

ASSESSING THE EFFECTIVENESS OF AQUATIC INVASIVE SPECIES  
OUTREACH INFLUENCING BOATER BEHAVIOR IN FIVE STATES

THESIS

Presented in Partial Fulfillment of the Requirements for  
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By

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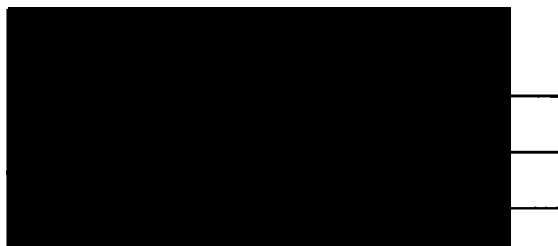
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## ABSTRACT

This study was the first to comprehensively assess and compare the efficacy of boater outreach aimed at preventing the introduction and spread of (AIS) in five states. Boaters in California, Kansas, Minnesota, Ohio, and Vermont were surveyed by mail (53% of 1,952 boaters responded) to determine their awareness of AIS and the actions they took or would be willing to take to prevent the spread of AIS. Boaters were especially knowledgeable and took greater levels of action at water accesses in Minnesota (90%) and Vermont (82%) than in Ohio (45%), California (40%), and Kansas (30%). An indication that AIS outreach can sustain behavior is the 20% increase in taking desired actions by Minnesota boaters; 70% reported taking action in 1994. Importantly, when asked about the likelihood of taking actions in the future, intent for action rose to over 94% in each state. Boaters reported taking action based on such attitudes as "a sense of personal responsibility", "a desire to keep AIS out of our lakes", and "prevent damage to my boat and equipment". Comparing these survey results to those previously reported by boaters in each state, the frequency of potential introduction of AIS (a.k.a., propagule pressure) decreased between 57-93%. This study demonstrates that effective AIS outreach can motivate boaters to act regardless of region. It also reveals that boaters will most likely take action if outreach is made a priority, targets the most important means for outreach, frames value on personal actions that are effective in preventing spread (self-efficacy), and conveys consistent messages. Human dimensions research offers an opportunity to improve AIS outreach, and help sustain and influence behaviors among boaters. More effective outreach offers an opportunity improve AIS management and policy.

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## CHAPTER ONE

### INTRODUCTION

The Five State Aquatic Nuisance Species and Boating Survey is a comprehensive study to assess, understand, and improve the efficacy of future boater communication and education aimed at preventing and slowing the spread of aquatic nuisance species (commonly referred to now as aquatic invasive species, AIS; used herein) to marine and fresh waters. Primary goals of the study were to investigate the effectiveness of AIS outreach (communication and education efforts) influencing behavior of boaters in five states, to determine the level of understanding of boaters about AIS, and to make recommendations on effective design of public programs and campaigns aimed at preventing the spread of AIS by transforming and sustaining behavioral change.

Next to habitat loss, invasive species pose the greatest risk to biodiversity of our natural resources. Non-native species move naturally and by human activities to locations where they are not native and do not belong. Once established in their new environment, these invasive species can cause ecological and economic damage. In the United States, economic losses are estimated at over \$100 billion annually (Pimentel, Lach, Zuniga & Morrison, 2000; Pimentel, Zuniga & Morrison, 2005).

Management of AIS requires physical, chemical and biological control, but it is widely recognized that preventing the spread and establishment of AIS is the best approach to effectively manage and minimize the harmful impacts of AIS. Preventing and controlling the spread of AIS requires targeted efforts that interrupt the pathways for spread.

Water recreation provides benefits to our society and economy as well as multiple pathways for the spread of AIS. Boating, angling, and other recreational activities such as waterfowl hunting and scuba diving can unintentionally introduce or spread AIS, thereby threatening the nation's sustainability, health, and quality of life. One of the greatest challenges as an asset to meet the AIS challenge is an "informed and involved" public. Unfortunately, many water recreationists are unaware of the threats and how their activities are responsible for the spread and impacts.

Those impacts can have negative consequences for recreational users whether they recognize it or not. Sea lamprey, zebra mussel, Chinese mitten crab, Eurasian ruffe, round goby, and invasive waterfleas have damaged highly prized recreational fisheries. Zebra mussels foul boat hulls and motors, create hazards on beaches, and harm recreational waters. Purple loosestrife degrades wetland habitat for waterfowl and fish. Eurasian watermilfoil, hydrilla, and water chestnut interfere with boating (Great Lakes Commission, 2007; Invasive Species Program, 2009; U.S. Congress, 1993).

