, though I am not convinced he was right.

All of my family has been remarkably tolerant of my many diversions over the years. Thanks especially to Lia and Tess for supporting their dad's efforts to be inquisitive and engaged in many facets of life. Their best interests have been more important than any of my work over these years, but I also hope their interests were served by learning to work as a family to support each other in pursuit of our goals. Finally, words cannot express my gratitude and love for Niki Jo, for absolutely everything.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

KEY TO ABBREVIATIONS

bTB	Bovine Tuberculosis
DMU	Deer Management Unit
LED	Michigan Department of Natural Resources Law Enforcement Division
MDARD	Michigan Department of Agriculture and Rural Development
MDNR	Michigan Department of Natural Resources
NELP	Northeast Lower Peninsula of Michigan
NREPA	Natural Resources and Environmental Protection Act (Act 451)
NRC	Natural Resources Commission
RSS	Michigan Department of Natural Resources Retail Sales System
WLD	Michigan Department of Natural Resources Wildlife Division

INTRODUCTION

Wildlife population management in North America is primarily carried out by state government agencies vested with the authority to adopt scientifically based regulations to control consumption of wildlife through recreational hunting or trapping (Geist et al. 2001, Jacobson and Decker 2006). Under the public trust doctrine that developed out of North American case law, wildlife is to be managed for the benefit of all people (Bean 1983). Natural resource agency personnel serve as trust managers, bearing the responsibility for enforcement and providing technical expertise to inform adoption of regulations, while elected and appointed officials are accountable as the trustees of public wildlife resources, holding direct authority for enacting laws and regulations (Morse 1973, Horner 2000, Smith 2011).

This framework of authority and responsibility was developed in the late nineteenth and early twentieth century at a time of unregulated wildlife harvest and habitat destruction by a growing human population. The dramatic decline in quantity and quality of wildlife and other natural resources resembled the escalation of exploitation observed in many other public property contexts. Reflection upon these trends led to formalization of the "tragedy of the commons" concept (Hardin 1968). Theorists and management systems devised based on this vein of thought presume the human tendency to pursue personal gains will inevitably drive public property resources towards overexploitation, unless regulation is implemented and enforced with sufficient deterrence to ensure compliance (Hønneland 1998). A dominant view of science as certain and precise, and natural systems as ordered around cause-and-effect relationships, led to a tendency to rely upon scientific insight to provide suitable guidance to formulate these needed regulations (Knight and Meffe 1997).

In the decades following establishment of these regulations and institutions, many game populations recovered, leading some to characterize these arrangements as a successful "Model of North American Wildlife Management" (Geist et al. 2001). More recently, political conflict regarding wildlife management has been perceived to be increasing, leading to calls for institutional changes (Peyton 2000, Nie 2004, Jacobson and Decker 2008, Jacobson et al. 2010). It is unclear, however, if any such rising conflict is simply a reflection of declining trust and growing dissatisfaction with political systems (Levi and Stoker 2000) or is unique to wildlife management. Amidst this uncertainty, modern state wildlife agencies face three significant challenges as they attempt to meet their public trust responsibilities by adopting regulations and applying deterrence-based approaches to achieve adequate compliance. These include financial limitations, reduced management capacity due to overlooking alternative means of influence, and constraints from disregarding the different needs of enhancing rather than restricting harvest. As such, it is important to understand what drives compliance and assess approaches designed to increase it.

Regulatory compliance may be determined by instrumental models of behavior, normative models of behavior, or both (Meares 2000, Winter and May 2001, Tyler 2003). Instrumental models focus on "rational calculations of utility," a decision process in which individuals balance deterrence based on their perceived risk of being caught and expected severity of sanctions with their perceived potential for personal gains (Winter and May 2001). Deterrence-based approaches to attempting to achieve adequate compliance with regulations thus require substantial commitment of resources to maintain sufficient deterrence (Burby and Paterson 1993, Meares 2000). This challenge is often particularly pronounced when it comes to

enforcement pertaining to natural resource violations (Sutinen and Kuperan 1999, Sherblom et al. 2002, Falcone 2004).

Normative models of human behavior may offer alternative or complementary means to gain compliance. Normative models focus on an internal sense of duty arising from moral obligation, social norms, and assessment of the way in which agencies exercise their authority and the consequent responsibility to comply (Tyler 1990, Levi and Stoker 2000, Meares 2000, Winter and May 2001, Tyler 2003). Nearly exclusive dependence on deterrence disregards an expanded understanding of these factors that have been shown to influence human behavior (Tyler 1990, Hausman and McPherson 1993). Research in contexts as diverse as police agencies (Sunshine and Tyler 2003), federal law making (Tyler 1994), tax payment (Murphy 2005), and environmental regulations (Winter and May 2001) have found an important influence of normative factors on compliance.

Though sustaining compliance with restrictive regulations was the primary management need for protection of scarce or declining populations, many key wildlife challenges now require reducing abundant populations, which necessitates a different approach dependent upon hunter cooperation (Ankney 1996, Geist et al. 2001, Côté et al. 2004). Cooperation involves individuals taking actions beyond strict compliance in an effort to assist in achieving intended management outcomes of the regulatory agency. Reducing abundant deer populations, for example, requires harvest of a sufficient number of female deer (identified for hunting purposes as antlerless deer), often exceeding basic hunter demand (Brown et al. 2000, Giles and Findlay 2004). Thus, hunters may comply with all regulations but still not cooperate with objectives to manage deer populations if they make no effort to aid in reaching desired antlerless harvest levels. Enforcement can be an important influence on compliance behavior (Kuperan and Sutinen 1998,

Hilborn et al. 2006), but does not influence cooperation. Normative influence through moral obligation, social norms, and trust of agencies can affect both tendency to comply and tendency of cooperation (Sunshine and Tyler 2003).

A pertinent case study for examining the modern challenges faced by wildlife management agencies is offered through the experience of the Michigan Department of Natural Resources (MDNR) over more than 15 years of efforts to eradicate a self-sustained infection of bovine tuberculosis (bTB) within free-ranging white-tailed deer. In 1975, MDNR documented what was believed to be an isolated bTB-positive white-tailed deer in Michigan's Northeast Lower Peninsula (NELP; Figure 1). Following discovery of a second infected deer in 1994 approximately 13 km from the initial location, subsequent surveillance revealed these cases were located near the center of an area of an endemic bTB infection in white-tailed deer (*Odocoileus virginianus*), the first documented instance in North America (Schmitt et al. 1997). The disease and associated management efforts have had broad economic, cultural and political ramifications for the state (O'Brien et al. 2006). Thus far, deer are the only free-ranging wildlife species acting as a reservoir host (O'Brien et al. 2011a). Management of the overall impacts of bTB therefore depends on intervention through deer management practices.

High population densities and localized concentrations created by uneven distribution of deer are conditions that enhance the probability of disease becoming established and increasing in prevalence (Wobeser 2002). Initial bTB control strategies included implementation of liberalized harvest regulations (to substantially reduce deer densities) and a ban on feeding and baiting (to reduce aggregation of deer; Rudolph et al. 2006). These strategies apparently constrained the outbreak but did not appear sufficient to eliminate the infection, and controversy

around their implementation raised concerns over potentially growing distrust in MDNR (Hickling 2002, O'Brien et al. 2002, O'Brien et al. 2006, Rudolph et al. 2006).

The proportion of deer hunters that used bait in Michigan increased from <30% to nearly 50% over several decades prior to establishment of baiting regulations, and MDNR Law Enforcement Division (LED) staff noted regular violations after restrictions were established (Frawley 2000, Rudolph et al. 2006). Financial constraints on the ability to create sufficient deterrence were apparent. Enforcement of these rules faced many obstacles characteristic of natural resource violations, including the difficulty of patrolling and detecting violations in remote locations, low ratios of conservation officers per resource user, and low fines relative to the average individuals' investment in deer hunting (Sutinen and Kuperan 1999, Sherblom et al. 2002, Falcone 2004, Leonard 2004, O'Brien et al. 2011b).

Following establishment of liberalized harvest regulations, estimates generated through sex-age-kill modeling (Mattson and Moritz 2008) indicated the deer population in the bTB area declined through 2004, but that abundance then increased to an intermediate level between the 15-year minimum and maximum (O'Brien et al. 2011a). Apparent prevalence of bTB also initially declined and then stabilized short of eradication, indicating management was hampered by the challenges of seeking to maximize rather than restrict recreational harvest through regulations (Giles and Findlay 2004, Van Deelen et al. 2006, O'Brien et al. 2001a). Documented public opposition to further reductions of deer populations (Dorn and Mertig 2005) and the continued illegal use of bait at a sufficiently high level to attract public attention (Gwizdz 2004) created a need to broaden the management approach from simple adoption of regulations and application of deterrence to better understand hunter decisions regarding both compliance and cooperation with bTB management efforts (Rudolph et al. 2006, O'Brien et al. 2011b).

An abundance of research was conducted subsequent to discovering the bTB outbreak to evaluate whether the management interventions were appropriately targeting disruption of the disease dynamics (Rudolph et al. 2006). Research indicated *Mycobacterium bovis* (the bacteria that causes bTB) may survive on feed and bait 7–100+ days (much longer than previously thought), and indirect deer-to-deer transmission of bTB through use of shared bait or feed materials was documented under controlled conditions (Palmer et al. 2004, Palmer and Whipple 2006). Studies in Michigan indicated deer-to-deer encounter rates were higher at baiting locations, and locations of bTB positive deer were correlated with the presence of feeding operations identified through aerial surveys (Garner 2001, Hickling 2002). Surveys also indicated the potential reduction of hunter participation and/or efficiency due to a baiting ban was not of sufficient concern to offset the need to reduce direct and indirect bTB transmission (Frawley 2002a, b; Rudolph et al. 2006). However, noncompliance limited the effectiveness of the baiting ban at reducing bTB transmission. Research had not been conducted to estimate the rate of violation, nor to assess opportunities to improve compliance with the ban and cooperation with deer population reduction (O'Brien et al. 2011b). Such research was identified as necessary for wildlife trust managers to continue to provide the best possible technical guidance to Michigan's wildlife trustees for formulation of appropriate bTB eradication strategies. This study was therefore initiated with the following objectives:

1. Estimate the rate of violation with baiting regulations.
2. Characterize the extent to which enforcement, expected personal gains, and normative factors were associated with past decisions to comply with baiting regulations.
3. Characterize the extent to which expected personal gains and normative factors were associated with past decisions to cooperate with reaching harvest objectives.

4. Evaluate judgments associated with hunter trust in MDNR.
5. Identify alternative regulatory and enforcement approaches that may be expected to improve compliance, cooperation, and trust.

A literature review was conducted to develop a conceptual model of factors demonstrated to influence individual decisions regarding compliance and cooperation in a variety of regulatory contexts (Figure 2). This conceptual model was then compared to insights and data from the natural resources literature and Michigan's experience with bTB eradication efforts to identify those factors most likely relevant to wildlife management and this specific case study. This facilitated a theory-based approach to applied research for evaluating the association of factors to hunter compliance and cooperation specifically with bTB management interventions, and placed these findings in context with prior research and theory.

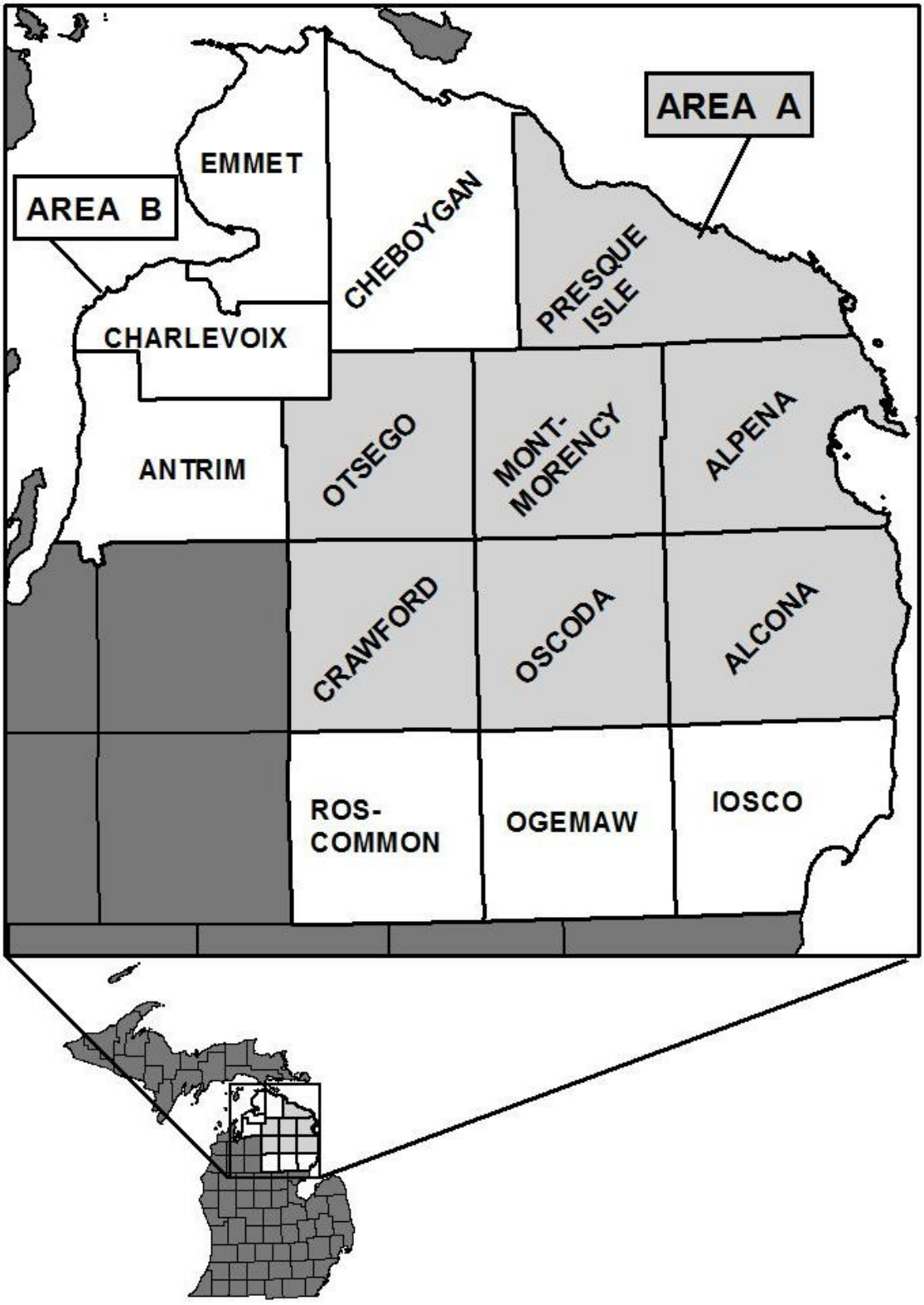

Figure 1. Map of counties composing the Northeast Lower Peninsula (NELP) of Michigan. The 7-county Area "A" designates the area that has received greater management attention due to a higher rate of infection of bovine tuberculosis among deer.

LITERATURE REVIEW: EFFECTS OF DETERRENCE, PERSONAL GAINS, AND NORMATIVE INFLUENCES

The broadest categories of factors thought to influence compliance and cooperation include the perceived costs of deterrence, the perceived benefits of personal gains, and normative influence from factors that create an internal sense of duty to behave in particular ways (Tyler 1990, Meares 2000, Winter and May 2001, Tyler 2003). Components of these factors, plus conditions such as knowledge of the regulations and capacity to comply (Franck 1990, Burby and Paterson 1993, Winter and May 2001) that may moderate their influence, are described below. A conceptual arrangement of these factors is portrayed in Figure 2.

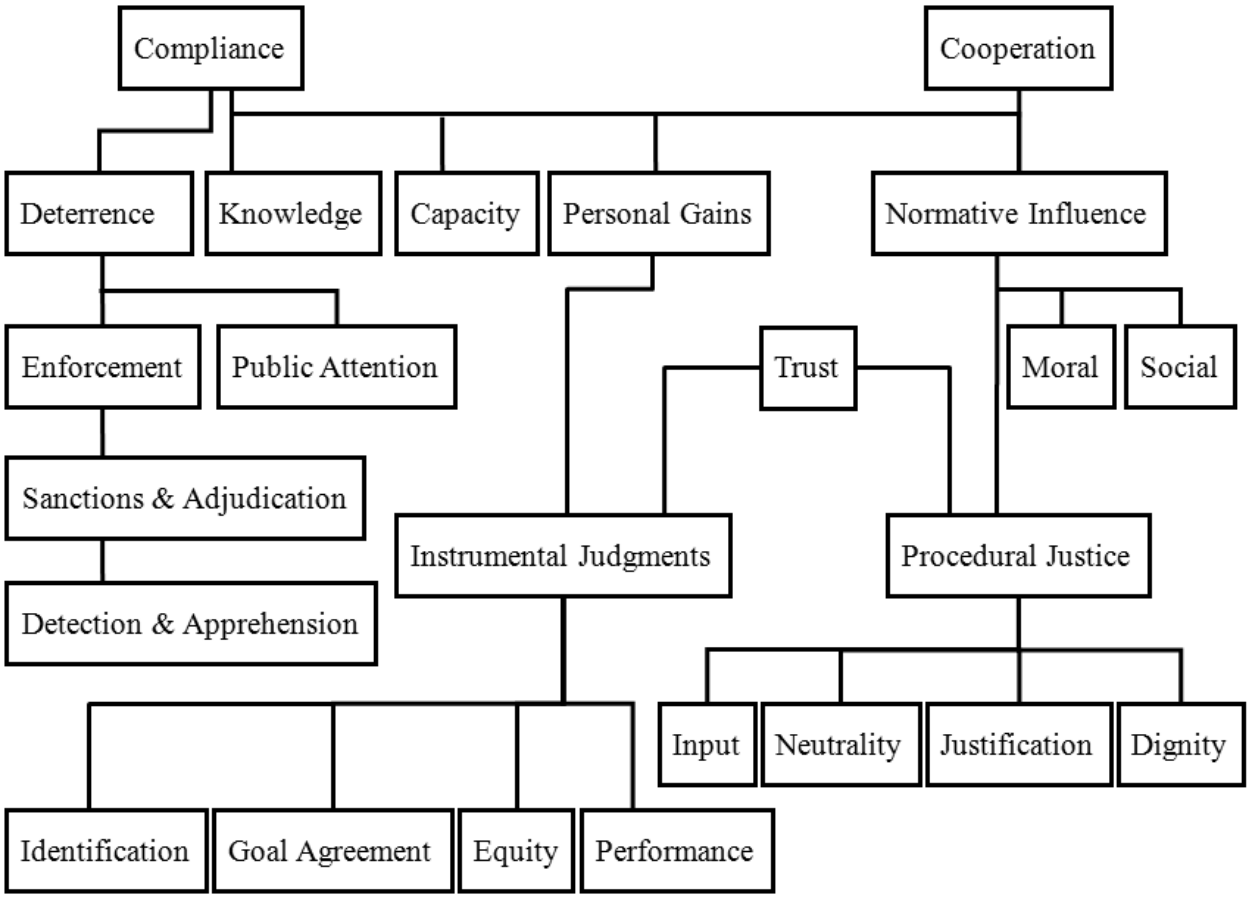

Figure 2. Conceptual model of factors influencing individual decisions regarding compliance and cooperation.

Instrumental Compliance

Under an instrumental approach to attempting to achieve compliance, tendency to comply is presumed to be decreased by the influence of individuals' perceived personal gains from illegal behavior, and deterrence is applied to increase tendency to comply and offset that influence (Winter and May 2001). Deterrence typically occurs through enforcement, which requires creating a credible threat of punishment (Burby and Paterson 1993, Leader-Williams and Milner-Gulland 1993, Meares, 2000). Detection and apprehension is one element of enforcement, incorporating the likelihood that those that violate are discovered and caught by enforcement officers. Another element is sanctions and adjudication, which includes the penalties that may be applied and the likelihood that those penalties will be applied by enforcement officers and judicially upheld for those that appeal. Sanctions may include fines, imprisonment, loss of privileges (e.g., future hunting opportunities) or loss of equipment used for violations (e.g., hunting equipment or vehicles). Deterrence may also be applied when agencies bring unwanted public attention on violators by publicizing documented illegal acts or the detrimental impacts of these acts (May 2005). Figure 2 thus identifies public attention and enforcement as separate contributors to deterrence, with sanctions and adjudication plus detection and apprehension as 2 components of enforcement.

Some personal gains may increase tendency to comply. Individuals may evaluate whether authorities are providing personal gains by working to protect what they view as their own interests through factors that may be collectively categorized as instrumental judgments (Levi and Stoker 2000). Factors associated with instrumental judgments are characteristics of regulators or the regulations themselves, including goal agreement, identification, equity, and performance (Braithwaite 1995, Tyler 2000, Murphy et al. 2009, Sunshine and Tyler 2003).

Goal agreement occurs when regulators and regulatees desire the same ultimate outcomes or means of achieving them. Individuals may assess rules and laws themselves and voluntarily comply with those that are consistent with their own moral values or that dictate behavior in which they already plan to engage (Braithwaite 1995, Murphy et al. 2009). Apart from judging whether behaviors required by rules and laws are deemed appropriate, individuals may also share the goal intended to be reached through the means dictated by laws and regulations (Braithwaite 1995). Distinct from either a shared commitment to goals or means of achieving them, identification is the result of social bonds shared between regulators and regulatees that may contribute to voluntary compliance (Braithwaite 1995, Tyler 2000).

Equity, sometimes called distributive justice, may affect compliance based on individuals' assessment of outcomes or distribution of services or management attention. Equity may increase compliance when authorities are perceived to deliver outcomes either equally or proportional to the need of individuals or groups, allocating resources in what is perceived to be a fair manner (Tyler 2000, Sunshine and Tyler 2003). In addition to judging allocation of resources, overall performance may affect behavior when regulatees perceive the agency to be effective at producing valuable outcomes (Sunshine and Tyler 2003). Figure 2 thus indicates that identification, goal agreement, performance, and equity all contribute to instrumental judgments that can result in personal gains influencing tendency to comply.

Several additional factors may moderate the influence of deterrence and personal gains on tendency to comply. If regulations are complex or compliance requires specific effort or expense (e.g., environmental regulations that require sophisticated monitoring or equipment for storing waste or treating discharge), sufficient capacity (e.g., financial resources or technical capability) to meet the standards of compliance may be important (Burby and Paterson 1993).

Finally, individuals must be aware of rules and possess knowledge of what the rules require to be able to knowingly comply (Franck 1990, Winter and May 2001). Knowledge and capacity are therefore indicated on Figure 2 as potential factors influencing compliance.

Individuals' tendency for compliance may therefore be determined in part by a rational calculation of utility (Winter and May 2001). Through this calculation, individuals with sufficient knowledge of the regulations and the characteristics, goals and actions of regulators weigh the likely costs of deterrence (incorporating both the perceived cost and likelihood of facing sanctions) plus an assessment of their capacity relative to costs of compliance and instrumental judgments of personal gains from compliance against the expected personal gains from knowingly engaging in illegal activities. An individual then weighs the perceived net benefits of violating relative to their existing level of wealth (Hatcher et al. 2000). Given the nature of this calculation, Tyler (2003) noted "the psychological or subjective estimates of risk are the key to people's behavior, not the objective risk" (Tyler 2003:303).

Instrumental Compliance in Natural Resources and Wildlife Management

Research has generally shown that, among the components of instrumental influence on compliance, the perceived risk of detection and apprehension is more important than the perceived severity of sanctions and adjudication (Burby and Paterson 1993). Tyler (2003) indicated this is unfortunate from a policy perspective, for improving detection and apprehension is generally a more difficult task than applying more severe penalties. These challenges are particularly pronounced when enforcing hunting regulations. Ratios of conservation officers per resource user are often lower than in many other enforcement situations, patrolling and detecting violations is complicated by the need to occur in often remote locations, and public resistance and legal challenges to the use of aggressive enforcement techniques that can offset these

challenges (such as using decoys to prompt efforts at illegal take in settings under which they may be reliably observed) have grown in recent years (Sutinen and Kuperan 1999, Sherblom et al. 2002, Falcone 2004).

Many challenges to applying effective deterrence are similar between fishing and hunting violations. The difficulty of enforcing compliance with commercial fishing regulations is considered an important factor affecting the ability to produce a desired harvest, or accurately anticipate harvest under alternative regulations (Anderson and Lee 1986). The value of research regarding effective regulation of harvest became recognized as these difficulties and the dramatic collapse of several regulated commercial fish stocks became apparent (Ludwig et al. 1993). An important factor driving commercial harvest decisions are the often strong economic incentives to violate (Kuperan and Sutinen 1998). In their evaluation of compliance with fishery regulations under the European Community's common fisheries policy in the United Kingdom, Hatcher et al. (2000) observed that the majority of study participants indicated that noncompliance was "wrong but an economic necessity" (459). Such strong economic incentives do not regularly apply to the motivations surrounding modern recreational harvest of North American wildlife.

Illegal harvest has been recognized for some time as an insufficiently addressed wildlife management issue (Beattie et al. 1977, Wright 1980, Eliason 2003), but the most critical needs for examining the effective application of enforcement to deter illegal wildlife harvest is primarily believed to exist in developing nations, such as conservation of African big game (Leader-Williams and Milner-Gulland 1993, Hilborn et al. 2006). The devastation of North American wildlife populations in the nineteenth century was driven by pursuit of personal gains through market hunting and for a cheap source of pre-industrial era food (Geist et al. 2001). Commercial trade in wildlife is now highly restricted in North America (Geist 1998), and other

food sources are readily available, including through social welfare programs for those in need (Eliason 2004). The demand for game meat has thus been dramatically reduced to a level largely accommodated by the level of sustainable harvest allowable under hunting and trapping regulations. Illegal harvest is generally not considered a serious threat to the sustainability of wildlife populations, but indications of emerging lucrative markets for game animal parts has led some to conclude the relationship between the wildlife trade and poaching in North America requires more attention (Musgrave et al. 1993). Prior research regarding compliance with North American hunting regulations has largely assessed poaching or other violation events as a cultural phenomenon or in terms of personal motivations or rationalizations (Brymer 1991, Muth and Bowe 1998, Eliason 2004).

Though widespread concern with the impacts of noncompliance on the ability to regulate overall take of game may not exist among North American wildlife managers, many states have encountered controversy as they have enacted regulations restricting the use of bait by deer hunters (Beauchaine 2000). In addition to the experience in Michigan, controversy and noncompliance with baiting regulations in neighboring Minnesota and Wisconsin, for example, suggest this may represent an instance of serious inability to regulate hunter behavior (Heberlein 2004, Van Deelen et al. 2006, Myers 2008). This difficulty of controlling baiting limits agencies' abilities to respond to the escalating spread of wildlife disease that is an increasingly common focus of wildlife management efforts (Dechen Quinn et al. 2012), but is also symptomatic of the general challenges of controlling hunter behavior, which is a significant obstacle to the overall effectiveness of the predominantly regulatory approach to wildlife management. An examination of how components of instrumental influence affect compliance behavior would help direct enforcement resources toward the best possible means of addressing this challenge.

An Expanded View of Behavior: Assessing Cooperation and Normative Influence

Normative models presume human behavior is influenced by an internal sense of duty to comply and cooperate arising from moral obligation, social norms, or trust in agencies (Tyler 1990, Levi and Stoker 2000, Meares 2000, Winter and May 2001, Tyler 2003). Moral norms create a sense of obligation to do "the right thing" or avoid guilt and shame that would occur from behaving against one's internalized values (Grasmick and Bursik 1990, Grasmick et al. 1991). Social norms create a sense of obligation to behave in a way deemed acceptable by people whose views are considered important to avoid embarrassment or a loss of respect (Grasmick and Bursik 1990, Grasmick et al. 1991). Trust has been conceptualized and measured in a variety of ways, but the influence arises from an individuals' obligation to obey or otherwise support agencies they view as appropriately exercising their power (Levi and Stoker 2000, Tyler 2003).

Deterrence only may affect behaviors that are explicitly dictated (or prohibited) by laws and regulations through enhancing tendency to comply. Normative influence, instrumental judgments, knowledge, and capacity may influence both tendency to comply and cooperate (Burby and Patterson 1993, Levi and Stoker 2000, Winter and May 2001, Sunshine and Tyler 2003), as indicated in Figure 2. These factors should be of interest to regulatory agencies, for they may influence behaviors that could extend beyond minimum standards of compliance to provide additional assistance in achieving management outcomes desired by the agency. The influence of trust occurs through assessments of the appropriateness of an agency's use of power through the processes and policies that guide setting and enforcement of regulations − aspects that may contribute to what is termed procedural justice. Agencies may consciously choose to address factors influencing procedural justice, which has led to suggestions that enhancing

procedural justice offers a promising approach to ultimately improving effectiveness of police and government agencies (Meares 2000, Tyler 2000, Blader and Tyler 2003).

Procedural Justice

Several specific factors of processes and policies used to guide decisions have been shown to contribute to views of procedural justice, which builds trust by conveying that authority is exercised according to fair processes (Tyler and Lind 1992, Paternoster et al. 1997, Tyler 2000). Procedural justice has an important normative influence on compliance and cooperation (Tyler 1994, Winter and May 2001, Sunshine and Tyler 2003, Murphy 2005). Tyler (2000) identified the components of procedural justice as consisting of participation (or input), neutrality, trustworthiness of authorities, and treatment with dignity and respect, though trustworthiness was identified as primarily being influenced by justification of decisions. A review of important characteristics of fair procedures conducted by Paternoster et al. (1997) identified 6 very similar elements of procedural justice as those provided by Tyler (2000), though different names were applied to these components, including representation, consistency and impartiality, accuracy, and ethicality (equivalent to participation, neutrality, trustworthiness, and dignity, respectively). An additional component of correctability was identified by Paternoster et al. (1997), which is an opportunity to appeal decisions to higher-level authorities. Input, neutrality, justification, and dignity are identified on Figure 2 as contributing to procedural justice, which may exert normative influence on compliance and cooperation.

Procedural justice may consist of both "formal" and "informal" elements that contribute to evaluations of fairness of processes. Formal components include established rules and policies guiding how decisions are made and influencing how individuals are treated, while informal components include the ways in which specific individuals of authority make decisions and treat

individuals, which can involve applying discretion and departing from strict dictates of laws and regulations (Scholz 1984, Blader and Tyler 2003). Although these formal and informal components involve different experiences through which individuals may gain perspectives shaping evaluations of authorities, repeated research regarding perceptions of fairness have shown the same type of justice judgments of input, neutrality, justification, and dignity occur through experiences with formal processes and informal interactions (Tyler and Lind 1992, Tyler 2000).

Participation opportunities vary depending on the decision-making context. Participation in a regulatory setting is judged by individuals based on the opportunity for those affected to provide input during establishment of laws or development of regulations and enforcement approaches (Tyler 2000). Formal elements include laws and policies that dictate opportunities for input during the process through which regulations are established. Informal elements include whether individual authorities provide opportunities for input, such as whether regulators or advisors to the process make themselves available to meet informally, or whether officers provide the chance for individuals to speak on their behalf during enforcement encounters.

Neutrality is judged based on perceptions that authorities are not overly influenced by their own biases and personal values (Tyler and Lind 1992, Tyler 2000). Judgments of neutrality are based upon whether impartial rules for making decisions exist and are followed, and assessments of whether factual, objective decisions are made. This factual basis can be incorporated by demonstrating that scientific findings and technical expertise are integrated within the consideration of alternative regulations (Stryker 1994, Tyler 2006). As science has come to play a greater role in shaping law, particularly in the US and western Europe (Stryker

1989), it may have begun to represent an alternative to application of impartial legal rules rather than an additional means of demonstrating neutrality (Stryker 1994).

Justification of authorities' final decisions when developing or enforcing regulations is a key component to building perceptions of trustworthiness (Tyler 2000). Justification may be based on both an explanation of how alternative arguments or options were considered (Tyler 1990) and whether the final option was selected based on shared beliefs regarding what laws and regulations are likely to accomplish (Beetham 1991, Tyler 2000). Neutrality is based largely on formal elements − the existence of rules and need for an underlying factual basis to guide decisions − whereas justification can be based on both formal practices of reporting on final decisions and informal components through the judgments of beliefs of specific decision-makers (Tyler 2000).

Dignity relates to perceptions of treatment with dignity and respect as individuals and members of society (Tyler 2000). Dignity is an informal component of procedural justice, as perceptions are primarily gained during direct interaction with authorities (Paternoster et al. 1997). Because it is based on individual treatment with basic politeness, it can be extended to all individuals with whom authorities interact (Tyler 2000).

Cooperation and Normative Influence in Natural Resources and Wildlife Management

Much of wildlife management is intended to be accomplished through enacting and enforcing laws and regulations (Morse 1973, Smith 2011). However, Aldo Leopold identified the importance of considering the influence of internalized norms when he wrote that a hunter's behavior is "dictated by his own conscience… It is difficult to exaggerate the importance of this fact" (Leopold 1966: 212). Enforcement is also unable to contribute to hunter tendency towards cooperation. In the context of deer management, hunters may comply with all regulations but

still not cooperate with objectives to manage deer populations if they make no effort to aid in reaching desired antlerless harvest levels.

As wildlife management agency missions have changed and the scope of issues they are required to address have expanded, instrumental judgments of agencies and regulations have likely reduced opportunities to achieve adequate cooperation. Many initially formulated state departments of *game* have been redefined as more broadly oriented state departments of *natural resources* (Falcone 2004). This has occurred as natural resource agency organic acts, or laws which create agencies and define how authority is delegated to departments (Fischman 2003), have come to mandate the conservation and protection of natural resources overall, beyond the initial narrow focus of committing agencies to providing for the use and enjoyment of wildlife resources through regulated hunting and trapping. Management objectives often now require reduction of wildlife populations that may grow to levels of abundance capable of degrading habitat, rather than being directed at protection of scarce or declining populations (Ankney 1996, Brown et al. 2000, Côté et al. 2004). Objectives requiring reduction of wildlife population densities in order to respond to or reduce the risk of zoonotic disease outbreaks, such as the 1998 Governor's Executive Directive (Engler 1998) that mandated all appropriate Michigan agencies to pursue eradication of bTB from Michigan, are also growing more common (Dechen Quinn et al. 2012).

Holsman (2000) concluded it may be unrealistic to expect that any significant proportion of hunters will act in ways contributing to stewardship of diverse natural resources, or that "stewardship is at least situational for hunters who may be willing to act as stewards if the sacrifices to individual benefits are not too high" (813–814). Michigan hunters do support considering a variety of factors when managing deer populations through hunting regulations

(including impacts of deer browsing on vegetation and the health of the deer population), but hunter dissatisfaction due to perceptions of too few deer is considered the most pressing problem in need of being addressed (Frawley and Rudolph 2008). Holsman and Petchenik (2006) concluded that agency efforts to influence hunter determination to take deer, even through experimentation with financial rewards and incentives, are almost entirely ineffective. Van Deelen et al. (2006) observed that implementation of expanded antlerless harvest quotas and lengthened hunting seasons is received by hunters as a novelty that generally only increases harvest levels for a limited time, and Giles and Findlay (2004) demonstrated that recreational harvest regulations are effective at restricting, but not maximizing, harvest levels. It appears that hunters do not judge personal gains through potential rewards and expanded harvest opportunities as sufficient to engender cooperation with meeting population reduction objectives. These insights suggest that instrumental judgments may reduce tendency of cooperation through lack of goal agreement (Braithwaite 1995, Murphy et al. 2009) or negative performance evaluations (Sunshine and Tyler 2003) regarding MDNR ability to continue to provide for the use and enjoyment of deer through maintaining suitable deer densities for satisfactory hunting experiences.

Changes over time in instrumental judgments regarding identification may have also reduced cooperation. Adoption of the initial laws and policies formulating wildlife management agencies and legal authorities were not only intended to conserve populations of game to be pursued by hunters and trappers, but were led by prominent sportsmen such as Theodore Roosevelt (Geist 1988). Wildlife conservation professionals have become less likely to be hunters or trappers and more likely to believe the focus of wildlife management should be on

sustaining ecosystem biodiversity rather than on providing for harvest of game species (Muth et al. 2002).

Finally, equity judgments may have negatively affected tendency of compliance and cooperation with regulations implemented for bTB eradication. A subset of 7 counties within the NELP has received greater management attention through long-standing bans on baiting and aggressive deer population reduction efforts due to a higher rate of infection of bovine tuberculosis among deer in the area (Area "A," Figure 1). If bTB eradication in this area is not perceived as sufficiently important, unfavorable equity judgments regarding the proportionally higher management efforts to which the region has been subjected may decrease tendency to comply and cooperate (Tyler 2000, Sunshine and Tyler 2003).

Considering opportunities to enhance compliance and cooperation with wildlife management through normative influences, moral and social norms often provide the strongest motivations for compliance and cooperation (Tyler 1990, Kuperan and Sutinen 1998), but there are substantial constraints on agencies' abilities to shape adoption of these norms in an effort to influence behavior (Pierce et al. 2001).However, studies of procedural justice involving police agencies (Sunshine and Tyler 2003), federal law making (Tyler 1994), tax payment (Murphy 2005), and environmental regulations (Winter and May 2001) have found that the process through which these authorities are exercised exerts an independent and often more important influence on compliance and cooperation than the outcome individuals experience, such as whether or not they are arrested, see laws passed that are deemed unfavorable, or bear the expenses of taxes or fines (Tyler and Lind 1992). In contrast, the opportunity for considerable illegal financial gains has often appeared to result in violations of commercial fishing regulations being driven largely by instrumental factors (Kuperan and Sutinen 1998, Hatcher et al. 2000, Ali

and Abdullah 2010). However, most studies of commercial fishing systems have suggested at least some significance of normative factors, and in some cases these appear to be the primary influences on fishing compliance (Hønneland 1998, Hønneland 2000, Gezelius 2002). Procedural justice has been proposed to exert consistent influence on acceptance of laws and decisions because the most fair or optimal outcome may not always be obvious, and so defaulting instead to acceptance of outcomes reached through fair procedures may aid in maintaining positive relationships among groups and society as a whole, even where disagreement and conflicts of interest exist (Tyler and Lind 1992). The variability of findings regarding importance of procedural justice in different commercial fisheries may be due to differences in the ability to judge optimal outcomes, different values placed on preserving societal structures, or poor overall opinions of the regulatory system masking judgment of the influence of specific procedural elements (Hatcher et al. 2000).

Difficulties of managing deer populations through recreational harvest have received much attention as a critical topic for wildlife management (Woolf and Roseberry 1998, Brown et al. 2000, Harden et al. 2005). Experiences with efforts to manipulate white-tailed deer population abundance through recreational harvest have demonstrated that regulations are effective at restricting, but not maximizing, harvest levels (Giles and Findlay 2004, Van Deelen et al. 2006). However, no prior assessment has been conducted to explicitly evaluate the extent to which expected personal gains and normative factors are associated with decisions to cooperate with reaching deer harvest objectives.

Trust in Government

Trust in legal and political systems and its influence on citizens has received considerable attention within the social and political science literature in recent years (Levi and Stoker 2000,

Tyler 2006). Knowledge or assumptions regarding the goals, motivations, and means of reaching decisions is required to place trust in an individual or institution (Hardin 1998). The processes through which power is exercised have been identified as vital in building trust (Miller and Listhaug 1990, Beetham 1991). Instrumental judgments have also been identified as contributing to trust, although different approaches to evaluation of goal agreement suggest agency objectives may be assessed by individuals relative to their own best interests (Levi and Stoker 2000) or more generally relative to the best interests of society as opposed to simply serving the interests of those in power (Beetham 1991, Tyler and Huo 2002, Tyler 2003). Figure 2 thus indicates that all components of instrumental judgments and procedural justice that may influence compliance and cooperation may also contribute to trust.

There is widespread agreement regarding several necessary components for building trust in government, but differences of opinion exist as to the mechanisms through which trust may exert influence on compliance and cooperation (Braithwaite and Levi 1998; Levi and Stoker 2000; Tyler 2003, 2006). Trust may be an intermediate step between assessments of instrumental judgments and procedural justice and improved compliance and cooperation, or compliance and cooperation may result directly from these assessments. Furthermore, building trust may lead to other benefits, such as improved efficiency or broader support for governments or agencies (Braithwaite and Levi 1998, Levi and Stoker 2000). There is therefore a need to evaluate trust distinctly from its potential influence on compliance and cooperation behaviors.

The Influence of Trust in Natural Resources and Wildlife Management

Levi and Stoker (2000) identified trust as being important when individuals are "vulnerable to the actions of political authorities or institutions" (495). This is a basic characteristic of a trustee/beneficiary relationship such as that created under the public trust

doctrine that established the authorities and guides the responsibilities of state wildlife agencies (Bean 1983, Horner 2000, Smith 2011). Trust is therefore an important variable to measure and assess in relation to wildlife agency operations.

For wildlife management, a number of potential benefits of trust arising from more general support for agencies beyond enhanced compliance with hunting regulations and cooperation with population management objectives exist. One valuable outcome that has been demonstrated in some contexts is gaining public assistance with enforcement efforts, such as through reporting violations (Hooper and Fletcher 1989, Sunshine and Tyler 2003). Conflict could also be decreased during encounters with enforcement officers, thereby reducing the potential for altercations for those that already significant hazards on the job (Sherblom et al. 2002, Sunshine and Tyler 2003). Improving trust could increase hunter tendency to support license fee increases, which may be of vital importance to offset reduced resources as license fee revenue diminishes coincident with a trend of declining hunting participation (Hooper and Fletcher 1989, Wright et al. 2001, Jacobson and Decker 2006). Though past research on trust may suggest such benefits, along with enhanced compliance and cooperation, are likely results of enhancing trust (Braithwaite and Levi 1998; Levi and Stoker 2000; Tyler 2003, 2006), such outcomes have not been assessed for wildlife agencies. Furthermore, much prior work has examined factors influencing trust in political actors in general, rather than assessing trust in specific agencies with respect to specific problems (Levi and Stoker 2000).

Many functions of government around the world are evolving from expert-based authoritative models to instead function through a collaborative governance approach of sharing authority and resources, including through greater interaction with and responsiveness to the public (Rudolph et al. 2012). This evolution is occurring for a number of reasons, but one

motivation or possible outcome is the potential to increase trust in agencies and sustainability of management decisions. In North America, many suggestions to implement institutional change to address rising political conflict regarding wildlife management focus on efforts to expand engagement of stakeholders beyond the traditional hunting and trapping constituencies (Peyton 2000, Nie 2004, Jacobson and Decker 2008, Jacobson et al. 2010). Yet the regulation of hunting and trapping is a primary function of state wildlife agencies, these activities continue to represent the only feasible means of potentially managing wildlife populations at the landscape level, and relationships with these traditional constituencies are also subjected in an increasing number of instances to high levels of conflict and mistrust (Heberlein 2004, Rudolph et al. 2006). Given these considerations and the importance of the trustee/beneficiary relationship to effectively functioning wildlife management (Horner 2000, Smith 2011), an assessment of how instrumental judgments and procedural justice influence hunter trust of MDNR would provide valuable perspective on these important dynamics while advancing knowledge of how trust may be built for a specific agency with regard to use of authority in an effort to address a specific problem (Levi and Stoker 2000).

BOVINE TUBERCULOSIS IN MICHIGAN: A CASE STUDY FOR EVALUATING THE ROLE OF ENFORCEMENT, PERSONAL GAINS, AND NORMATIVE FACTORS IN WILDLIFE MANAGEMENT

Tuberculosis (TB) is a zoonotic disease, a category of diseases caused by infectious agents that can be transmitted between (or are shared by) animals and humans (Daszak et al. 2000). TB is one of the most globally widespread infectious diseases, and a leading cause of death among adults in the world (Pan American Health Organization 2001). *Mycobacterium tuberculosis* is the bacteria that most commonly causes human TB, but an unknown proportion of cases are due

to *M. bovis*. *M. bovis* affects the largest number of animals throughout the world, and is the infectious agent causing bTB. The human health threat related to Michigan's bTB infection in deer does raise concerns, but the opportunities for crossover infection of bTB from free-ranging deer to humans is unlikely. Crossover infection from deer to cattle does occur, and an annual mean of 3.5 Michigan livestock herds/year test positive for bTB (O'Brien et al. 2011a), but efforts at disease control, elimination of infected livestock, and milk pasteurization in the U.S. and other industrialized countries have effectively reduced the potential crossover from cattle to humans (Frye 1995, Cosivi et al. 1998, Palmer and Waters 2011).

Diagnosis and management of bTB infections in free-ranging populations is more complex than addressing infection of captive wildlife or domestic animals (de Lisle et al. 2002). The pertinent threats corresponding to potential source of infection related to deer acting as a reservoir of *M. bovis* are impacts to the state economy and wildlife management created through financial burdens of disease surveillance and management programs. Agriculture generates $63.7 billion as the second largest industry in Michigan, and the state cattle and calf inventory was recently valued at $1.42 billion, but heightened effort and expense related to livestock testing and movement controls affect the profitability and marketability of livestock operations (National Agricultural Statistics Service 2008, Palmer and Waters 2011). MDNR has expended more than $23 million and Michigan Department of Agriculture and Rural Development (MDARD) more than $63 million on bTB related activities (O'Brien et al. 2011a).

Michigan's Bovine Tuberculosis Management Area

Prior investigations of documented cases of bTB infections in free-ranging deer concluded these instances were isolated incidents, and researchers felt that bTB could not be sustained in wild populations (Clifton-Hadley and Wilesmith 1991). Recognition of the case in

Michigan suggested unique conditions must have been present to lead to development of a sustained infection in the area. The NELP is an approximately 21,000 km^2 area consisting of 14 counties (Figure 1). The NELP is a region characterized by diverse landforms (glaciated moraine ridges, ice-contact ridges, outwash plains, and lake plains), vegetation types, and climate providing habitat and environmental conditions of varying suitability for white-tailed deer (Albert 1995, Felix et al. 2007, Beyer et al. 2010). The core area of Michigan with the highest apparent prevalence (% of deer in surveillance program testing positive) of bTB in deer was incorporated into Deer Management Unit (DMU) 452, an area approximately 1,500 km^2 consisting of portions of Alcona, Alpena, Montmorency, and Oscoda counties. Deer are infected with bTB elsewhere in the state, but a spatial analysis identified rapidly declining prevalence levels radiating outward from this core of infection (Hickling 2002). The area of DMU 452 encompassed 78% of all bTB positive deer, and 98% of all bTB positive deer originated from just 7 of 14 NELP counties (Area A, Figure 1). Efforts at statewide bTB eradication depend upon considering conditions and characteristics within a small portion of the state.

The DMU 452 core area has been characterized as "club country" because much of the land consists of large private holdings owned primarily for use as deer hunting clubs. Land in DMU 452 is 93% privately owned, compared to 65% private ownership in the remainder of the NELP. Some of the earliest formed clubs were purchased in the 1880s as a means of restricting year-round commercial harvest that occurred at that time, and public recreational hunting access was eventually restricted as well (Bartlett 1938). Members of these clubs continued for many decades to protect female deer, provided large quantities of supplemental food resources throughout the winter to attempt to sustain maximum deer densities, and later adopted the practice of using bait to aid in taking deer. High population densities and localized

concentrations created by uneven distribution of deer are conditions that enhance the probability of disease becoming established and increasing in prevalence (Wobeser 2002). MDNR efforts to manage bTB were initiated under the assumptions that the high population densities sustained by the practices of these hunting clubs, along with enhanced local concentrations of deer at feeding and baiting locations, created the unique conditions necessary for an initial crossover bTB to become a self-sustained infection in free-ranging deer in the area. Research conducted subsequent to discovering this outbreak indicated *M. bovis* may survive on feed and bait 7–100+ days (much longer than previously thought), and indirect deer-to-deer transmission of bTB through use of shared bait or feed materials was documented under controlled conditions (Palmer et al. 2004, Palmer and Whipple 2006). Studies in Michigan indicated deer-to-deer encounter rates were higher at baiting locations, and locations of bTB positive deer were correlated with the presence of feeding operations identified through aerial surveys (Garner 2001, Hickling 2002). The MDNR therefore established dual control strategies of liberalized harvest regulations (to substantially reduce deer densities) and bans on feeding and baiting (to reduce congregation of deer; Rudolph et al. 2006). These regulations were repeatedly reconsidered through a process involving recommendations generated by wildlife biologists reviewed by a public commission with the authority to enact regulations.

Authority for Enacting Bovine Tuberculosis Management Interventions in Michigan

The Natural Resources and Environmental Protection Act (NREPA, or Act 451 of 1994) serves as the MDNR organic act (Fischman 2003), establishing the department and defining how authority is delegated to it. NREPA vests exclusive authority to regulate the taking of game, regulate the feeding of deer and elk, and establish policies related to natural resources management in the Natural Resources Commission (NRC), a 7-member panel appointed by the

governor with the advice and consent of the senate. NREPA indicates the NRC "shall, to the greatest extent practicable, utilize principles of sound scientific management in making decisions regarding the taking of game." The NRC is also required to take input from the public and provide notice to members of key natural resources, agriculture, tourism, and appropriations committees of the state legislature prior to enacting regulations. The Wildlife Division of MDNR (WLD) provides technical expertise regarding principles of scientific management and recommends hunting and trapping regulations for adoption by the NRC. A 1998 Governor's Executive Directive (Engler 1998) directed all appropriate Michigan agencies to pursue the objective of eradication of bTB from Michigan. WLD staff therefore generates recommendations regarding means for addressing conditions that continue to sustain bTB in white-tailed deer and the NRC weighs those recommendations and a variety of other considerations prior to enacting regulations.

Antlerless deer harvests in Michigan are primarily regulated through allocation of antlerless licenses through quotas pertaining to individual DMUs. Guided by the objective to reduce deer population densities in the bTB area, WLD staff recommended offering additional hunting opportunities through the creation of special firearm antlerless deer hunting seasons before and after the standard Michigan firearm deer hunting season, discounts to antlerless license prices, and liberalization of antlerless license quotas, available in unlimited numbers during some years in some DMUs. Most recommendations provided by WLD regarding liberalization of regulations to promote antlerless harvest and deer population reduction were implemented by the NRC. The most substantial increase in hunting opportunity occurred through regulatory changes between the 1997 and 1998 hunting seasons, resulting in the greatest number

of individuals purchasing antlerless deer licenses and highest harvest of antlerless deer in the NELP (Frawley 2002b).

Initial Assessment of Bovine Tuberculosis Management Interventions

Since the peak in hunting participation, deer hunter numbers in the NELP and across the state reflect a declining trend of approximately 1−2% per year (Frawley 2011). Data from the MDNR Retail Sales System (RSS) database indicate only 50−60% of NELP hunters purchase ≥1 antlerless license, only a slightly higher proportion than the statewide average despite these expanded opportunities. WLD estimates generated through sex-age-kill modeling (Mattson and Moritz 2008) indicate the deer population in the bTB area declined from the time these management interventions were implemented through 2004, but that abundance increased following that time to an intermediate level between the 15-year high and low (O'Brien et al. 2011a). Without greater cooperation for meeting antlerless harvest objectives among the declining number of NELP deer hunters, this bTB management strategy will not accomplish bTB eradication.

Supplemental feeding (providing large quantities of feed with intent to sustain elevated deer numbers through nutritional supplementation) continues to be permitted only in portions of Michigan's Upper Peninsula when measures of winter severity exceed average conditions. A ban on supplemental feeding throughout the Lower Peninsula was recommended by WLD and enacted and maintained by the NRC. Acceptance of this recommendation was likely facilitated by ability to demonstrate the relationship between distribution of feeding sites and bTB infected deer, as well as the visibly high local concentrations of deer at feed sites that were documented through photo documentation. Aerial surveillance also aided enforcement actions. Feeding appears to be substantially curtailed and not likely contributing to maintaining bTB infection.

Baiting is regulated to some extent throughout Michigan, but has never been banned throughout the state (Table 1). The NRC rejected or modified WLD recommendations regarding baiting regulations several times. The rejection of recommendations and repeated changes to baiting regulations have been based on concerns over balancing the potential role of bait in either helping or hindering the ability to meet bTB management objectives and a desire to avoid public opposition leading to political pressure to modify NREPA to remove NRC authority over baiting and feeding regulations (Rudolph et al. 2006).

Table 1. Annual restrictions on the quantity of bait allowed for use to hunt deer in Michigan, including a description of each area regulated, the size each area encompassed (in square kilometers), and the restriction on quantity of bait allowed.

Year	Area	Size	Restriction
1998	NELP east of I-75 and north of M-55	14,038	5 gal per hunting location
1999	NELP east of I-75 and north of M-55	14,038	Illegal to bait
1999	Remainder of Michigan	136,472	5 gal per hunting location
2000	Counties with bTB documented	16,662	Illegal to bait
2000	Remainder of the lower peninsula	90,314	2 gal per hunting location
2000	Upper peninsula	43,534	5 gal per hunting location
2001	Counties with bTB documented	16,432	Illegal to bait
2001	Deer Management Unit 452	1,480	1 gal per hunting location
2001	Remainder of the lower peninsula	90,543	2 gal per hunting location
2001	Upper peninsula	43,534	5 gal per hunting location
2002–2007	7-county area	10,867	Illegal to bait
2002–2007	Remainder of Michigan	139,643	2 gal per hunting location
2008–2010	Lower peninsula	92,023	Illegal to bait
2008–2010	Upper peninsula	43,534	2 gal per hunting location

After initially regulating baiting in 1998, regulations changed each year through 2001. Regulations were stabilized 2002–2007, with a ban implemented in the 7 counties of the NELP that contained 98% of documented bTB infected deer (Alcona, Alpena, Crawford, Montmorency, Oscoda, Otsego, and Presque Isle). Discovery of a single deer infected with Chronic Wasting Disease (CWD) inside a captive deer facility in August of 2008 led to a ban on baiting throughout the Lower Peninsula during the 2008–2010 deer seasons as part of a previously adopted CWD Response Plan.

Prior to establishment of baiting regulations, a majority of Michigan hunters approved of bait use by deer hunters, and nearly half of hunters used bait and believed it was an aid in taking deer (Frawley 2000). Additional research helped identify the role of bait in sustaining bTB infection and refuted its potential benefits to sustaining high hunter participation and effectiveness (Rudolph et al. 2006), but Michigan Department of Natural Resources Law Enforcement Division (LED) staff noted numerous baiting ban violations, and compliance was sufficiently poor to attract public attention (Gwizdz 2004). Despite efforts to regulate hunter behavior to stop baiting, implementation of this strategy in pursuit of the objective of bTB eradication did not appear entirely effective.

Prevalence of bTB was initially around 5% in DMU 452, and was projected to increase if successful intervention did not occur (McCarty and Miller 1998). Prevalence declined significantly but then stabilized coincident with implementation of the initial management interventions, prompting efforts to develop more focused controls such as vaccination of deer against bTB infection (O'Brien et al. 2011a). Despite the initial progress and exploration of additional control methods, managers believe eradication, if possible at all, will require decades, and improving hunter compliance with the baiting ban and cooperation with deer population

reduction efforts currently represent the only feasible means of improving progress towards the objective of bTB eradication (O'Brien et al. 2011b). As WLD staff fulfilled their role as public trust managers, advising the NRC as trustees of Michigan's public wildlife resources, much of the effort to improve technical guidance focused on reducing uncertainty regarding deer and bTB dynamics, rather than assessing how choices among different approaches to adopting and enforcing regulations might influence compliance and cooperation. This shortage of information available to predict the effectiveness of alternative regulations and enforcement policies is a common pattern in natural resource management (Anderson and Lee 1986, Ludwig et al. 1993), and one eventually identified by WLD as a key limitation.

METHODS

Conceptual Model Review

After conducting an initial literature review, a preliminary conceptual model of factors expected to contribute to compliance and cooperation was developed as a first draft of Figure 2. Input was sought from researchers, wildlife managers, and law enforcement personnel to refine the model and identify priority components for assessment. An overview was presented to the MDNR Bovine Tuberculosis Working Group, an interagency group composed of staff from WLD, LED, and MDARD, and to a joint meeting of staff from both LED Districts covering portions of the NELP. Input from experts outside of Michigan was sought at the Environmental Crime and Natural Resources Sustainability Conference held at Michigan State University, the Annual Conference of The Wildlife Society, an annual meeting of the Midwest Deer and Wild Turkey Study Group, and as a portion of the material for a plenary paper regarding management of bTB in free-ranging wildlife delivered to the 5th International *Mycobacterium bovis* Conference.

Interviews

In-depth semi-structured interviews were conducted with a selection of NELP hunters that had attended public meetings held for MDNR personnel to explain and solicit input on bTB management strategies. The interview questions and approach explored whether all data for final analyses should be collected via interviews or if it would be feasible to construct a mail survey questionnaire to efficiently reach a larger sample of hunters. Numerous variables and potential sources for gaining impressions of trust in the agency were identified during development of the initial conceptual model. All of these components could not be included on a questionnaire of practical length. Responses during the interviews were used to determine if an important subset of factors could be identified that could be addressed using a mail survey.

In addition to assessing whether an appropriate set of factors relevant to decisions regarding compliance, cooperation, and trust in the agency had been identified for evaluation, interview participants were selected based on their moderate level of engagement with MDNR in order to determine if their evaluations of trust were influenced by experiences interacting with particular personnel (e.g., the NRC, WLD biologists and Lansing area staff, LED Conservation Officers). Interview results indicated that these individuals did not have regular interactions with specific personnel, and did not consider any such personal interactions when evaluating regulations and policies, but rather viewed them as the outcome of joint efforts among all levels of agency bureaucracy. This was an indication that informal elements of procedural justice and knowledge of regulators that can contribute to instrumental judgments (Braithwaite 1995, Tyler 2000, Blader and Tyler 2003) appear to have little influence on compliance, cooperation, and trust regarding Michigan deer management, even for these individuals that had some personal experience interacting with MDNR staff. Considering that there had been an average of

>700,000 licensed Michigan deer hunters in recent years (Frawley 2011), compared to a statewide force of <200 commissioned LED Conservation Officers, approximately 40 WLD staff involved in establishing recommendations for deer hunting regulations, and 7 NRC members, the vast majority of deer hunters did not have opportunities for even this moderate level of interaction with specific personnel. It was determined there was no need to distinguish among different experiences and expectations based on interactions with various staff at these specific levels of agency operations. It was therefore possible to construct a mail survey to assess formal elements of procedural justice and to collectively address the informal elements rather than including questions specific to experiences with a variety of personnel.

Focused Conceptual Model

Insight offered by expert review of the conceptual model and from the hunter interviews helped guide formulation of a more focused conceptual model (Figure 3). Public attention, capacity, knowledge, identification, and dignity were all components from the initial conceptual model (Figure 2) that were not retained within the focused conceptual model. Background is provided below as to the specific reasons for electing to not evaluate these factors initially identified as potentially influencing compliance, cooperation, and trust.

MDNR had not attempted to draw public attention to baiting violations as an additional source of deterrence. After eliminating public attention from Figure 2, enforcement became the sole method of deterrence. Enforcement was thus elevated to the level below compliance and deterrence was removed when constructing Figure 3. Capacity was also removed, as no resources were required of hunters to simply not use bait. Given the simplicity of the ban, basic awareness of regulation would be sufficient. Knowledge was therefore removed from the focused conceptual model, though responses regarding past baiting practices included the

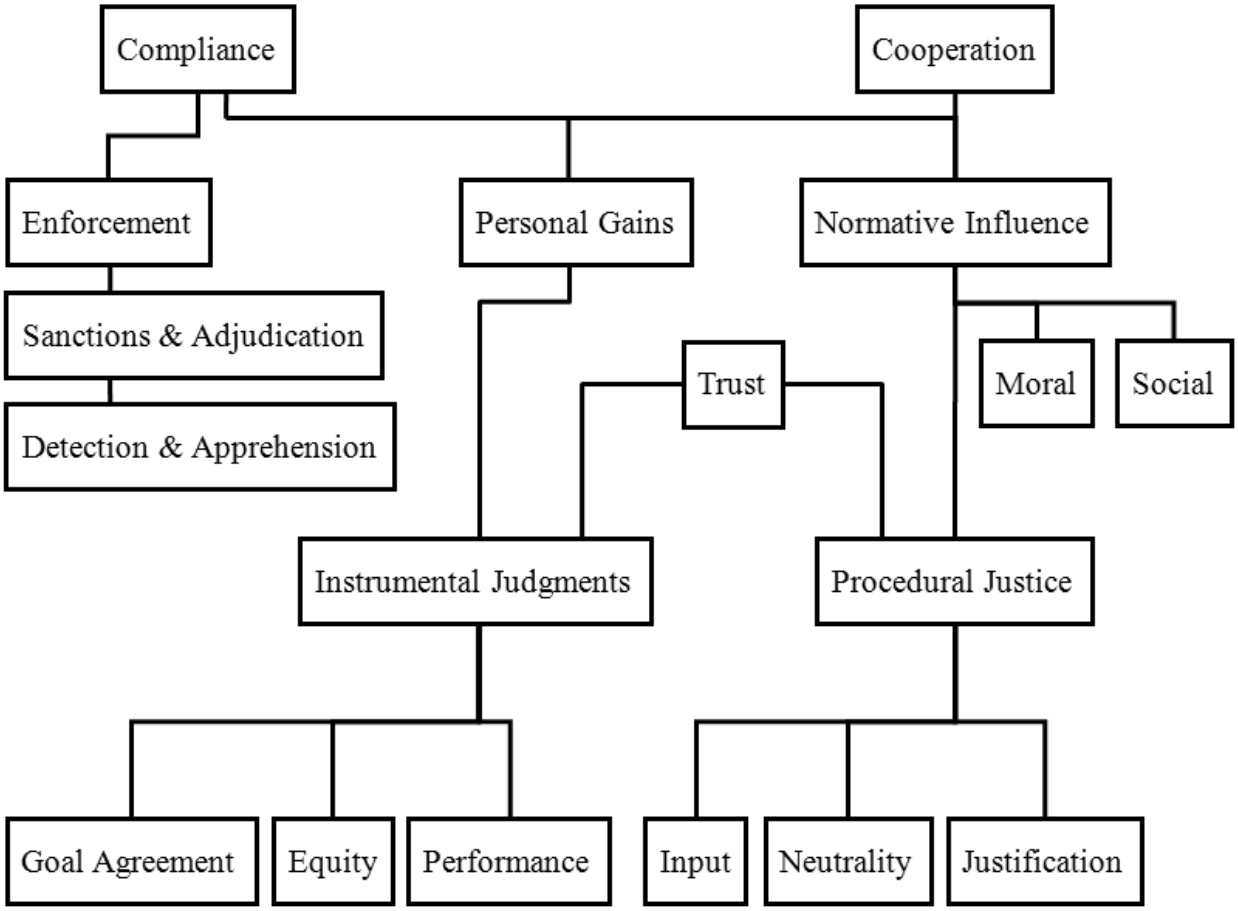

Figure 3. Focused conceptual model of factors influencing individual decisions regarding compliance and cooperation used to guide questionnaire development and analyses.

opportunity for individuals to indicate they may have illegally used bait in the past without realizing they were in violation of the regulations, and knowledge of sanctions and adjudication could be assessed by comparing subjective estimates to existing penalties.

Though the social bonds between regulators and regulatees can be an important influence on compliance and cooperation (Braithwaite 1995, Tyler 2000), the hunter interview results and consideration of number of hunters relative to agency personnel suggested most individuals have little opportunity to interact with and draw conclusions regarding the characteristics of specific staff and their role in establishing and enforcing regulations. The identification component of

instrumental judgments was therefore not included on the focused conceptual model. The dignity component of procedural justice was also omitted, for it relates to interpersonal interactions with and treatment received from individual authorities.

Questionnaire Variables and Models Evaluating Violations, Cooperation, and Trust

Construction of questions and word choice selection for development of the questionnaire was informed by the insights offered through the hunter interviews and expert review used to develop the focused conceptual model. Survey development also benefited from considering input received through numerous MDNR public meetings and correspondence that occurred throughout > 10 years of pursuing bTB management and eradication. Past surveys of deer hunters and bTB stakeholders by MDNR and other researchers were also reviewed and discussed with those principal investigators, and the peer-reviewed literature regarding compliance, cooperation, and trust was evaluated to provide insight for construction of the survey.

The supply of violations function presented by Hatcher et al. (2000) was modified to incorporate factors of influence relevant to Michigan deer hunter's decisions regarding violations with baiting regulations corresponding to the focused conceptual model (Figure 3). One or more variables was defined and measured using the mail survey to assess each factor of influence included within the violations model. The cooperation model was developed by removing the enforcement factor and applying different variables under personal gains and normative influence as appropriate (i.e., variables associated specifically with the use of bait were removed and those pertaining to deer harvest were added). The trust model incorporated all variables applied in the violations and/or cooperation model under the factors of instrumental judgments and procedural justice (i.e., variables pertaining to both baiting regulations and deer harvest were included).

Violations Model and Variables

The Violations Model expressed an individual's supply of violations function as:

V = *f*(Y, E, H, M, S, I, N, J, G, Q, P), where factors included:

V = violation behavior

Y = influence of personal gains through anticipated value of baiting

E = influence of enforcement

H = influence of personal gains through overall value of deer hunting

M = influence of moral obligation

S = influence of social norms

I = influence of procedural justice through input

N = influence of procedural justice through neutrality

J = influence of procedural justice through justification

G = influence of instrumental judgments through goal agreement

Q = influence of instrumental judgments through equity

P = influence of instrumental judgments through performance

These factors correspond to those included in the focused conceptual model (Figure 3), with the exception of the addition of the overall value of deer hunting (H). This factor was added to create a non-economic equivalent to the comparison that individuals make between their existing level of wealth and the perceived net benefits when economic personal gains are associated with violating (Hatcher et al. 2000).

The overarching survey question that assessed violation behavior asked respondents to indicate how frequently they had used bait in areas where it was banned. Responses to this question were dichotomously coded to produce the dependent variable REPORTED (Table 2).

Survey recipients were reassured information provided in response to the question regarding past violations did not constitute a confession and researchers were under no obligation to report such information and would keep respondents' identities confidential to the maximum extent allowable by law. This information was provided immediately prior to this question, and the confidentiality notice was also provided at the beginning of the questionnaire (Appendix). A total of 30 independent variables were incorporated in the violations model based on calculations from other data collected using the survey instrument, with one or more variable addressing each of the remaining factors.

Sutinen and Kuperan (1999) pointed out that courts often decline to apply maximum sanctions for fishing violations, viewing them as excessively severe. LED staff indicated Michigan courts had also often applied less than maximum fines for baiting violations. Thus variables under the factor of enforcement (Table 2) assessed perceptions of actual fines and other penalties typically faced along with subjective estimates of detection and apprehension, rather than assuming the sanctions established by law and any objective assessment of risk of punishment are directly linked to violation decisions (Tyler 2003). Subjective estimates of risk of punishment were asked to be assessed as how many out of every 10 hunters that do not follow baiting rules are caught and end up having to pay a ticket or facing other penalties (P_TICKET and P_PENALTY, respectively; Table 2). Respondents were asked to indicate what they believed to be the maximum fine for baiting (C_TICKET) and whether they believed having hunting privileges revoked (C_PENALTY_HUNT) or facing confiscation of equipment used during baiting violations (C_PENALTY_EQUIP; Table 2) were other penalties that could be applied for baiting violations.

Table 2. Descriptions and calculations of variables used in the violations models.

Category/Variable	Description
(V) Violations	
REPORTED	How frequently have you used bait in areas where it has been banned? (never used bait/may have without realizing ban = 0; a few times/several or many times/whenever I hunted = 1)
(Y) Baiting Value	
	Indicate how strongly you agree/disagree this factor affected your deer hunting satisfaction… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
EFFICIENT	harvesting deer in as little time as possible
TIME	spending as much time as possible deer hunting
SAFE	harvesting deer as safely as possible
HARVEST	harvesting a deer
DEER	seeing deer while hunting
WILDLIFE	seeing other wildlife while hunting
	Indicate how strongly you agree/disagree the following are benefits to deer hunters that use bait… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
BAIT_EFFICIENT	deer harvested in less time
BAIT_TIME	more time enjoyed in the field
BAIT_SAFE	a safer target
BAIT_HARVEST	better chance of harvesting a deer
BAIT_DEER	more deer can be seen
BAIT_WILDLIFE	enjoy seeing other wildlife
(E) Enforcement	
P_TICKET	Out of every ten hunters that do not follow baiting rules… how many… are caught and end up having to pay a ticket? (0-10 out of 10)
C_TICKET	What is the maximum fine for violating baiting rules? (≤$100 = 1; ≤$250 = 2; ≤$500 = 3; >$500 = 4)
P_PENALTY	Out of every ten hunters that do not follow baiting rules… how many… are caught and end up facing other penalties? (0-10 out of 10)
C_PENALTY_HUNT	What other penalties can be applied for violating baiting rules? (Loss of hunting privileges)
C_PENALTY_EQUIP	What other penalties can be applied for violating baiting rules? (Confiscation of equipment)

Table 2 (cont'd)

Category/Variable	Description
(H) Hunting Value	
IMPORTANCE	How important is deer hunting to you compared to your other recreational activities? (Not at all = 1; Less than most = 2; No more than others = 3; One of more important = 4; Most important = 5)
(M) Moral Norms	
RULES	Following all hunting rules is the right thing to do. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
ETHICS	Hunting deer over bait is not ethical. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(S) Social Norms	
NORM_BAIT	Many other hunters still use bait. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
RATE	Out of every ten hunters, how many follow baiting rules? (0-10 out of 10)
(I) Input	
INPUT	Steps in setting deer hunting rules should include opportunities to provide input. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_INPUT	MDNR provides enough opportunities for input when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(N) Neutrality	
SCIENCE	Steps in setting deer hunting rules should include using the best available science. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
PROCEDURE	Steps in setting deer hunting rules should include using consistent decision-making procedures. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_SCIENCE	MDNR considers the best available science when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_PROCEDURE	MDNR follows consistent decision-making procedures when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)

Table 2 (cont'd)

Category/Variable	Description
(J) Justification	
EXPLAIN	Decision-makers should explain different options considered and why final options were selected when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_EXPLAIN	MDNR decision-makers explain different options considered and why final option was selected when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DEER_TB	it is possible to get rid of all bTB from deer
COW_TB	it is possible to get rid of all bTB from livestock
BAITING_SPREAD	bTB can spread from deer to deer at locations where bait is used
DEER_SPREAD	Deer can spread bTB to livestock
BAITING_DEER	MDNR staff believes that baiting rules are needed to get rid of all bTB from deer
BAITING_COW	MDNR staff believes that baiting rules are needed to get rid of all bTB from livestock
(G) Goal Agreement	
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
GOAL _DEERERAD	it is important to reduce or get rid of bTB from deer
GOAL _COWERAD	it is important to reduce or get rid of bTB from livestock
(Q) Equity	
AREA_A	Hunt mostly in Area A (Presque Isle, Otsego, Montmorency, Alpena, Crawford, Oscoda, Alcona)
(P) Performance	
SATISFACTION	How satisfied/dissatisfied were you with recent deer hunting experiences in northeast Michigan? (Very dissatisfied = 1; Somewhat dissatisfied = 2; Neutral = 3; Somewhat satisfied = 4; Very satisfied = 5)

Regarding personal gains, past MDNR surveys indicated hunters often used bait to enhance chances of taking deer, or of drawing deer to specific locations that allow for safe harvest, and that hunting satisfaction was strongly associated with the opportunity to simply spend time outdoors, participate in hunting, and see deer as well as by whether or not any deer were taken (Frawley 2000, Frawley and Rudolph 2008). Comments by hunters and NELP field staff indicated other personal benefits hunters attributed to use of bait included enjoyment seeing other wildlife that visit baiting locations, and that visiting hunting locations to place bait was an extension of time enjoyed spent outdoors while hunting. A number of variables were constructed to distinctly measure beliefs of individuals regarding these potential benefits associated with using bait and the subjective value they personally ascribed to those benefits (Table 2). For example, an individual may have felt that using bait enables hunters to harvest deer in less time (assessed by the variable BAIT_EFFICIENT), but harvesting deer in as little time as possible may have had little influence on their deer hunting satisfaction (assessed by the variable EFFICIENT). Additional perspective on the value of these specific potential gains related to the use of bait was offered through the variable IMPORTANCE, which was created under the factor of overall importance of deer hunting and was measured relative to the importance of other recreational activities. Individual gains of using bait should have been more valuable to those that placed on overall higher value on hunting.

The factors of goal agreement, equity, and performance were assessed as components of instrumental judgments potentially leading to perceived personal gains. Prior research had assessed overall support for bTB eradication (Dorn and Mertig 2005), but management efforts may focus primarily on reducing prevalence of bTB in deer or preventing livestock infection. Variables under goal agreement therefore separately assessed whether individuals agreed that it

was important to eradicate bTB from deer and whether it was important to eradicate bTB from livestock (the variables GOAL_DEERERAD and GOAL_COWERAD, respectively; Table 2).

The influence of equity was not directly measured. However, the 7-county area of Alcona, Alpena, Crawford, Montmorency, Oscoda, Otsego, and Presque Isle was under a long-standing baiting ban from 2002−2010, whereas the use of bait was allowed throughout the rest of the NELP from 2002−2007, when a peninsula-wide ban came into effect (Table 1). These counties were identified on the questionnaire as Area A, and hunters were asked if they primarily hunted within this area or elsewhere within the NELP. If the corresponding variable AREA_A was related to violation behavior independently of other variables, it would be an assumed indication of the influence of unequal treatment of individuals hunting in different portions of the NELP, regardless of MDNR justification of this unequal treatment due to the importance of this area in sustaining bTB.

Along with the variables created to assess personal gains through determination of how perceived benefits of using bait may affect deer hunting satisfaction, the variable SATISFACTION assessed basic satisfaction with recent NELP deer hunting experiences (Table 2). This variable served as an indirect measure of the factor of performance, which may affect behavior through instrumental judgments based on whether regulatees perceive the agency to be effective at producing valuable outcomes (Sunshine and Tyler 2003). Although much of the MDNR deer management efforts in the NELP have been driven by bTB eradication efforts, the agency also does have an overall obligation to provide for use and enjoyment of deer through hunting. Judgment of performance in this area was likely pertinent to instrumental judgments by NELP hunters and may have therefore affected decisions regarding violations.

Variables for procedural justice factors explicitly pertaining to the process of adopting regulations were generated to assess both the basic importance of those factors and subjective measures of how well MDNR addressed those factors in practice. For example, the influence of the factor of input was assessed by asking survey participants about both the general importance of providing hunters opportunities to provide input when setting deer hunting rules and asking to what extent they agreed that MDNR provides enough opportunities for hunters to provide input when setting deer hunting rules (INPUT and DNR_INPUT, respectively; Table 2).

Neutrality is judged by whether impartial rules for making decisions exist and are followed, and whether decisions are perceived to be based upon factual, objective assessments (Tyler and Lind 1992, Paternoster et al. 1997, Tyler 2000). Neutrality was therefore assessed based on the perceived importance of following consistent decision-making procedures and using the best available science when setting hunting rules (PROCEDURE and SCIENCE, respectively; Table 2) and by performance of MDNR in following these practices (DNR_PROCEDURE and DNR_SCIENCE, respectively; Table 2). Measures of PROCEDURE and DNR_PROCEDURE assessed respondents' level of agreement with the statements "it is important to follow consistent decision-making procedures when setting hunting rules" and "DNR follows consistent decision-making procedures when setting hunting rules" (Table 2 and Appendix, question 8 and question 9). These variables were similar to those used by Blader and Tyler (2003) to assess both formal and informal elements of procedural justice based on agreement with the statements "The rules and procedures are applied consistently across people and situations" and "My supervisor's decisions are consistent across people and situations" (757).

Measures of SCIENCE and DNR_SCIENCE assessed respondents' level of agreement with the statements "it is important to use the best available science when setting hunting rules" and "DNR considers the best available science when setting hunting rules" (Table 2 and Appendix, questions 8 and 9). Blader and Tyler (2003) assessed formal and informal elements of procedural justice based on agreement with the statements "The rules ensure that decisions are made based on facts, not personal biases and opinions" and "My supervisor's decisions are made based on facts, not their personal biases and opinions" (757). A variable used by Sunshine and Tyler (2003) to assess procedural fairness measured perceptions of whether the police "Make their decisions based on facts, not their personal biases or opinions" (542). Some regulatory settings, including wildlife management, pursue a factual basis for decision-making by incorporating scientific findings and technical expertise within the consideration of alternative regulations (Stryker 1994, Geist et al. 2001, Jacobson and Decker 2006, Tyler 2006). This led to a different approach for measuring these variables compared to that used by Blader and Tyler (2003) and Sunshine and Tyler (2003) in assessing procedural justice in decisions by supervisors and the police.

Justification may be based on both an explanation of how alternative arguments or options were considered (Tyler 1990) and whether the final option was selected based on shared beliefs regarding what laws and regulations are likely to accomplish (Beetham 1991, Tyler 2000). Variables addressing this factor assessed hunter perceptions regarding the overall importance of explaining why final options are selected from amongst alternatives considered and how well DNR provides such explanations (EXPLAIN and DNR_EXPLAIN, respectively; Table 2). Measures of EXPLAIN and DNR_EXPLAIN assessed respondents' level of agreement with the statements "it is important that decision-makers explain different options considered

when deer hunting rules are set, and why the final option was selected" and "DNR explain what options are considered when deer hunting rules are set, and why the final option was selected" (Table 2 and Appendix, questions 8 and 9). These variables were similar to those used by Blader and Tyler (2003) to assess both formal and informal elements of procedural justice based on agreement with the statements "The rules require that I get an honest explanation for how decisions are made" and "My supervisor usually gives me an honest explanation for the decisions he/she makes" (757). A similar variable was also used by Sunshine and Tyler (2003) to assess procedural fairness by measuring perceptions of whether the police "Clearly explain the reasons for their actions" (542−543). Additional variables assessed individuals' beliefs about dynamics of bTB spread (BAITSPREAD and DEERSPREAD, Table 2), whether it was believed that bTB could be eradicated from deer or livestock (DEERTB and COWTB, Table 2), and respondents' perceptions regarding whether they felt MDNR staff truly believed baiting rules were needed to eradicate bTB from deer or livestock (BAITDEER and BAITCOW, Table 2).

Several variables were created to evaluate moral and social normative influence on tendency of violation. The variables ETHICS and RULES were intended to measure moral norms specifically regarding the ethicality of hunting deer over bait and moral norms regarding whether following rules in general is simply the right thing to do (Table 2). NORM_BAIT was intended to assess social norms by determining the influence of perceptions that many other hunters do not following baiting rules (Table 2). An error in question wording intended to collect data for all 3 of these variables forced survey participants to evaluate statements indicating both whether they did or did not use bait and a reason potentially influencing that decision. For example, for the question intended to assess ETHICS, respondents were asked to agree or disagree with the statement "I do not use bait because hunting deer over bait is not ethical"

(Appendix, question 19). Because it was not possible to determine whether individuals were generating their response based on whether or not they used bait or whether or not they agreed with the rationale potentially influencing that decision, the variables ETHICS, RULES, and NORM_BAIT could not be used in analyses. However, the variable RATE assessed subjective estimates of what proportion of hunters followed baiting rules (Table 2). The relationship between tendency of violation and this variable was used to assess the influence of social norms.

Statistically significant variables in the Violations Model aided with addressing objective 2 (characterize the extent to which enforcement, expected personal gains, and normative factors were associated with past decisions to comply with baiting regulations). No prior research regarding compliance with North American hunting regulations had applied such a conceptual framework. The economic incentives that have appeared at times to limit the influence of normative factors on commercial fishing compliance (Ludwig et al. 1993, Kuperan and Sutinen 1998, Hatcher et al. 2000) do not broadly apply to recreational hunting (Geist 1998), but general recreational value of hunting was expected to be an influential form of personal gains. Some elements of enforcement were also expected to be significant, though substantial barriers exist to effectively applying deterrence to hunting violations (Sherblom et al. 2002, Falcone 2004). The primary interest was in exploring opportunities for normative factors associated with procedural justice to offset these difficulties and the personal gains potentially associated with violations.

Cooperation Model and Variables

The Cooperation Model expressed an individual's tendency of cooperation function as:

C = f(Y, H, M, S, I, N, T, G, Q, P), where factors included:

C = cooperative behavior

Y = influence of personal gains through anticipated value of cooperation

H = influence of personal gains through overall value of deer hunting

M = influence of moral obligation

S = influence of social norms

I = influence of procedural justice through input

N = influence of procedural justice through neutrality

T = influence of procedural justice through trust

G = influence of instrumental judgments through goal agreement

Q = influence of instrumental judgments through equity

P = influence of instrumental judgments through performance

These factors correspond to those included in the focused conceptual model (Figure 3). The dichotomously coded dependent variable PURCHASE was calculated via a query of the RSS database to determine during how many of the 5 hunting seasons prior to conducting the survey individuals purchased ≥1 antlerless license valid for the NELP (Table 3). Data collected using the survey instrument were used to calculate 24 total independent variables that were incorporated in the cooperation model, with one or more variable addressing each of the remaining factors.

A number of variables were constructed to distinctly measure the personal gains individuals believed to be associated with purchasing antlerless licenses, and the subjective value they personally ascribed to those benefits (Table 3). For example, an individual may recognize that possessing an antlerless license enables hunters to harvest deer additional deer above the allowable number of antlered bucks that may be taken (measured by the variable HUNT_MULTI), but harvesting multiple deer may have little influence on their deer hunting

satisfaction (measured by the variable MULTI). As with the evaluation of baiting benefits, additional perspective on the value of the potential gains related to the purchase of antlerless licenses was offered through the variable IMPORTANCE, which was created under the factor of overall importance of deer hunting and assessed relative to the importance of other recreational activities. Individual gains of using purchasing antlerless licenses should have been more valuable to those that placed on overall higher value on hunting.

Variables used to assess instrumental judgments through goal agreement, equity, and performance were identical to those examined under the violations model (Table 3). Variables used to assess procedural justice through input, neutrality, and justification were identical to those examined under the violations model, with 3 exceptions that placed the point of emphasis on decisions relative to purchasing or using antlerless licenses rather than on decisions pertinent to the choice of whether to use bait. In place of BAITDEER and BAITCOW, used in the violations model to assess the influence of justification through respondents' perceptions regarding whether they felt MDNR staff truly believed baiting rules were needed to eradicate bTB from deer or livestock (Table 2), DNRDEER and DNRCOW instead assessed perceptions of whether respondents felt hunting regulations other than baiting rules were important for bTB eradication (Table 3). Also, BAITSPREAD evaluated respondents' perceptions regarding whether bTB could be spread from deer to deer at locations where bait is used (Table 2), and in place of this variable, DEERNO assessed perceptions regarding whether bTB could spread more easily when deer numbers are high (Table 3).

Two variables were created to evaluate moral and social normative influence on tendency of cooperation. RESPONSIBILITY assessed whether respondents felt they had a basic

Table 3. Descriptions and calculations of variables used in the cooperation models.

Category/Variable	Description
(C) Cooperation	
PURCHASE	Retail Sales System records of number of years out of previous 5 during which ≥1 antlerless license was purchased (0/1/2 years = 0; 3/4/5 years = 1)
(Y) Cooperation Value	
	Indicate how strongly you agree/disagree this factor affected your deer hunting satisfaction… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
TIME	spending as much time as possible deer hunting
HARVEST	harvesting a deer
MULTI	harvesting multiple deer
	Indicate how strongly you agree/disagree the following reasons affected your decision to purchase an antlerless deer hunting license in the last 5 years… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
HUNT _TIME	to increase the amount of time I could hunt
HUNT _HARVEST	to increase my chance to take at least one deer
HUNT _MULTI	to increase the number of deer I could harvest
(H) Hunting Value	
IMPORTANCE	How important is deer hunting to you compared to your other recreational activities? (Not at all = 1; Less than most = 2; No more than others = 3; One of more important = 4; Most important = 5)
(M) Moral Norms	
RESPONSIBILITY	I have a responsibility to help manage the deer population. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(S) Social Norms	
NORM_HUNT	My hunting partners/neighbors wanted antlerless deer taken. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)

Table 3 (cont'd)

Category/Variable	Description
(I) Input	
INPUT	Steps in setting deer hunting rules should include opportunities to provide input. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_INPUT	MDNR provides enough opportunities for input when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(N) Neutrality	
SCIENCE	Steps in setting deer hunting rules should include using the best available science. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
PROCEDURE	Steps in setting deer hunting rules should include using consistent decision-making procedures. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_SCIENCE	MDNR considers the best available science when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_PROCEDURE	MDNR follows consistent decision-making procedures when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(J) Justification	
EXPLAIN	Decision-makers should explain different options considered and why final options were selected when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_EXPLAIN	MDNR decision-makers explain different options considered and why final option was selected when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DEER_TB	it is possible to get rid of all bTB from deer
COW_TB	it is possible to get rid of all bTB from livestock
DEER_NO	bTB spreads more easily when deer numbers are high
DEER_SPREAD	Deer can spread bTB to livestock
DNR_DEER	MDNR staff has set deer hunting rules they believe are needed to get rid of all bTB from deer
DNR_COW	MDNR staff has set deer hunting rules they believe are needed to get rid of all bTB from livestock

Table 3 (cont'd)

Category/Variable	Description
NEED	MDNR has indicated a need for hunters to take antlerless deer
(G) Goal Agreement	
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
GOAL _DEERERAD	it is important to reduce or get rid of bTB from deer
GOAL _COWERAD	it is important to reduce or get rid of bTB from livestock
(Q) Equity	
AREA_A	Hunt mostly in Area A (Presque Isle, Otsego, Montmorency, Alpena, Crawford, Oscoda, Alcona)
(P) Performance	
SATISFACTION	How satisfied/dissatisfied were you with recent deer hunting experiences in northeast Michigan? (Very dissatisfied = 1; Somewhat dissatisfied = 2; Neutral = 3; Somewhat satisfied = 4; Very satisfied = 5)

responsibility to help manage the deer population (Table 3). NORM_HUNT assessed whether respondents believed their hunting partners or neighbors wanted antlerless deer taken (Table 3).

Statistically significant variables in the Cooperation Model aided with addressing objective 3 (characterize the extent to which expected personal gains and normative factors were associated with past decisions to cooperate with reaching harvest objectives). Personal gains through the recreational value provided by deer hunting (Frawley and Rudolph 2008) were expected to have influenced decisions to purchase antlerless licenses, while general resistance to strategies to bTB eradication (Dorn and Mertig 2005) led to expectations that instrumental judgments had reduced past cooperation. The primary interest was in exploring opportunities for normative factors associated with procedural justice to be leveraged to overcome the repeatedly

documented difficulties of managing deer populations through recreational harvest (Woolf and Roseberry 1998, Brown et al. 2000, Giles and Findlay 2004, Harden et al. 2005, Van Deelen et al. 2006). No prior assessment had been conducted to explicitly evaluate the extent to which expected personal gains and normative factors are associated with decisions to cooperate with reaching deer harvest objectives.

Trust Model and Variables

The trust model expressed an individual's level of trust function as:

T = f(I, N, J, G, Q, P), where factors included:

T = assessment of trust in MDNR deer management

I = influence of procedural justice through input

N = influence of procedural justice through neutrality

J = influence of procedural justice through justification

G = influence of instrumental judgments through goal agreement

Q = influence of instrumental judgments through equity

P = influence of instrumental judgments through performance

These factors correspond to those included in the focused conceptual model (Figure 3). The overarching survey question that assessed the level of trust in MDNR asked respondents to indicate how strongly they agreed or disagreed with the statement "I trust the MDNR to establish appropriate deer hunting rules." Responses to this question were dichotomously coded to produce the dependent variable TRUST (Table 4). Sunshine and Tyler (2003) measured trust by assessing agreement with the statement "I trust the leaders of the NYPD to make decisions that are good for everyone in the city" (543). I focused evaluation to ensure the causes and consequences of citizens' trust were explicitly assessed regarding actors and actions pertaining to

Table 4. Descriptions and calculations of variables used in the trust models.

Category/Variable	Description
(T) Trust	
TRUST	I trust the MDNR to establish appropriate deer hunting rules. (Strongly Disagree/Disagree/Not Sure = 0; Agree/Strongly Agree = 1)
(I) Input	
INPUT	Steps in setting deer hunting rules should include opportunities to provide input. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_INPUT	MDNR provides enough opportunities for input when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(N) Neutrality	
SCIENCE	Steps in setting deer hunting rules should include using the best available science. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
PROCEDURE	Steps in setting deer hunting rules should include using consistent decision-making procedures. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_SCIENCE	MDNR considers the best available science when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_PROCEDURE	MDNR follows consistent decision-making procedures when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
(J) Justification	
EXPLAIN	Decision-makers should explain different options considered and why final options were selected when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DNR_EXPLAIN	MDNR decision-makers explain different options considered and why final option was selected when setting deer hunting rules. (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DEER_TB	it is possible to get rid of all bTB from deer
COW_TB	it is possible to get rid of all bTB from livestock
DEER_NO	bTB spreads more easily when deer numbers are high
BAITING_SPREAD	bTB can spread from deer to deer at locations where bait is used

Table 4 (cont'd)

Category/Variable	Description
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
DEER_SPREAD	Deer can spread bTB to livestock
BAITING_DEER	MDNR staff believes that baiting rules are needed to get rid of all bTB from deer
DNR_DEER	MDNR staff has set deer hunting rules they believe are needed to get rid of all bTB from deer
BAITING_COW	MDNR staff believes that baiting rules are needed to get rid of all bTB from livestock
DNR_COW	MDNR staff has set deer hunting rules they believe are needed to get rid of all bTB from livestock
(G) Goal Agreement	
	Indicate how strongly you agree/disagree with statements about bTB in Michigan… (Strongly Disagree = 1; Disagree = 2; Agree = 3; Strongly Agree = 4)
GOAL _DEERERAD	it is important to reduce or get rid of bTB from deer
GOAL _COWERAD	it is important to reduce or get rid of bTB from livestock
(Q) Equity	
AREA_A	Hunt mostly in Area A (Presque Isle, Otsego, Montmorency, Alpena, Crawford, Oscoda, Alcona)
(P) Performance	
SATISFACTION	How satisfied/dissatisfied were you with recent deer hunting experiences in northeast Michigan? (Very dissatisfied = 1; Somewhat dissatisfied = 2; Neutral = 3; Somewhat satisfied = 4; Very satisfied = 5)
P_TICKET	Out of every ten hunters that do not follow baiting rules… how many… are caught and end up having to pay a ticket? (0-10 out of 10)
P_PENALTY	Out of every ten hunters that do not follow baiting rules… how many… are caught and end up facing other penalties? (0-10 out of 10)

deer hunting regulations, as appropriate given the focus of other variables (Levi and Stoker 2000).

A total of 19 independent variables were incorporated in the trust model based on calculations from other data collected using the survey instrument, with one or more variable addressing each of the remaining factors. Variables used to assess procedural justice through input and neutrality were identical to those examined under the violations and cooperation models. Variables pertaining to justification in either the violations or cooperation model were applied to the trust model. Variables used to assess instrumental judgments through goal agreement, equity, and performance were identical to those examined under the both the violations and cooperation models. However, in addition to the performance variable based on satisfaction with past NELP deer hunting experiences, P_TICKET and P_PENALTY were categorized as performance variables for the trust model (Table 4). These variables were more likely influential as elements of enforcement in determining tendency of violations, but may have served as an indication of whether the MDNR is effective at upholding the baiting regulations enacted. As such, they provided an additional dimension of assessment of performance for consideration in the trust model.

Statistically significant variables in the Trust Model aided with addressing objective 4 (evaluate judgments associated with hunter trust in MDNR). Prior observations regarding high levels of conflict between hunters in the NELP and MDNR (Rudolph et al. 2006) led to the expectation that trust levels would not be high. However, given that much prior work examining trust in government had focused on political actors in general, rather than assessing trust in specific agencies with respect to specific problems (Levi and Stoker 2000), it was unclear to

what extent instrumental judgments compared to procedural justice had influenced hunter trust in MDNR to establish appropriate deer hunting regulations.

Sampling

Available operational funds were sufficient to allow for a sample of 3,500 individuals. A sampling frame was required that would identify individuals that had hunted within the NELP in recent years. Residents of the NELP bear different costs related to bTB (such as the restrictions on livestock operations in the area) and bTB management interventions (such as the potential for reduced tourism in the area that may occur if deer populations and associated hunting and viewing opportunities are reduced) than nonresidents, and resident and nonresident hunters were previously shown to hold different beliefs and knowledge regarding bTB (Dorn and Mertig 2005). Subsamples were therefore desired to identify NELP hunters that lived within the NELP (the NELP Sample) and that lived outside of the NELP (the Nonresident Sample). Due to the importance of exploring factors related to violations, it was also desirable to ensure a suitable number of survey recipients had violated baiting regulations in the past (the Known Violators Sample). The ability to sample based on past violations was available through LED information regarding past citations for baiting violations. Three different sources of hunter names and contact information existed for generating the sampling frame for selection of these samples: the LED citations database, the WLD harvest survey prior respondents database, and the RSS database.

Prior Baiting Citations Sampling Frame

LED provided names and contact information for inclusion in the sampling frame from their database of individuals that received citations. Information was provided regarding hunters cited for violation of deer baiting regulations within the 14 counties constituting the NELP. The

list was reduced to those individuals cited from 2008−2010, the years during which baiting was banned throughout the entire Lower Peninsula. This produced a list of 676 individuals.

NELP and Nonresident Sampling Frames

WLD annually estimates deer hunting harvest and participation using a mail survey of a randomly selected sample of approximately 50,000 individuals. Survey recipients are selected from among all individuals within the RSS database that had purchased a deer hunting license for the prior season (e.g., Frawley 2011). Individuals were identified that participated in recent (2007−2009) harvest surveys and indicated they hunted within the NELP. Individuals within the RSS database that had purchased a license for deer hunting within the NELP in recent (2007−2009) seasons were also identified for inclusion in the sampling frame. Only antlerless license sales were used for this determination, as they are the only type of deer license that must be used within specific DMUs and could therefore be attributed to the NELP. Only hunters that had a Michigan mailing address at the time of this study were included in the sampling frame, and to meet requirements of the Michigan State University Committee Involving Research on Human Subjects and the Institutional Review Board, those <18 years of age were excluded. All remaining individuals were assigned to the NELP (if they lived within the NELP) or Nonresident (if they lived outside of the NELP) sampling frame based on the county of their mailing address.

Known Violators, NELP, and Nonresident Sample Selections

All 676 individuals that were included the prior baiting citations sampling frame were selected to receive a survey, constituting the Known Violators sample. After these 676 individuals were selected to account for a portion of the 3,500 total intended surveys, an equal number of 1,412 individuals was able to be selected for the NELP sample and Nonresident sample. The NELP sample included 1,412 randomly selected individuals out of 25,244 total in

the NELP sampling frame. The Nonresident sample included 1,412 randomly selected individuals out of 63,154 total in the Nonresident sampling frame.

Survey Execution

Starting with the initial sample of 3,500 individuals and associated mailing addresses, the U.S. Postal Service identified undeliverable addresses and provided updated addresses for those that had moved ≤18 months from the mailing date. Following survey mailing initiated on 18 May 2011, reminder postcards were sent on 3 June 2011 and 2 additional survey mailings on 27 June and 14 July 2011 to nonrespondents. Final data compilation was completed 16 August 2011. Demographics of respondents were compared to the overall hunting population and the survey response rate was compared to that of the annual WLD hunter mail survey.

The overall adjusted sample size after removing deceased individuals and those determined following mailing to have an undeliverable address was 3,222. The NELP sample was adjusted from 1,412 to 1,284. The Nonresident sample was adjusted from 1,412 to 1,333. The Known Violators sample was adjusted from 676 to 605.

The total number of returned surveys was 1,652, resulting in a 51.3% overall return rate. After removing 317 surveys that were returned largely incomplete or with a screening question selected indicating recipients who did not wish to participate, the final response rate was 41.4% based on 1,335 respondents that provided usable data. These rates were similar among the NELP, Nonresident, and Known Violators samples. Return rates for these groups were 50.9%, 51.2%, and 48.4%, respectively, and response rates were 41.2%, 41.3%, and 42.1%, respectively. Respondents that provided usable data included 529 individuals from the NELP sample, 551 from the Nonresident sample, and 255 from the Known Violators sample. For regression modeling purposes, a total of 632 respondents were categorized as NELP hunters (529 from the

NELP sample + 103 NELP residents from the Known Violators sample). A total of 551 respondents were categorized as Nonresident hunters (551 from the Nonresident sample + 152 respondents from the Known Violators sample that resided outside of the NELP).

Data Analysis, Statistical Methods, and Software

Data compilation, exploration of responses, response rate calculation, and factor analysis was performed using IBM SPSS Statistics Version 19. To meet the first study objective of estimating the rate of violation of baiting regulations, respondents from the Known Violators sample were excluded from calculations, for they were not randomly selected as to the likelihood of past violations. The potential for embarrassment or concerns regarding facing legal action created stronger motivation for past violators to indicate compliance than for those who complied to indicate past violations (Warner 1965). However, estimates of violations based on observations during enforcement activities require accounting for numerous biases, particularly since effective enforcement necessitates that agents not make entirely random contacts with resource users (Cowles et al. 1979). Using "Random Response Model" methods (Warner 1965) to create complete anonymity by randomly directing participants to respond to either the sensitive question or another non-sensitive question (for which there exists a known probability of eliciting an affirmative or negative response) can produce unacceptably low response rates if they are perceived by survey participants to be cumbersome, confusing, or nonsensical (Locander et al. 1976, Stem and Steinhorst 1984). A group of researchers previously attempted to estimate the rate of violation of Michigan baiting regulations through a survey applying a Random Response Model technique. Their unpublished findings yielded an estimated violation rate of -12.6%, a nonsensical result that indicated the effort failed to produce a useful estimate.

Several steps were taken to address potential sources of bias with obtaining suitably accurate violation reports. Survey recipients in this study were advised that information provided in response to the question regarding past illegal use of baiting did not constitute a confession, and that researchers were under no obligation to report such information and would keep respondents' identities confidential to the maximum extent allowable by law. These assurances were provided immediately before the question was posed, and the basic confidentiality statement was also provided on the first page of the survey (Appendix). To avoid compromising the overall survey response rate due to any aversion to replying to this question in particular, respondents could select "I prefer not to answer this question." A very specific type of violation was assessed, which would minimize overreporting that can confound accurate estimation of general rates of violation of laws (Huizinga and Elliott 1986). To assess reliability of self-reported violation data, the reported violation rate and reports of receiving past citations were compared between the Known Violators sample and the other samples, and comments provided by some Known Violators sample respondents were examined to assess any evidence that individuals were not intentionally evading an accurate response. With such methods and validation efforts in place, self reported measures are regarded the best means of obtaining data suitable for research needs examining violations (Huizinga and Elliott 1986).

The overall distribution of responses was examined to identify potential measurement errors or variables that were not useful for detecting differences among respondents. Factor analysis with principal axis factoring extraction was used for structure detection to assess internal validity of data by examining whether underlying relationships between the variables matched the overall structure of the conceptual model around which the survey instrument was designed. The Kaiser-Meyer-Olkin measure of sampling adequacy (KMO-test) and anti-image

correlation matrix were used to determine if the sample was adequate, and the anti-image correlation matrix was examined for evidence of any redundant (highly correlated) variables (Field 2000). Bartlett's test of sphericity was used to determine whether variables were unrelated and therefore unsuitable for structure detection. The eigenvalues associated with each factor and a scree plot of the eigenvalues were examined to assess the amount of overall variability in the variables that were accounted for in the top factors. Varimax rotation was used, and the rotated factor matrix was examined to determine which variables were associated with each of the top factors. Extraction communalities were examined for any small values, which indicate variables with variance not well accounted for by the factors.

Logit analyses were used to evaluate the Violation, Cooperation, and Trust models (Maddala 1983). For these analyses, respondents from the Known Violators Sample were categorized as NELP or Nonresident hunters based on the county of their mailing address. To determine if factors associated with compliance, cooperation, and trust in the agency differed among NELP and Nonresident hunters, each of the Violation, Cooperation, and Trust models were evaluated using data from all respondents combined (referred to as the Global sample) and using just the NELP and just the Nonresident hunter respondents (i.e., 3 base models run using 3 different data sets amounted to 9 initial models examined). Overall significance of each of the Violation, Cooperation, and Trust models using the Global, NELP, and Nonresident samples was assessed using a likelihood ratio test to compare residual deviance of the 9 models with individual predictors to deviance of a null model (i.e., a model using just the intercept; Hosmer and Lemeshow 2000). The benefits of separately assessing significant factors among the NELP and Nonresident samples was determined by using a likelihood ratio test to compare residual deviance of each NELP and Nonresident model with the corresponding Global model. Overall fit

of each of the 9 models was assessed using a Pearson's chi-square test of the residual deviance for each model.

Alternative model formulations were developed using composite variables in place of a number of individual variables. Composite variables explored included combining the variables under the factors of sanctions & adjudication and detection & apprehension (e.g., P_TICKET + C_TICKET), combining the satisfaction and value variables that contributed to personal gains (e.g., TIME + HUNT_TIME), combining process and practice variables contributing to individual factors of procedural justice (e.g., SCIENCE + DNR_SCIENCE), and combining all variables contributing to individual factors of procedural justice (e.g., Neutrality = SCIENCE + PROCEDURE + DNR_SCIENCE + DNR_ PROCEDURE). No composite variables were found to be statistically significant in any of these alternative model formulations, even when one or more of the individual variables were found to be statistically significant in the basic Violations, Cooperation, and Trust models. Combining the individual variables appeared to result in a loss of information from the data, and so no model formulations using composite variables are summarized here.

Kuperan and Sutinen (1998) and Hatcher et al. (2000) used probit analyses to evaluate the influence of instrumental and normative factors on decisions regarding compliance with commercial fishing regulations. Logit analysis is a virtually identical method to assess dichotomous variables such as decisions to violate or not, but logit coefficients may be exponentiated for interpretation as odds ratios, which indicate how much more (or less) likely the outcome of interest is to occur given an increase in each independent variable examined (Long 1997, Hosmer and Lemeshow 2000). The odds ratios associated with statistically significant variables in each model were used to generate insight to address study objectives 2−4. Objective

5 (identify alternative regulatory and enforcement approaches that may be expected to improve compliance, cooperation, and trust) is addressed through overall review of results in the discussion section. Software R (R Development Core Team 2011) was used for calculation of logit analyses, significance tests, and exponentiation of coefficients as odds ratios.

RESULTS

Response Rates

Response rates of those providing usable data were similar among the NELP, Nonresident, and Known Violators Samples (41.2%, 41.3%, and 42.1%, respectively), suggesting no bias related to response rates was introduced through the sampling frames. The survey return rate of 51.3% was similar to the 56.6% response rate to the 2010 MDNR deer harvest survey (Frawley 2011). Based on a total of 1,307 responses that were provided through this survey regarding year of birth and 1,319 regarding gender, the mean age of respondents was 51 years at the end of 2010, and 93% were males. Frawley (2011) indicated the mean age of 2010 Michigan deer license buyers was 43 years, and 91% were male. However, this study excluded hunters <18 years of age. Adjusting the mean 2010 Michigan deer license buyers' age by excluding youth hunters yields an approximate mean age of 46 years old, indicating survey participants were very similar to the overall population of Michigan deer hunters.

Rate of Violation

Excluding respondents from the Known Violators Sample, 1,080 total survey respondents provided usable data, and 1,047 (96.9%) selected a response to the question regarding past bait use. Among those that selected a response, 691 (66.0%) indicated they never used bait where it was banned, 22 (2.1%) indicated they may have used bait without realizing it was illegal at the time, 154 (14.7%) indicated they used bait a few times, and 78 (7.4%) indicated they used bait

several times, many times, or whenever they hunted in a banned area. One-hundred and two (9.7%) respondents selected "I prefer not to answer this question." The rate of violation based on the 945 respondents that did indicate their past baiting practices was 24.6%, including 232 individuals that indicated knowingly using bait in an illegal manner.

Considering the rate of violation with baiting regulations among the NELP Sample, among the 529 respondents that provided usable data, 510 (96.4%) responded to Question 17 regarding past bait use. Among those that selected a response, 322 (63.1 %) indicated they never used bait where it was banned, 9 (1.8%) indicated they may have used bait without realizing it was illegal at the time, 85 (16.7 %) indicated they used bait a few times, and 45 (8.8%) indicated they used bait several times, many times, or whenever they hunted in a banned area. Forty-nine (9.6 %) of these respondents selected "I prefer not to answer this question." The rate of violation for the NELP Sample based on the 461 respondents that did indicate their past baiting practices was 28.2%, or 130 individuals that indicated knowingly using bait in an illegal manner.

Considering the rate of violation with baiting regulations for the Nonresident Sample, among the 551 respondents that provided usable data, 537 (97.5%) responded to Question 17 regarding past bait use. Among those that selected a response, 369 (68.7%) indicated they never used bait where it was banned, 13 (2.4%) indicated they may have used bait without realizing it was illegal at the time, 69 (12.8%) indicated they used bait a few times, and 33 (6.1%) indicated they used bait several times, many times, or whenever they hunted in a banned area. Fifty-three (9.9 %) of these respondents selected the response "I prefer not to answer this question." The rate of violation for the Nonresident Sample based on the 484 respondents that did indicate their past baiting practices was 21.1%, or 102 individuals that indicated knowingly using bait in an illegal manner.

Within the Known Violators Sample of 255 respondents that provided usable data, 245 (96.1%) selected a response to the question regarding past bait use. By comparison to the NELP and Nonresident Sample respondents, a lower proportion of those that selected a response indicated they had never used bait (12.7%; 31 respondents) and a higher proportion selected "I prefer not to answer this question" (15.9%; 39 respondents). At first consideration, it may appear that the individuals indicating they had never used bait responded untruthfully. Information provided by some Known Violators Sample respondents regarding receiving a ticket in the past was examined to identify a potential reason that some participants may not have been intentionally evading an accurate response. Within the sample of 255 respondents that provided usable data, 243 (95.3%) selected a response to the question regarding receiving a ticket in the past for using bait against the rules. Among those that selected a response, 188 (77.4%) indicated they had received a citation, 26 (10.7%) selected "I prefer not to answer this question," and 29 (11.9%) indicated they had not received a citation for using bait against the rules, another seeming incongruence with prior knowledge from the LED citations database. Comments were provided in the general comment section at the end of the survey by 20 out of 29 (69.0%) of the Known Violator Sample respondents that indicated they had not received a citation. Comments of 2 of these individuals suggested they received a baiting ticket for what they felt were feeding activities. This indicates some individuals were willing to admit they received a ticket and acknowledged engaging in illegal activities (indeed, they took the time and effort to write about it without being specifically prompted to do so), yet they felt their actions were not in violation of baiting regulations, for they indicated they did not intend to use those feed materials in an effort to aid in taking deer − the definition of baiting. Therefore, the apparent incongruence between the prior knowledge from the LED citations database and the indication by 12.7% of the

Known Violator Sample respondents that they never used bait where it was banned may be explained for at least some respondents based on their interpretation of the conditions of their circumstance, not due to evasion of answering the question regarding engaging in illegal activities.

To avoid compromising the overall survey response rate due to any aversion to replying to this question in particular, respondents could select "I prefer not to answer this question." Just 3.1% of the combined NELP and Nonresident Sample respondents who were used to calculate the rate of violations left this question blank, and just 9.7% of those that selected a response indicated they preferred not to answer this question. Considering that a higher proportion of the Known Violators Sample respondents preferred not to answer the question regarding violations (15.9%, compared to 9.6% and 9.9% among the NELP and Nonresident Sample Respondents, respectively), it is likely that a considerable number of these respondents had used bait in the past but were averse to indicating this response. Addressing the first study objective of estimating the rate of violation of baiting regulations, the rate of violation of 24.6% that knowingly used bait in an illegal manner (varying from 28.2% among NELP Sample respondents to 21.1% among Nonresident Sample respondents) should be considered a minimum rate of violation, but the variety of considerations presented here appears to validate the approach of directly asking respondents to provide information regarding prior illegal activities as a practical means of collecting reliable information regarding rate of violations.

Level of Trust

Among the 1,335 total survey respondents that provided usable data, 1,319 responded to the question used to calculate the variable TRUST. Three-hundred ninety-five of these respondents (29.9%) strongly agreed or agreed with the statement "I trust the MDNR to establish appropriate

deer hunting rules," 760 (57.6%) strongly disagreed or disagreed, and 164 (12.4%) selected "not sure" (Table 5). Among the 529 NELP Sample respondents, 521 responded to this question. One-hundred fifty-four of these respondents (29.6 %) strongly agreed or agreed, 309 (59.3 %) strongly disagreed or disagreed, and 58 (11.1 %) selected "not sure." Among the 551 Nonresident Sample respondents, 547 responded to this question. One-hundred ninety-five of these respondents (35.6 %) strongly agreed or agreed, 268 (49.0 %) strongly disagreed or disagreed, and 84 (15.4 %) selected "not sure." Among the 255 Known Violator Sample respondents that provided usable data, 251 responded to this question. Forty-six of these respondents (18.3 %) strongly agreed or agreed, 183 (72.9 %) strongly disagreed or disagreed, and 8 (3.2 %) selected "not sure."

Table 5. Agreement of survey respondents with the statement "I trust the MDNR to establish appropriate deer hunting rules." Data are reported as number (%) of respondents.

Sample	Strongly Agree	Agree	Disagree	Strongly Disagree	Not Sure
Global (n = 1,319)	71 (5.4)	324 (24.6)	394 (29.9)	366 (27.7)	164 (12.4)
NELP (n = 520)	23 (4.4)	131 (25.1)	147 (28.2)	162 (31.1)	58 (11.1)
Nonresident (n = 547)	40 (7.3)	155 (28.3)	171 (31.3)	97 (17.7)	84 (15.4)
Known Violators (n = 251)	8 (3.2)	38 (15.1)	76 (30.3)	107 (42.6)	22 (8.8)

Data Exploration

Some unusual response patterns were identified that, following additional consideration, helped determine that poor question wording invalidated responses pertaining to several variables. The survey questions that elicited responses intended to calculate the variables RULES, ETHICS, and NORM_BAIT (Table 2) inappropriately included reference to whether or not hunters used bait and followed baiting rules as well as reasons behind the decision to do so. Thus it was not clear if responses pertained to whether or not individuals used bait or whether or not they agreed with the reasoning for using or not using bait. These variables could not be used in logit modeling. The variable RATE was similar to NORM_BAIT and provided an alternate measure for assessing influence of social norms, but the errors in RULES and ETHICS prevented logit modeling assessment of the moral norms component of the focused conceptual model pertaining to violations (Figure 3). Crosstabulation of responses to the questions pertaining to RULES and ETHICS with other responses regarding past baiting practices was used to more generally evaluate association of these considerations with past violations.

The variable RULES was intended be calculated based on agreement with the statement "I follow baiting rules because following all hunting rules is the right thing to do" (Appendix, question 19). The variable ETHICS was intended to be calculated based on agreement with the statement "I do not use bait because hunting deer over bait is not ethical" (Appendix, question 19). Responses were examined among only those respondents that indicated they never used bait where they knew it was banned (i.e., variable REPORTED = 0; Table 2) to remove the confounding effect of improper question wording. Responses pertaining to RULES were provided by 728 such individuals, and 359 (49.3%) strongly agreed, 316 (43.4%) agreed, and 53 (7.3%) disagreed or strongly disagreed with the statement. Responses pertaining to ETHICS

were provided by 674 individuals that indicated they never used bait where they knew it was banned, and 195 (29.0%) strongly agreed or agreed, while most respondents (479; 71.1%) strongly disagreed or disagreed with this statement. Thus, among those that complied with the baiting ban, moral norms pertaining to following rules in general appeared to be a stronger influence than moral norms specifically pertaining to the practice of baiting.

Respondents indicated almost completely uniform answers for several variables. Fewer than 3% of respondents disagreed or strongly disagreed that seeing deer (DEER) and other wildlife (WILDLIFE) while hunting and harvesting deer as safely as possible (SAFE) were important considerations pertaining to baiting value that affected their satisfaction with deer hunting (Table 2). These variables were therefore excluded from the factor analysis and logit modeling. Also, <3% of respondents disagreed with the importance of providing hunters opportunities for giving input (INPUT) and explaining different options considered and why final options are selected when developing hunting rules (EXPLAIN), and <14% of respondents disagreed or strongly disagreed with questions pertaining to the importance of using the best available science (SCIENCE) and following consistent decision-making procedures (PROCEDURE) when developing hunting rules (Table 2, 3, and 4). In comparison to these "process" variables pertaining to procedural justice, greater range in responses was documented for questions pertaining to "practice" variables that provided subjective measures of how well MDNR addressed these factors in practice when setting deer hunting rules (DNR_INPUT, DNR_SCIENCE, DNR_PROCEDURE, and DNR_EXPLAIN; Table 2, 3, and 4). Alternative model formulations did not find any composite variables that combined "process" and "practice" factors to be statistically significant, even when one or more of the individual variables were found to be statistically significant in the basic Violations, Cooperation, and Trust models. Given

these considerations, the similarity between the assessments addressed by the "process" and "practice" variables, and the relatively uninformative responses to the "process" variables, the variables INPUT, SCIENCE, PROCEDURE, and EXPLAIN (Table 2, 3, and 4) were not incorporated in the factor analysis and logit modeling.

Factor Analysis

The KMO-test value of .802 and values >0.5 on the diagonal of the anti-image correlation matrix for all 40 variables indicated factor analysis may be useful for the data (Field 2000). Highly correlated values occurred on the anti-image correlation matrix only for variables that were conceptually very closely related, including between C_PENALTY_HUNT and C_PENALTY_EQUIP, between P_TICKET and P_PENALTY, and between GOAL_DEERERAD and GOAL_COWERAD. These correlated variables assessed distinct components of enforcement and bTB eradication goals, so they were not determined to be redundant for application to logit modeling. For example, P_TICKET measured survey respondents' estimated probability that hunters that do not follow baiting rules are caught and end up having to pay a ticket, and P_PENALTY measured respondents' estimated probability that hunters that do not follow baiting rules are caught and end up facing other penalties. They would be expected to be subjectively estimated as similarly probable outcomes, but they measured perceptions that may have different influence on hunter behavior, and were therefore retained for analysis.

Bartlett's test of sphericity was statistically significant ($p < 0.001$), which indicated the data were suitable for structure detection using factor analysis. Twelve factors in the initial solution had eigenvalues >1, though the scree plot indicated the last substantial decrease in eigenvalues occurred between factor 5 and 6. Rotated factor scores >0.450 were used to assign

individual variables to 5 factors (Table 6). The top 5 factors accounted for just 41.5% of the variability in the original variables. The factors represented groupings of variables aligned with the structure of the focused conceptual model (Figure 3). Factor names were created to identify the common nature of the variables assigned to each factor.

Table 6: Factor analysis rotated factor scores used to assign individual variables to top 5 factors.

		Factor				
		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Variable	Models*	Justification	Bait Value	Procedural Justice	Hunt Value	Hunt Norms
BAITING_COW	V, T	.918				
DNR_COW	C, T	.853				
DNR_DEER	C, T	.814				
BAITING_DEER	V, T	.758				
BAITING_SPREAD	V, T	.509				
BAIT_DEER	V		0.824			
BAIT_HARVEST	V		0.800			
BAIT_WILDLIFE	V		0.696			
BAIT_EFFICIENT	V		0.679			
BAIT_SAFE	V		0.657			
BAIT_TIME	V		0.605			
DNR_SCIENCE	V,C, T			0.828		
DNR_PROCEDURE	V,C, T			0.801		
DNR_INPUT	V,C, T			0.780		
DNR_EXPLAIN	V,C, T			0.765		
MULTI	C				0.843	
HARVEST	V, C				0.629	
HUNT_MULTI	C				0.563	
EFFICIENT	V				0.458	
NEED	C					0.719
NORM_HUNT	C					0.624
RESPONSIBILITY	C					0.555

* Indicates model(s) in which variables were used; V = Violations Model, C = Compliance Model, T = Trust Model

Factor 1 (Justification) and 3 (Procedural Justice) included variables representing components of procedural justice. Justification (Factor 1) included only variables related to the focused conceptual model factor of justification (Figure 3). These variables addressed whether MDNR staff believe baiting and hunting rules are needed to eradicate bTB from deer and livestock, plus 1 variable (BAITING_SPREAD) assessed respondent beliefs regarding whether bTB can spread among deer at bait locations. These variables were used in the Trust Model and either the Violations Model or Cooperation Model. The factor Procedural Justice (Factor 3) included variables pertaining to the conceptual model components input, neutrality, and justification (Figure 3). This included all of the variables assessing respondents' views of MDNR rule setting. All Factor 3 variables were used in the Violations Model, Cooperation Model, and Trust Model.

Factor 2 (Bait Value) and Factor 4 (Hunt Value) included only variables related to the focused conceptual model factor of personal gains (Figure 3). Bait Value included variables associated solely with past violations of baiting regulations, and so were only used in the Violations Model. Hunt Value included variables associated with hunting satisfaction that may affect tendency of violation or cooperation, and so were used in the Violations Model, Cooperation Model, or both.

Factor 5 (Hunt Norms) included just 3 variables. Each variable was related to 1 of the components of normative influence (moral, social, and procedural justice) incorporated in the focused conceptual model (Figure 3). These variables were all potential normative influences related to cooperation with antlerless harvest, and so were only included in the Cooperation Model.

Overall, factor analysis indicated relationships between variables reflected in the collected data closely matched relationships in the conceptual model of factors expected to influence violations, cooperation, and trust (Figure 3). Highly correlated values were only identified among variables that were conceptually very closely related, but that assessed potentially distinct influences on behavior (e.g., subjective probability of different potential sanctions). The top factors did not account for the bulk of the variability in the original variables. Factor analysis could therefore validate the conceptual basis around which the data and analyses were constructed, but could not be used for data reduction without losing potentially important variables.

Logit Model Estimation

For logit modeling analyses, respondents from the Known Violators Sample were categorized as NELP or Nonresident hunters based on the county of their mailing address. A total of 632 respondents were categorized as NELP hunters (529 from the NELP Sample + 103 NELP residents from the Known Violators Sample). A total of 551 respondents were categorized as Nonresident hunters (551 from the Nonresident Sample + 152 respondents from the Known Violators Sample that resided outside of the NELP).

Model Fit and Significance

The likelihood ratio tests comparing residual deviance of each of the Violations, Cooperation, and Trust models for each data set (Global, NELP, and Nonresident) to a null model were all statistically significant ($p < 0.05$), indicating all 9 models were significantly better than a null model. The likelihood ratio test comparing residual deviance of the NELP and Nonresident models to the Global models were not significant ($p > 0.05$) for the Violations and Trust models, indicating greater support for the Global Violations and Global Trust models than

the corresponding NELP and Nonresident models. The statistically significant likelihood ratio tests comparing residual deviance of the NELP and Global Cooperation models (Pearson's chi-square = 256.997, 199 d.f., p = 0.00349) and Nonresident and Global Cooperation models (Pearson's chi-square = 272.007, 206 d.f., p = 0.00140) indicated greater support for the NELP and Nonresident Cooperation models compared to the Global Cooperation model.

The Pearson's chi-square test of the residual deviance for the Violations, Cooperation, and Trust models for each data set (Global, NELP, and Nonresident) was completed to assess overall model fit. The tests were not significant (p >0.05) for any of the Violations or Trust models, indicating good fit for all of these models to the data sets. The statistical significance of the residual deviance for the Global Cooperation model (Pearson's chi-square = 500.28, 380 d.f., p = 3.219e-05), NELP Cooperation model (Pearson's chi-square = 243.29, 181 d.f., p = 0.00138), and Nonresident Cooperation model (Pearson's chi-square = 228.28, 174 d.f., p = 0.00360), indicated poor fit of these models. Considering results of the likelihood ratio tests that compared the Global models to each of the regional models, the NELP and Nonresident Cooperation model analyses were still examined for potential insight regarding hunter behavior towards cooperation with antlerless deer harvest, but these models should be interpreted with caution based on the poor overall fit of all of the Cooperation models.

Global Violations Model

The intercept and 8 of 30 (26.7%) variables from the Global Violations model were significant at the 0.001, 0.01, or 0.05 level (Table 7). These included 2 variables pertaining to enforcement, 1 pertaining to personal gains, 2 instrumental judgments variables, and 3 pertaining to normative influence (including 1 social norms variable and 2 procedural justice variables). Four of the statistically significant variables were negatively associated with past violations and

4 were positively associated with past violations. Addressing study objective 2, to characterize the extent to which enforcement, expected personal gains, and normative factors were associated with past decisions to comply with baiting regulations, these results indicate variables associated with all of these influences were associated with likelihood of violations.

The enforcement variable C_PENALTY_HUNT had the strongest negative association with past violations. This variable was a component of sanctions & adjudication (Figure 3), and assessed the belief that loss of hunting privileges was a penalty that could be applied for baiting violations (Table 2). In contrast, C_TICKET, which measured subjective estimates of the maximum fine for violating baiting rules (Table 2), was positively associated with past violations. The odds of an individual violating were 1.26 times greater as their estimate of the maximum fine increased (Table 7), which at first appears to be a nonsensical result. However, individuals who had chosen to violate in the past may have had greater awareness of the potential fine, either from investigating that cost prior to making their decision to violate or from past experience having been caught and ticketed. The modal response to the question regarding the maximum fine was "I don't know," selected by 74.2% of respondents that replied, but by a smaller proportion of those that admitted knowingly committing violations (63.9%) than those that indicated they've complied with past regulations (79.4%). This response was selected by less than half (46.8%) of respondents that indicated receiving a ticket in the past. Few respondents overall (7.6%) estimated the cost of the fine at a level higher than the actual $500 maximum established by law.

The variable BAIT_HARVEST had the strongest positive association with past violations. This variable was a component of personal gains (Figure 3), and assessed the extent to which respondents agreed that using bait created a better chance of harvesting a deer (Table

Table 7. Logit estimation of the Global Violations model.

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(Intercept)	-4.472*	1.747	-2.560	0.010	0.01
(Y) Baiting Value					
EFFICIENT	-0.020	0.195	-0.100	0.920	0.98
TIME	0.221	0.226	0.978	0.328	1.25
HARVEST	0.194	0.230	0.842	0.400	1.21
BAIT_EFFICIENT	-0.367	0.261	-1.405	0.160	0.69
BAIT_TIME	0.420	0.230	1.823	0.068	1.52
BAIT_SAFE	-0.216	0.237	-0.914	0.361	0.81
BAIT_HARVEST	1.219***	0.335	3.634	0.000	3.38
BAIT_DEER	0.141	0.337	0.418	0.676	1.15
BAIT_WILDLIFE	0.164	0.314	0.522	0.602	1.18
(E) Enforcement					
P_TICKET	0.110	0.117	0.947	0.344	1.12
C_TICKET	0.235*	0.100	2.355	0.019	1.26
P_PENALTY	-0.075	0.112	-0.672	0.502	0.93
C_PENALTY_HUNT	-0.924*	0.396	-2.332	0.020	0.40
C_PENALTY_EQUIP	0.629	0.405	1.554	0.120	1.88
(H) Hunting Value					
IMPORTANCE	-0.192	0.239	-0.806	0.420	0.82
(S) Social Norms					
RATE	-0.221***	0.061	-3.596	0.000	0.80
(I) Input					
DNR_INPUT	0.786**	0.272	2.892	0.004	2.19
(N) Neutrality					
DNR_SCIENCE	-0.799*	0.324	-2.470	0.014	0.45
DNR_PROCEDURE	0.260	0.285	0.914	0.361	1.30
(J) Justification					
DNR_EXPLAIN	-0.304	0.247	-1.232	0.218	0.74
DEER_TB	-0.066	0.220	-0.297	0.766	0.94

Table 7 (cont'd)

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(J) Justification					
COW_TB	-0.052	0.205	-0.254	0.800	0.95
BAIT_SPREAD	-0.195	0.233	-0.840	0.401	0.82
DEER_SPREAD	0.185	0.217	0.851	0.395	1.20
BAIT_DEER	-0.244	0.222	-1.096	0.273	0.78
BAIT_COW	0.215	0.240	0.894	0.371	1.24
(G) Goal Agreement					
GOAL_DEERERAD	-0.883**	0.283	-3.123	0.002	0.41
GOAL_COWERAD	0.672*	0.291	2.311	0.021	1.96
(Q) Equity					
AREA_A	0.197	0.301	0.656	0.512	1.22
(P) Performance					
SATISFACTION	0.179	0.106	1.691	0.091	1.20

*** p<0.001 ** p<0.01 * p<0.05

2). The odds of an individual violating were 3.38 times greater as agreement with this benefit of baiting increased.

The second strongest positive association with violations corresponded to PRACTICE_INPUT, the variable assessing the input component contributing to procedural justice in the conceptual model (Figure 3). With greater agreement that MDNR provides enough opportunities for hunter input regarding hunting rules, the odds of an individual violating were 2.19 times greater (Table 7). GOAL_COWERAD was also positively associated with violations. GOAL_COWERAD was a variable related to instrumental judgments of goal agreement in the conceptual model (Figure 3), and was calculated based on the importance respondents placed on the goal to get rid of bTB from livestock (Table 2). The odds of an individual violating were 1.96

times greater among those that placed higher importance on eradicating bTB from livestock (Table 7). It was not expected that individuals agreeing that MDNR provides enough opportunities for hunter input and in agreement with the goal of eradicating bTB from livestock would be more likely to commit baiting violations. Potential explanations and implications of these finding are discussed below.

The variables DNR_SCIENCE and GOAL_DEERERAD were negatively associated with past violations (Table 7). DNR_SCIENCE was a procedural justice variable that related to the neutrality component of the focused conceptual model, and GOAL_DEERERAD related to the goal agreement component of instrumental judgments (Figure 3). The odds of an individual violating were only 0.45 times as great with increasing agreement that MDNR considers the best available science when setting hunting rules, the measure used to calculate DNR_SCIENCE (Table 2). The odds of an individual violating were only 0.41 times as great among those that placed higher importance on eradicating bTB from deer, the measure used to calculate GOAL_DEERERAD (Table 2).

The variable RATE pertained to the social norms component of normative influence in the focused conceptual model (Figure 3), and was negatively associated with violations. RATE was calculated based on subjective estimates of the proportion of deer hunters that follow baiting rules (Table 2), so the result indicated those that complied with baiting regulations in the past believed a greater proportion of their fellow deer hunters complied. The odds of an individual violating were only 0.80 times as great as the estimate of compliance increased (Table 7).

NELP Cooperation Model

Three of 24 (12.5%) variables from the NELP Cooperation Model were significant at the 0.001 or 0.05 level (Table 8). Addressing study objective 3, to characterize the extent to which

Table 8. Logit estimation of the NELP Cooperation model.

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(Intercept)	-2.162	1.629	-1.327	0.185	0.12
(Y) Cooperation Value					
TIME	-0.210	0.278	-0.754	0.451	0.81
HARVEST	0.407	0.287	1.416	0.157	1.50
MULTI	-0.299	0.272	-1.097	0.272	0.74
HUNT_TIME	0.132	0.235	0.564	0.573	1.14
HUNT_HARVEST	0.162	0.266	0.609	0.543	1.18
HUNT_MULTI	0.231	0.267	0.866	0.387	1.26
(H) Hunting Value					
IMPORTANCE	0.405	0.270	1.501	0.133	1.50
(M) Moral Norms					
RESPONSIBILITY	-0.108	0.210	-0.517	0.605	0.90
(S) Social Norms					
NORM_HUNT	0.022	0.211	0.106	0.915	1.02
(I) Input					
DNR_INPUT	0.829*	0.356	2.331	0.020	2.29
(N) Neutrality					
DNR_SCIENCE	-0.690	0.364	-1.894	0.058	0.50
DNR_PROCEDURE	0.166	0.336	0.494	0.622	1.18
(J) Justification					
PRACTICE_EXPLAIN	-0.144	0.292	-0.491	0.623	0.87
DEER_TB	-1.030***	0.300	-3.430	0.001	0.36
COW_TB	0.647*	0.254	2.546	0.011	1.91
DEER_NO	-0.119	0.243	-0.490	0.624	0.89
DEER_SPREAD	0.047	0.227	0.206	0.837	1.05
DNR_DEER	0.290	0.311	0.934	0.350	1.34
DNR_COW	-0.504	0.302	-1.668	0.095	0.60
NEED	0.207	0.223	0.929	0.353	1.23

Table 8 (cont'd)

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(G) Goal Agreement					
GOAL_DEERERAD	0.286	0.288	0.992	0.321	1.33
GOAL_COWERAD	-0.428	0.298	-1.436	0.151	0.65
(Q) Equity					
AREA_A	0.538	0.369	1.459	0.145	1.71
(P) Performance					
SATISFACTION	0.094	0.130	0.729	0.466	1.10

*** p<0.001 ** p<0.01 * p<0.05

expected personal gains and normative factors were associated with past decisions to cooperate with reaching harvest objectives, all significant variables identified through the NELP Cooperation Model pertained to components of procedural justice in the focused conceptual model (Figure 3). These included DNR_INPUT, an input variable that assessed perceptions of whether MDNR provided enough opportunities for hunter input regarding hunting rules (Table 3), and DEER_TB and COW_TB, both of which were justification variables. DEER_TB and COW_TB evaluated whether respondents agreed it was possible to get rid of all bTB from deer and from livestock, respectively (Table 3).

DNR_INPUT and COW_TB were positively associated with cooperation, and DEER_TB was negatively associated with cooperation. The dependent variable PURCHASE was based on past license purchase history (Table 3). The odds of an individual cooperating with antlerless license purchase were 2.29 times greater as agreement increased that MDNR provided enough opportunities for hunter input regarding hunting rules (Table 8). The odds of cooperation were 1.91 times greater with an increase in agreement that it was possible to get rid of all bTB from

livestock, and only 0.36 times as great with an increase in agreement that it was possible to get rid of all bTB from deer.

Nonresident Cooperation Model

The intercept and 3 of 24 (12.5%) variables from the Nonresident Cooperation Model were significant at the 0.01 or 0.05 level (Table 9). Addressing study objective 3, to characterize the extent to which expected personal gains and normative factors were associated with past decisions to cooperate with reaching harvest objectives, significant variables identified through the Nonresident Cooperation Model pertained to personal gains and procedural justice components in the focused conceptual model (Figure 3). These included HUNT_HARVEST, a personal gains variable, and COW_TB and DNR_DEER, both of which pertained to the justification component of procedural justice. All of the statistically significant variables were positively associated with cooperation. The estimated odds ratios indicated the strongest association with cooperation corresponded to HUNT_HARVEST, followed by DNR_DEER and then COW_TB (Table 9).

HUNT_HARVEST assessed whether having a better chance to take at least 1 deer was an important influence on past decisions to purchase antlerless licenses (Table 3). DNR_DEER assessed whether respondents felt MDNR staff has set hunting rules they believe are needed to accomplish bTB eradication from deer, and COW_TB assessed whether respondents felt it is possible to eradicate bTB from livestock in the NELP (Table 3). The odds of an individual cooperating with antlerless license purchase were 2.30 times greater, 1.97 times greater, and 1.75 times greater with larger values of HUNT_HARVEST, DNR_DEER, and COW_TB, respectively (Table 9).

Table 9. Logit estimation of the Nonresident Cooperation model.

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(Intercept)	-4.022*	1.784	-2.254	0.024	0.02
(Y) Cooperation Value					
TIME	-0.223	0.289	-0.771	0.441	0.80
HARVEST	-0.501	0.351	-1.426	0.154	0.61
MULTI	0.261	0.326	0.801	0.423	1.30
HUNT_TIME	0.234	0.245	0.957	0.338	1.26
HUNT_HARVEST	0.833**	0.294	2.833	0.005	2.30
HUNT_MULTI	-0.171	0.245	-0.696	0.487	0.84
(H) Hunting Value					
IMPORTANCE	0.377	0.304	1.243	0.214	1.46
(M) Moral Norms					
RESPONSIBILITY	0.115	0.254	0.453	0.650	1.12
(S) Social Norms					
NORM_HUNT	0.040	0.250	0.158	0.874	1.04
(I) Input					
DNR_INPUT	-0.049	0.328	-0.149	0.881	0.95
(N) Neutrality					
DNR_SCIENCE	-0.123	0.375	-0.328	0.743	0.88
DNR_PROCEDURE	0.087	0.384	0.228	0.820	1.09
(J) Justification					
DNR_EXPLAIN	-0.423	0.370	-1.142	0.253	0.65
DEER_TB	-0.262	0.278	-0.942	0.346	0.77
COW_TB	0.557*	0.277	2.014	0.044	1.75
DEER_NO	-0.336	0.248	-1.356	0.175	0.71
DEER_SPREAD	-0.250	0.245	-1.021	0.307	0.78
DNR_DEER	0.680*	0.316	2.152	0.031	1.97
DNR_COW	-0.544	0.342	-1.588	0.112	0.58
NEED	0.349	0.252	1.385	0.166	1.42

Table 9 (cont'd)

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(G) Goal Agreement					
GOAL_DEERERAD	0.244	0.372	0.656	0.512	1.28
GOAL_COWERAD	-0.183	0.417	-0.438	0.661	0.83
(Q) Equity					
AREA_A	0.458	0.366	1.251	0.211	1.58
(P) Performance					
SATISFACTION	0.259	0.134	1.934	0.053	1.29

*** p<0.001 ** p<0.01 * p<0.05

Global Trust Model

The intercept and 5 of 19 (26.3%) variables from the Global Trust model were significant at the 0.001, 0.01, or 0.05 level (Table 10). Addressing study objective 4, to evaluate judgments associated with hunter trust in MDNR, the significant variables included 3 pertaining to procedural justice components and 2 pertaining to instrumental judgment components in the focused conceptual model (Figure 3). The significant procedural justice variables included both neutrality variables DNR_SCIENCE and DNR_PROCEDURE and the justification variable DNR_EXPLAIN. These variables assessed agreement that MDNR considered the best available science, followed consistent decision-making procedures, and explained different options considered and why the final option was selected when setting hunting regulations, respectively (Table 4). The significant instrumental judgments variables included GOAL_DEERERAD (a goal agreement variable) and SATISFACTION (a performance variable). GOAL_DEERERAD was calculated based on the importance respondents placed on the goal to get rid of bTB from deer , and SATISFACTION reflected how satisfied respondents were with recent NELP deer

Table 10. Logit estimation of the Global Trust model.

Category/Variable	Coefficient	Std. Error	z value	Pr(>|z|)	Odds Ratio
(Intercept)	-12.644***	1.493	-8.467	0.000	0.00
(I) Input					
DNR_INPUT	0.277	0.296	0.935	0.350	1.32
(N) Neutrality					
DNR_SCIENCE	1.707***	0.339	5.039	0.000	5.51
DNR_PROCEDURE	1.099***	0.322	3.411	0.001	3.00
(J) Justification					
DNR_EXPLAIN	0.890**	0.308	2.890	0.004	2.44
DEER_TB	-0.061	0.280	-0.217	0.828	0.94
COW_TB	-0.240	0.268	-0.893	0.372	0.79
DEER_NO	-0.026	0.251	-0.105	0.916	0.97
BAIT_SPREAD	-0.111	0.309	-0.359	0.720	0.90
DEER_SPREAD	-0.221	0.303	-0.728	0.467	0.80
BAIT_DEER	0.346	0.306	1.130	0.259	1.41
DNR_DEER	0.180	0.350	0.514	0.607	1.20
BAIT_COW	0.093	0.416	0.224	0.823	1.10
DNR_COW	0.266	0.365	0.730	0.466	1.31
(G) Goal Agreement					
GOAL_DEERERAD	0.929*	0.418	2.223	0.026	2.53
GOAL_COWERAD	-0.701	0.419	-1.673	0.094	0.50
(Q) Equity					
AREA_A	-0.187	0.358	-0.523	0.601	0.83
(P) Performance					
SATISFACTION	0.370**	0.127	2.923	0.003	1.45
P_TICKET	0.168	0.125	1.346	0.178	1.18
P_PENALTY	-0.078	0.122	-0.639	0.523	0.93

*** p<0.001 ** p<0.01 * p<0.05

hunting experiences (Table 4). All of the statistically significant variables were positively associated with trust.

The estimated odds ratios indicated both neutrality variables had the strongest association with trust. The odds of an individual placing trust in MDNR were 5.51 times greater and 3.00 times greater among those for whom agreement was greater that MDNR considers the best available science (DNR_SCIENCE) and among those for whom agreement was greater that MDNR follows consistent decision-making procedures (DNR_PROCEDURE) when setting hunting rules (Table 10). Among 10 justification variables, DNR_EXPLAIN was the only one associated with TRUST. The estimated odds ratio of an individual trusting MDNR were 2.44 times greater among those for whom DNR_EXPLAIN was higher (Table 10).

GOAL_DEERERAD had the strongest association with TRUST between the 2 significant instrumental judgments variables. SATISFACTION was the significant variable least strongly associated with TRUST. Higher agreement with the bTB goal for deer was associated with 2.53 times greater odds of placing trust in MDNR, and higher satisfaction with deer hunting experiences was associated with 1.45 times greater odds of placing trust in MDNR (Table 10).

DISCUSSION

This study increased knowledge regarding compliance with hunting regulations beyond prior research that largely assessed poaching or other violation events as a cultural phenomenon (Brymer 1991), in terms of personal motivations or rationalizations (Eliason 2004), or primarily as an activity to be deterred by enforcement (Hilborn et al. 2006). The multiple interacting factors assessed in my conceptual framework guiding this research (Figure 3) drew on findings from compliance research that evolved over time from focusing exclusively on rational economic utility to exploring normative influence as well (Tyler 1990, Kuperan and Sutinen 1998, Hatcher

et al. 2000). The assessment also extended beyond addressing violation behavior to integrate examination of hunter cooperation with wildlife management efforts and assessments of agency trust. In so doing, it presented an opportunity to examine how agency actions and policies contribute collectively to compliance, cooperation, and trust rather than studying these outcomes in isolation. Past theories were also tested in a new context, through a detailed assessment of individuals' trust, compliance, and cooperation with specific actors exercising specific authorities, which is a necessary approach for developing specific recommendations to enhance government performance (Levi and Stoker 2000).

A motivation for this research was to explore an alternative means through which wildlife agencies may meet their public trust responsibilities other than through the typical approach of simply adopting regulations and applying deterrence-based strategies to achieve adequate compliance. Solely through modification of policies and procedures, procedural justice may represent an efficient way for agencies to build trust, improve compliance, and elicit cooperative behavior that cannot be influenced through deterrence (Burby and Paterson 1993, Levi and Stoker 2000, Meares 2000). These research findings indicated establishing fair and impartial processes for implementing regulations may build trust among the hunting public. The potential benefits of procedural justice were less clearly evidenced, however, when comparing significant findings from the analysis of trust to those of compliance and cooperation. The additional normative factors, personal gains, and enforcement approaches that can influence compliance and cooperation in some instances overshadow the influence of procedural justice, and in some cases procedural justice variables appeared negatively related to the expected influence on compliance and cooperation behaviors. These results are discussed in more detail below, along with recommendations for future directions in research and management.

Assessing the Association of Procedural Justice and Instrumental Judgments to Trust

The findings with respect to trust supported prior research regarding the importance of establishing fair and impartial processes for adopting regulations, while acknowledging that trust can also be derived instrumentally, from basic judgments by the public of laws or the motivations for their establishment (Tyler 2000, Blader and Tyler 2003, Murphy et al. 2009). Results highlighted the importance of public evaluations of the process through which regulations are adopted rather than perceptions regarding the justification provided during that process. Three out of the 4 procedural justice variables in the Global Trust model specifically relating to subjective assessments of MDNR practice during the process of adopting regulations were significant: DNR_SCIENCE, DNR _PROCEDURE, and DNR _EXPLAIN (Table 10). Variables designed to assess the conceptual importance of these factors when setting deer hunting regulations (INPUT, SCIENCE, PROCEDURE, EXPLAIN; Table 4) were not included in analyses because virtually all respondents agreed with statements in the questionnaire regarding the importance of these variables. None of the justification variables that assessed whether hunters shared beliefs with MDNR regarding the dynamics of bTB and need for specific management strategies (DEER_TB through DNR_COW; Table 4) were significant.

DNR_INPUT was the only process-related procedural justice variable not significantly associated with TRUST (Table 10). This appears counter to expectations based on past findings regarding procedural justice (Tyler and Lind 1992, Paternoster et al. 1997, Tyler 2000). However, Tyler (2000) noted input may be an ineffective source of procedural justice on its own, and Kaina (2008) indicated that citizen demands to have input may be indicative of low trust due to unwillingness to accept decisions without intervening personally in the process. Those that express trust in MDNR to establish appropriate deer regulations may therefore not concern

themselves with evaluations of whether opportunities provided for input are adequate. This may be the reason that DNR_INPUT did not contribute significantly to trust in the logit analyses.

Among the variables assessed that pertained to instrumental judgments, GOAL_DEERERAD and SATISFACTION were significant and positively associated with trust (Table 10). The odds ratios suggested SATISFACTION was the variable least strongly associated with trust. SATISFACTION measured overall satisfaction with recent deer hunting experiences in the NELP (Table 4), and so it represented a variable over which MDNR had only limited influence. GOAL_DEERARAD was more strongly associated with trust than DNR_EXPLAIN, but less strongly associated with trust in comparison to the other procedural justice variables (Table 10). GOAL_DEERARAD measured goal agreement between respondents and MDNR by assessing perceived importance of getting rid of bTB from deer (Table 4). Collectively, then, favorable evaluations of the processes used by MDNR to establish deer hunting regulations were more likely to elicit expressions of trust in MDNR for carrying out this responsibility. Agreement with a primary goal that motivated recent MDNR regulatory approaches (eradication of bTB from deer) and direct benefits to hunters in terms of overall satisfaction with deer hunting were additional factors influencing trust.

Assessing the Association of Personal Gains and Normative Influence to Cooperation

Consideration of Regression Modeling Approach

The likelihood ratio tests supported the NELP and Nonresident Cooperation Models over the Global Cooperation Model. The statistical significance of the residual deviance for all of the Cooperation models, however, indicated poor fit of all of these logit models. In contrast, good fit was indicated for all of the Violations and Trust Models, but in each case the Global models were supported over the distinct sample models. There appears to be more unexplained

variability and challenge in assessing decisions regarding cooperation than was encountered in efforts to examine significant factors affecting compliance and trust.

Collective Insight Regarding Cooperation

The difficulty encountered in efforts to assess decisions regarding cooperation was not unexpected. An abundance of prior research has failed to identify aspects of agency management efforts that substantially influence hunter motivation to harvest deer (Brown et al. 2000, Riley et al. 2003, Giles and Findlay 2004, Holsman and Petchenik 2006, Van Deelen et al. 2006). The findings regarding the positive influence of personal gains on cooperation through HUNT_HARVEST in the Nonresident Cooperation Model (Table 9) was consistent with prior research that has indicated hunter harvest decisions are largely driven by opportunities to enhance recreation experiences rather than by agency rationale for reducing deer densities Holsman and Petchenik 2006, Van Deelen et al. 2006). That this variable was only significant within the Nonresident Cooperation Model may indicate that hunters traveling to the NELP hold different expectations regarding what constitutes substantial personal gains through recreational hunting. No personal gains potentially created through instrumental judgments were significant in either the NELP or Nonresident Cooperation Models.

Despite the interest in increasing the chance to take at least 1 deer, hunters were not motivated by personal gains to harvest sufficient antlerless deer to reduce overall deer densities, likely out of concern about consequently seeing fewer deer when hunting in the future. Frawley and Rudolph (2008) found that 62% of hunters believed there were very extensive to moderate problems with the number of deer where they hunted, while just 21% of hunters in the NELP region were concerned with deer herd health in their area. However, hunters were even more concerned with the number of bucks and number of mature bucks in their hunting area (viewed

as very extensive to moderate problems by 67 and 72% of hunters, respectively). Hunters may be encouraged to harvest antlerless deer rather than bucks in an effort to alter population sex ratios, even though this may also maintain a smaller population. Pursuit of this concept, however, represents a risk. Older male deer are the segment of the deer population at greatest risk of bTB infection (O'Brien et al. 2002). If shifting harvest away from bucks caused the proportion of older male deer in the population to increase, it would be necessary to increase antlerless harvest sufficiently to offset a rise in bTB prevalence.

No relationship was found between moral and social norms and cooperation. Norms that broadly apply to following of rules could not influence cooperation, as no regulations specifically mandated this behavior. Those variables that assessed general moral norms regarding deer management and any potential influence of hunting partner or neighbor's desires for more antlerless deer to be taken (RESPONSIBILITY and NORM_HUNT, respectively; Table 3) were not significant.

Procedural justice does appear to exert some normative influence on cooperation behavior. COW_TB and DNR_DEER, 2 variables related to the justification component of procedural justice, were both associated with higher levels of cooperation in the Nonresident Cooperation Model (Table 9), and COW_TB demonstrated the same relationship in the NELP Cooperation Model (Table 8). COW_TB assessed perceptions of whether it is possible to get rid of bTB from livestock, and DNR_DEER assessed whether respondents believed MDNR staff truly believed deer hunting rules they established were needed to get rid of bTB from deer (Table 3). DNR_INPUT was another procedural justice variable positively associated with antlerless license purchase in the NELP Cooperation Model, but DEER_TB (which assessed perceptions of

whether it is possible to get rid of bTB from deer; Table 3) was negatively associated with cooperation in that logit model (Table 8).

The collective results of the cooperation logit models indicate that some hunters choose to cooperate with antlerless license purchase out of their own interest in enhancing opportunities to take at least one deer, but that a variety of evaluations regarding the possibility of eradicating bTB and whether MDNR staff truly felt past regulations were justified based on a desire to reach this goal are also related to cooperation. The negative association between DEER_TB and cooperation in the NELP Cooperation Model may initially appear counterintuitive relative to theory regarding impacts of procedural justice, the potential exists that some respondents may believe it is possible to eradicate bTB from deer but still oppose or at least not feel obligated to cooperate with the management strategies implemented in an effort to achieve that goal. Agreeing that a goal can be achieved and endorsing the means to do so are different questions, and the significance of DNR_INPUT in the NELP model may reflect an expectation by NELP resident hunters to be engaged in MDNR decisions regarding the approach to this goal.

Assessing the Association of Enforcement, Personal Gains, and Normative Influence to Violations

Personal Gains and Violations

As expected, general recreational value of hunting was an influential form of personal gains, similar to the economic incentives that have appeared at times to limit the influence of normative factors on commercial fishing compliance (Ludwig et al. 1993, Kuperan and Sutinen 1998, Hatcher et al. 2000, Ali and Abdullah 2010). Although illegally enhanced income is not a factor pertaining to motivation for deer hunters to use bait, personal gains associated with a perceived improved opportunity to harvest a deer (BAIT_HARVEST) was the variable most

strongly associated with past violations (Table 7). However, two very similar variables assessing potential personal gains through instrumental judgments demonstrated contrasting relationships to past violations. Goal agreement with MDNR goals to eradicate bTB from deer and from livestock were both expected to reduce violations. GOAL_DEERERAD was negatively associated with past violations, but GOAL_COWERAD was positively associated with past violations. Individuals that feel reducing or eradicating bTB from livestock is an important goal may be more likely to violate if they feel the baiting ban is ineffective or counter to reaching that goal. This could result if individuals believe baiting creates more good than harm to bTB eradication by enhancing the harvest of deer sufficiently to counteract any negative effects through enhancing concentrations of deer. Such comments have regularly been made by the hunting public as an appeal to allow baiting throughout the NELP, though past evaluations have indicated baiting does not increase overall harvest of deer (Rudolph et al. 2006, Van Deelen et al. 2006).

Normative Influence and Violations

Moral influence may arise from either believing a specific action such as baiting or antlerless deer harvest is inherently the right or wrong thing to do or believing rule violation is inherently the wrong thing to do. Questionnaire errors prevented some opportunities of incorporating several variables that measured normative influence into the logit models. However, examining the data from those that complied with the baiting ban indicated moral norms pertaining to following rules in general potentially exerted an influence on decisions regarding the practice of baiting. Regression models indicated a belief that a greater proportion of hunters comply with baiting rules was negatively associated with past violations, meaning those that believe compliance is common were more likely to comply themselves. This suggests

a social normative influence as a consequence of individuals conforming to the real or perceived rate of violations.

Among the procedural justice variables, DNR_SCIENCE was negatively associated with past violations. However, DNR_INPUT was positively associated with past violations. The dominant theory and bulk of prior procedural justice research would predict those that more favorably judged the opportunities provided for input by agencies would have been less likely to violate. Input in particular, however, may be an ineffective source of procedural justice on its own, for individuals must also believe their input has been sincerely considered (Tyler 2000). Considering that no procedural justice variables pertaining to justification were significant in the Global Violations Model, this may be a reasonable explanation for the positive association between DNR_INPUT and violations.

Enforcement and Violations

Research has shown the risk of punishment is more important to determining compliance than the severity of the punishment (Burby and Paterson 1993, Tyler 2003), but variables assessing subjective measures of detection and apprehension (P_TICKET and P_PENALTY) were not significant in the Global Violations Model. It is possible that public awareness of the challenges faced in enforcement of natural resources violations − low ratios of conservation officers per resource user, the difficulties of detecting violations in often remote locations, and public resistance and legal challenges to the use of aggressive enforcement techniques (Sutinen and Kuperan 1999, Sherblom et al. 2002, Falcone 2004) − is sufficient that the risk of punishment is less influential than in other contexts. The only significant enforcement variable that was negatively associated with violations was C_PENALTY_HUNT (the loss of hunting privileges as a penalty of violating baiting rules), a component of sanctions and adjudication.

Collective Insight Regarding Violations

In comparison to past research and theory, these findings appear intermediate between prior findings within the general policing literature regarding general policing and federal law making authority (Tyler 1994, Sunshine and Tyler 2003, Murphy 2005) and assessments applying that theory to specific natural resource contexts such as commercial fishing. It is not certain that the strong promise identified in the general policing literature regarding attempting to secure compliance through procedural justice rather than expensive investment in enforcement (Meares 2000, Tyler 2000) would be be likely to substantially improve compliance with the baiting ban established in pursuit of bTB eradication in Michigan. My data suggests that decisions to comply with baiting regulations may be more complex than the commercial fishing contexts that largely have been shown to incorporate a balance of enforcement threats with promise of personal gains (Kuperan and Sutinen 1998, Hatcher et al. 2000, Ali and Abdullah 2010). Furthermore, the expense of enhancing enforcement in this instance may not be prohibitive. As Tyler (2003) indicated, applying sufficiently severe penalties to influence deterrence is generally a more obtainable goal than improving detection and apprehension. The results of the enforcement assessment present a possible means of accomplishing this end. In addition to potentially serving as an effective deterrent, loss of hunting privileges may be less likely to be perceived as an excessive and unjust penalty in comparison limited support that often exists within the legal system for applying higher natural resource violation fines equal to or in excess of other criminal acts (Sutinen and Kuperan 1999).

Limitations to Applying Findings

Prior to considering implications of this research for application to management efforts or further study, several recognized limitations should be acknowledged. Of course, all research is

subject to errors in methodology. Errors in wording of questions intended to assess the variables RULES, ETHICS, and NORM_BAIT (Table 2) prevented consideration of these variables and the overall moral category within the logit models of violations. This was unfortunate, but careful review of the distribution of survey responses and repeated reference to the original survey instrument (Appendix) throughout data analysis identified these errors before data were inappropriately applied.

The questionnaire developed for this research was based on a focused conceptual model (Figure 3) that excluded the instrumental judgment factor of identification and procedural justice factor of dignity identified in the initial conceptual model (Figure 2). Identification and dignity have been shown through past research to be important factors (Braithwaite 1995, Paternoster et al. 1997, Tyler 2000), but the interpersonal interactions through which identification and dignity are built were likely to have been experienced by a very small subset of most survey recipients. These variables were therefore excluded from assessment. Indirect measures were used to evaluate the instrumental judgment variables of equity and performance, so a different approach to measurement may have yielded different results.

Several other challenges exist that are unique to applying the type of data used in this study. The difficulties of relying on self-reported instances of violations have been previously addressed, and significant effort was invested in overcoming the challenges to collecting reliable violation data. However, the approach of associating past behaviors with present (as of the time of the survey) opinions introduced other limitations. The measured perceptions of survey participants relevant to enforcement, personal gains, and normative influence were assumed to have influenced past decisions regarding violations and cooperation, but they may have differed at the time of the survey in comparison to the perceptions held at the time the behavior of interest

occurred. This problem of temporal ordering was reviewed by Paternoster (1987) relevant to assessing the influence of sanctions, for data is regularly collected from violators whose experience with enforcement may have changed their views about the certainty or severity of punishment from those held at the time they chose to violate. These complications may have emerged in this study among the survey respondents that had received a citation. Similarly, recent direct experiences with rule-making processes may have produced different assessments of trust than those that drove past behavior. Paternoster (1987) pointed out problems of temporal order were most likely to skew conclusions when only a single or few independent variables are assessed in relation to the behavior of interest. This study minimized this vulnerability through exploration of multiple independent variables.

With no prior reliable knowledge regarding the rate of violation, it was important to not rely on an entirely random sample to recruit a suitable number of study participants that had violated in the past. A sample of participants was therefore recruited from a list of known violators to be sure the important perspectives of these individuals were measured, despite the potential that the experience of facing sanctions may have affected perceptions regarding relationships studied through this research. For example, 42.6% of respondents from the Known Violators sample strongly disagreed that they trust the MDNR to establish appropriate deer hunting rules (the measure of the dependent variable TRUST), compared to 31.1% in the NELP sample and 17.7% in the Nonresident sample (Table 5). Though the personal experiences of these individuals may have substantially altered their perceptions relative to others in this study, those that have experienced enforcement of the regulations are an important segment of the deer hunting community. The general questionnaire used for all study participants, however, did not

allow for assessing specific elements of their experiences with enforcement. This is a limitation that could be addressed through future research.

A final recognized methodological limitation of this study relates to the challenges of implementing changes based on these analyses of hunter perceptions. Perceptions may not match reality. This was an important motivation for directly measuring hunter perceptions of detection and apprehension and sanctions and adjudication, for example, because the ability to apply large fines will not deter violations among those that are not aware of those fines. The power of perception may also limit the effectiveness of implementing policies and practices to emphasize factors of procedural justice. Research may guide formulation of what most of the hunting public would consider to be ideal processes, but if individuals are unaware of what those processes involve, they cannot possibly develop perceptions about them that are likely to influence future behavior.

Trust was measured in terms of establishment of appropriate deer hunting rules, and as Levi and Stoker (2000) note, trust "is given to specific individuals or institutions over specific domains" (476). Conclusions regarding many potential benefits of trust cannot be assessed here, so efforts should not simply seek to increase perceptions of trust without considering the opportunity costs relative to tangible benefits of doing so. However, several potential outcomes of enhanced trust directly related to this case study could result from increased hunter support for enforcement. Such support could increase reporting of violations or decrease conflict during encounters with LED conservation officers, thereby reducing the potential for altercations for those that already significant hazards on the job (Hooper and Fletcher 1989, Sherblom et al. 2002, Sunshine and Tyler 2003).

Lastly, this study was of necessity limited in scope. This work focused exclusively on assessing levels of compliance, cooperation, and trust ascribed to the agency only by deer hunters of the NELP. This was motivated by the recognition that these individuals not only represent an important stakeholder affected by bTB, but that regulating their behavior represents the most viable means of accomplishing the eradication goal of the state of Michigan. Efforts to develop more focused controls are ongoing (O'Brien et al. 2011a), but improving hunter compliance and cooperation has been identified as the only feasible means of furthering MDNR's current broad-scale bTB control strategies (O'Brien et al. 2011b). Previous research indicated hunters from different areas of the state hold different perceptions regarding the acceptability of area-specific bTB management strategies (Frawley 2000, Dorn and Mertig 2005, Rudolph et al. 2006). Therefore, perceptions of study participants cannot be assumed to be typical of all deer hunters. Furthermore, a potential exists that accumulating trust regarding deer management could translate to overall higher regard for the agency among the hunting public, as approximately 90% of all licensed hunters in a given year pursue deer, and 60% of hunters purchase only a deer license (Frawley 2006). Given the importance of deer hunting within the hunting community, enhanced trust could potentially increase support generally for efforts to manage other species through hunting regulations or for general hunting license fee increases or other funding initiatives. Where these findings are consistent with the body of previous literature, concepts identified that may help shape future levels of compliance, cooperation, and trust are likely to apply to deer hunters throughout the state and even more broadly. Otherwise, findings may be context-specific based on deer hunter perceptions and conditions in the NELP.

Research and Management Recommendations

Recommendations Regarding Enforcement

Enforcement efforts for improving compliance should focus on applying loss of hunting privileges to the extent currently possible as a penalty for those who use bait, seeking broader discretion to apply this penalty, and raising public awareness about this consequence for baiting violations. The perception that loss of hunting privileges is an applicable baiting penalty was the strongest negative association with past violations, but directly applying this penalty simply for using bait is not currently provided by law. The suspension of hunting privileges is applicable as a penalty to those that possess an illegally taken deer (NREPA Sec. 324.40118 (3) and (6)). Therefore, a potential means currently available to MDNR for improving enforcement overall would involve citing those that harvest a deer using bait as possessing an illegal deer, and applying suspension of hunting privileges as a consequence. MDNR staff and NRC members have attempted (unsuccessfully, thus far) to facilitate legislative adoption of this penalty directly for baiting violations, and continuing these efforts appears warranted.

My results indicated a high level of misperception regarding suspension of hunting privileges and low knowledge regarding the potential amount of baiting fines. This highlights the importance that any effort to influence hunter behavior through sanctions and adjudication depends not simply on applying penalties viewed as significant, but also on public awareness of those penalties. If MDNR pursues a policy of citing hunters that illegally use bait to aid in taking deer as possessing an illegal deer, or if this penalty ultimately comes to be legally applied to baiting violations directly, efforts should be undertaken to publicize these policies and laws. Future research may be necessary to guide or evaluate efforts to increase this awareness and assess its effectiveness.

Recommendations Regarding Personal Gains

Efforts should be considered to advise hunters regarding the best locations and methods of hunting that do not involve using bait, provide assistance through habitat management to increase deer sightings, or encourage hunters to harvesting antlerless deer rather than bucks in an effort to maintain a smaller population. Though it is unclear that such programs could be efficiently or effectively delivered, the rate of violations and cooperation were strongly associated with the perceived benefits that using bait and possessing an antlerless license enhances the opportunity to take at least 1 deer (though in the latter instance, this was only the case among hunters that resided outside of the NELP). The programs suggested for consideration may provide an opportunity to enhance compliance and cooperation through the capacity component of the original conceptual model (Figure 2). Future research may be needed to guide development or assess effectiveness of such programs.

Recommendations Regarding Normative Influence

Potential benefits of trust are a topic where additional research is needed.

Alternative approaches to enhancing compliance and cooperation through procedural justice could focus on hunter input in the process of setting regulations or reinforcing the scientific basis used to substantiate regulations necessary for eradicating bTB from deer. Although assessment of adequate opportunities for input was positively associated with violations, input was also positively associated with cooperation. Better demonstrating that input is given serious consideration may be of benefit, DNR_SCIENCE was strongly associated with both trust and reduced likelihood of past violations, as was GOAL_DEERERAD, so efforts could focus on emphasizing that the best available science is used to formulate recommendations, or to increase recognition of the benefits of eradicating bTB from deer. Future

research could examine whether such efforts could build trust, and if enhanced trust minimizes expectations for input.

Opportunities to Implement Change

This research was conducted out of a desire to enhance the technical guidance provided to policy makers by improving understanding of the association of diverse aspects of enforcement, personal gains, and normative influence with hunter compliance and cooperation, particularly with regard to bTB management efforts. Increasing evidence regarding bTB dynamics and persistence in the deer population suggests complete eradication may not be feasible. The majority of hunters also believe this to be the case, for only 19.4% of survey respondents agreed that it was possible to eradicate bTB from NELP deer, and only 4.7% strongly agreed. As the hunting public expects MDNR procedures for adopting and enforcing regulations to make use of the best available science, pursuing an impossible goal may lead to eroding trust of the agency and ineffectiveness of regulations with which it is desired that hunters comply.

It is not within the authority of WLD staff or even overall leadership of MDNR or the NRC to replace the goal of bTB eradication. A 1998 Governor's Executive Directive (Engler 1998) committed all appropriate Michigan agencies to pursue the objective, and the federal government is also committed to a national bTB eradication program (Frye 1995). The challenge of pursuing goals established by such directives and providing technical guidance when that goal is not feasible is not unique to bTB eradication efforts. Operating under the North American public trust doctrine, natural resource agency personnel serve as trust managers, bearing the responsibility for providing technical guidance and enforcing regulations, while elected and appointed officials are accountable as the trustees of public wildlife resources, holding direct

authority for final decision making and enacting laws and regulations (Morse 1973, Horner 2000, Smith 2011). It is encouraging that hunters appear to recognize the value of this role played by wildlife managers. Agency performance regarding use of the best available science was strongly associated with assessments of trust and was the only component of procedural justice positively associated with compliance. Maintaining and building on the positive perceptions of scientifically-based management may require raising public awareness to distinguish the separate roles played by trust managers and trustees in setting and pursuing goals (Horner 2000, Smith 2011).

Ludwig et al. (1993) suggested scientists should be relied on "to recognize problems, but not to remedy them" (36). The technical advice provided by agency staff to policy makers should emphasize the importance of defining achievable goals for wildlife management, and for how to effectively engage the public in the process of defining those goals. Greater interaction with and responsiveness to the public has become common as part of an evolution towards overall collaborative governance approaches (Rudolph et al. 2012). Research capable of informing decisions regarding appropriate engagement will not only be relevant to the framework for managing public trust wildlife resources, but may also help build on the limited influence that procedural justice currently appears to have on improving wildlife management effectiveness. This research may prove useful in providing a framework for measuring these associations. Efforts to potentially improve management capacity can be guided by such insight, but implementation in many instances is at the discretion of the elected and appointed officials ultimately accountable as the trustees of public wildlife resources.

APPENDIX

MATERIAL USED FOR BACKGROUND INFORMATION, INSTRUCTIONS, QUESTIONS, AND RESPONSES IN A MAIL SURVEY OF NORTHEAST LOWER PENINSULA MICHIGAN HUNTERS.

You are being asked to participate in a study of hunter opinions regarding regulations that the Michigan Department of Natural Resources (DNR) indicates are necessary to manage white-tailed deer populations and address an infection of bovine tuberculosis (TB) in northeast Michigan. This study is being conducted collaboratively by Michigan State University (MSU) and DNR. You are being contacted because data on hunting license sales and/or past information you have provided to DNR indicated that you have hunted deer in northeast Michigan.

Your answers will be kept completely confidential. The survey has identifying information so that we may check your name off our mailing list when it is returned. **Your name and address will never be associated with your responses in any way and your privacy will be protected to the maximum extent allowable by law.** By completing and returning this survey, you indicate your voluntary agreement to participate in this study.

While your response to this survey and any of the questions is completely voluntary, your help may aid wildlife managers more effectively involve the public in resource management decisions. Information you provide will also serve as another form of input as future hunting regulations are developed that may be important to you.

Unless otherwise indicated, you should respond to questions specifically based on your hunting experiences within northeast Michigan, including Alcona, Alpena, Antrim, Charlevoix, Cheboygan, Crawford, Emmet, Iosco, Montmorency, Ogemaw, Oscoda, Otsego, Presque Isle, and Roscommon counties. If you hunt elsewhere as well, please provide your answers about your hunting within this region only.

We look forward to hearing from you soon. Please fill out this survey at your earliest convenience – it should take about **15 minutes or less**. Then tape it shut, and drop it in any mailbox (postage is provided and no envelope is needed). If you choose not to complete the questionnaire, please check this box, seal it, and return it as-is:

☐ I do not wish to participate in this study.

If you have concerns or questions about this study, please contact the Primary Investigator Dr. Shawn J. Riley at Department of Fisheries and Wildlife, 13 Natural Resources, MSU, East Lansing, MI 48824, 517-353-9456, email rileysh2@msu.edu, or Study Coordinator Brent A. Rudolph at Rose Lake Wildlife Research Center, 8562 East Stoll Road, East Lansing, MI 48823, 517-641-4903, email rudolphb@michigan.gov.

If you have any questions or concerns about your role and rights as a research participant, or would like to register a complaint about this study, you may contact, anonymously if you wish, Michigan State University's Human Research Protection Program at 517-355-2180, Fax 517-432-4503, e-mail irb@msu.edu, or regular mail at 207 Olds Hall, MSU, East Lansing, MI 48824.

GENERAL DEER HUNTING EXPERIENCES

1. **About how many years ago did you start hunting deer? _____ Years**

2. **How important is deer hunting for you compared to your other recreational activities?**

   (Select one choice.)

   My most important recreational activity

   One of my more important recreational activities

   No more important than other recreational activities

   Less important than most of my recreational activities

   Not at all important as a recreational activity

3. **Listed below are factors that may affect deer hunting satisfaction. For each factor, please indicate how strongly you agree or disagree that this factor affected YOUR hunting satisfaction with your deer hunting each season. *(Please choose only one response for each factor.)***

   Factors

   Harvesting deer in as little time as possible

   Spending as much time as possible deer hunting

   Harvesting deer as safely as possible

   Harvesting a deer

   Harvesting multiple deer

   Seeing deer while hunting

   Seeing other wildlife while hunting

   Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

DEER HUNTING IN NORTHEAST MICHIGAN

4. **How satisfied or dissatisfied were you with your recent deer hunting experiences in northeast Michigan?** ***(Select one choice.)***

   Very satisfied

   Somewhat satisfied

   Neutral

   Somewhat dissatisfied

   Very dissatisfied

5. **In how many of the last 5 years do you recall having purchased one or more ANTLERLESS deer hunting licenses for northeast Michigan?**

   _____ Years *(Fill in 0 through 5.)* OR _____ I don't remember

6. **In how many of the last 5 years do you recall having purchased one or more ANTLERLESS deer hunting licenses?**

   _____ Years *(Fill in 0 through 5.)* OR _____ I don't remember

7. **Indicate how strongly you agree or disagree that the following reasons affected your decision to purchase an ANTLERLESS deer hunting license or harvest an ANTLERLESS deer in northeast Michigan in the last 5 years.** ***(Please choose only one response for each reason.)***

   Reasons

   It was a way to increase the amount of time I could hunt deer

   It was a way to give me a chance to take at least one deer

   It was a way to increase the number of deer I could harvest

   My hunting partners or neighbors wanted antlerless deer taken

The DNR has indicated a need for hunters to take antlerless deer

I have a responsibility to help manage the deer population

Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

DEVELOPMENT OF HUNTING RULES

8. Indicate how strongly you agree or disagree with the following statements about steps in setting deer hunting rules. *(Please choose only one response for each statement.)*

Statement

It is important for hunters to have opportunities to provide input regarding hunting rules

It is important to use the best available science when setting hunting rules

It is important to follow consistent decision-making procedures when setting hunting rules

It is important that decision-makers explain different options considered when deer hunting rules are set, and why the final option was selected

Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

9. Indicate how strongly you agree or disagree with the following statements about the approach used by the Michigan Department of Natural Resources to set deer hunting rules. *(Please choose only one response for each statement.)*

Statement

DNR provides enough opportunities for hunters to have input regarding hunting rules

DNR considers the best available science when setting hunting rules

DNR follows consistent decision-making procedures when setting hunting rules

DNR explains different options considered when deer hunting rules are set, and why the final option was selected

I trust the DNR to establish appropriate deer hunting rules

Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

BOVINE TUBERCULOSIS

Bovine tuberculosis (TB) is a disease caused by a bacterial infection that makes breathing difficult. If left untreated, it may result in the death of the infected animal. The disease affects cattle, and is found every year in a small number of wild deer in northeast Michigan. Michigan's goal is to get rid of all TB in the state.

10. Indicate how strongly you agree or disagree with the following statements about bovine tuberculosis (TB) in Michigan. ***(Please choose only one response for each statement.)***

Statement

It is **possible** to get rid of all TB from **deer** in northeast Michigan

It is **possible** to get rid of all TB from **livestock** in northeast Michigan

It is **important** to reduce or get rid of all TB from **deer** in northeast Michigan

It is **important** to reduce or get rid of all TB from **livestock** in northeast Michigan

TB spreads more easily when deer numbers are high

TB can spread from deer to deer at locations where bait is used by hunters

Deer can spread TB to livestock

DNR staff believes that **baiting** rules are needed to get rid of all TB from **deer** in northeast Michigan

DNR staff has set deer **hunting** rules they believe are needed to get rid of all TB from **deer** in northeast Michigan

DNR staff believes that **baiting** rules are needed to get rid of all TB from **livestock** in northeast Michigan

DNR staff has set deer **hunting** rules they believe are needed to get rid of all TB from **livestock** in northeast Michigan

Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

BAITING, COMPLIANCE & ENFORCEMENT

Baiting was banned throughout northeast Michigan from the 2008 through 2010 hunting seasons, and was banned in some counties in this region even prior to this. Despite this, some hunters continued to use bait. It is important to know more about this use of bait and the approach used to enforce baiting rules to evaluate the ban.

11. What is the maximum fine for violating baiting rules?

_____ Dollars OR I don't know.

12. What other penalties can be applied for violating baiting regulations? *(Please mark all that you feel apply.)*

Loss of hunting privileges

Confiscation of equipment (vehicle, firearm, etc.)

None

I don't know

13. Out of every ten hunters, please choose how many you think follow baiting rules.

_____ out of every 10

14. Out of every ten hunters that do not follow baiting rules, please choose how many you think are caught and end up having to pay a ticket.

_____ out of every 10

15. Out of every ten hunters that do not follow baiting rules, please choose how many you think are caught and end up facing other penalties.

_____ out of every 10

16. Indicate how strongly you agree or disagree that the following are benefits provided to deer hunters that use bait. ***(Please choose only one response for each potential benefit.)***

Potential Benefits

There is a better chance of harvesting a deer when hunting over bait

Deer can be harvested in less time when hunting over bait

More deer can be seen when hunting over bait

A deer at bait provides a safer target

Deer hunters can enjoy seeing other wildlife that visit baiting locations

Time spent putting out bait is more time to be enjoyed in the field

Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

We would like to know about your baiting practices. Any such information you provide does not constitute a confession. Researchers collecting this data are under no obligation to report such information and will keep your identity and information about you confidential to the maximum extent allowable by law.

THANK YOU FOR YOUR PARTICIPATION!

17. How frequently have you used bait in areas where it has been banned? ***(Please select only one response.)***

I have never used bait in such areas.

I have used bait a few times that I have hunted in such areas.

I have used bait several or many times that I have hunted in such areas.

I have used bait whenever I have hunted in such areas.

I may have used bait without realizing it was banned where I have hunted.

I prefer not to answer this question.

18. Have you ever received a ticket for using bait against the rules? *(Please select only one response.)*

Yes.

No.

I prefer not to answer this question.

19. Indicate how strongly you agree or disagree that the following factors affect your decision of whether or not to follow baiting rules. *(Please select only one response for each factor.)*

Factors

I do not follow baiting rules because many other hunters still use bait.

I follow baiting rules because following all hunting rules is the right thing to do.

I do not use bait because hunting deer over bait is not ethical.

I do not use bait because it can increase the risk of spreading disease among deer.

Responses: Strongly agree, Agree, Disagree, Strongly disagree, Not sure

BACKGROUND INFORMATION

20. Your gender:

_____ Male

_____ Female

21. In what year were you born? _____

22. What is your highest completed level of education?

_____ Less than a high school diploma

_____ High school diploma or GED

_____ Some college

_____ Associate's Degree (2 years)

_____ Bachelor's Degree (4 years)

_____ Graduate/Professional Degree

_____ Please indicate if you would like to receive a summary of the survey results.

To return this survey, please place in the postage-paid envelope included.

THANK YOU FOR YOUR PARTICIPATION!

Please use the space below for any additional comments that you would like to share about deer hunting in northeast Michigan.

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LITERATURE CITED

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