Recreational activities contribute to unintentional AIS introduction and spread primarily when aquatic plants and animals "hitchhike" on boat hulls, motors and trailers, and through transfer of contaminated water. Movement of aquatic plants is particularly problematic because even if the plant is not invasive, it may carry eggs from invasive fish, snails, mussels, or have other organisms caught within its tangled mat of vegetation. With over 12.8 million registered boats in the United States (National Marine Manufacturers Association, 2000), recreational boating is the most significant recreational pathway for overland spread of AIS to our nation's lakes, reservoirs, rivers, and oceans.

Raising awareness must be one of the first lines of defense. To sustain our economy and environment, the public needs to know how they are at risk. When zebra mussels were found in the Great Lakes, concerned agencies and programs announced their presence, warned surface water users, set up monitoring programs, held conferences and workshops, and developed outreach materials like fact sheets and brochures.

Public outreach needs to move beyond raising awareness. Improving the public's understanding and knowledge of what to look for is just a start. Gathering insights about motivations that affect people's behavior is the next step. Looking at our history, outdoor recreation is linked to environmental and conservation ethics. People often engage in water recreation as a way to "view scenery" and "experience or get close to nature." Others value outdoor recreation for fitness, relaxation, or family bonding. Recognizing these motivations is important because it is through these values that people form personal connections to lakes, rivers, reservoirs, and oceans.

Success in preventing the introduction and spread of AIS through boater outreach and other incentives is largely unknown. Understanding boater awareness, knowledge, attitudes, motivations, risks, and behaviors can help practitioners in AIS outreach create an informed and involved recreational public. Yet, gaps concerning these attributes are also largely unknown.

Successful AIS outreach will consist of communication and educational media designed to make the issue relevant to the public, so much so that their personal actions prevent AIS spread, thereby protecting the environment. Communication messages must target boaters' personal values and attitudes. Education needs to address the triangular relationship between boaters, the environment, and AIS. Providing people with specific

help, strategies or skills can promote self-efficacy, and improve learning and behavior (Dweck, 1999; Hungerford & Volk, 1990; Siemer & Knuth, 2001). Therefore, outreach must offer skills (so that boaters know what to do) to elicit appropriate actions that will prevent the spread of AIS.

Designing effective AIS outreach efforts requires merging advances in contemporary social sciences research with natural resource management, targeting sustained behaviors aimed at preventing, slowing, and minimizing the impacts of AIS. Can it work? How will we know?

Assessment of AIS outreach efforts can provide critical baseline or longitudinal data that can be used to guide future development and maximize effectiveness. Generally, questions concerning human-mediated spread of AIS are not the types of inquiries researchers and scientists (based in chemistry, biology or ecology) are well equipped to address. Furthermore, agencies and organizations rarely have or make the capacity, expertise or time to conduct thorough assessments of AIS outreach. More research is needed to gain insights on how boater values, beliefs, norms, and attitudes lead to behavior intent across the country. Understanding whether AIS boater outreach efforts can transform behavior, thereby protecting water resources, is vital so that policy makers, natural resource professionals, and educators can justify spending time, effort, and resources on AIS boater outreach across the Great Lakes and beyond.

### *Significance of the Study*

This is the first study of its kind to comprehensively assess and compare the efficacy of AIS boater outreach efforts in different regions of the United States. Results will be compared to a similar survey conducted in three Great Lakes states in 1994. The



present study focuses on four regions, including the Great Lakes, Northeast, Great Plains, and West Coast. Results of the study are intended to offer empirical evidence critical to a discussion of limitations and enhancement of discourse in AIS outreach with an eye on potential applications in other environmental education efforts. It provides for the entry of AIS outreach into the rich history of environmental education and assessment.

### *Purpose of the Study*

This study has two purposes:

1. Assess and compare the efficacy of AIS boater outreach in five states (California, Kansas, Minnesota, Ohio, and Vermont) using a comprehensive mail survey. Each state selected for study represents varied levels of emphasis on AIS outreach, types of boating opportunities in marine, fresh water, inland, and coastal waters, and different AIS of concern at state, regional and national levels. Study objectives are to determine:
  - a. the level of boater awareness, knowledge, values, motivations, and attitudes concerning AIS in each state;
  - b. the approaches and methods that best reach boaters;
  - c. the risks that boaters pose for transporting and spreading AIS;
  - d. if outreach influences boater behavior aimed at preventing the spread of AIS;  
and
  - e. relationships between these factors within and among states.

Results of this survey will be compared to a similar mail survey conducted in Minnesota and Ohio in 1994, and will provide baseline assessments for California, Kansas and Vermont.

2) Develop a model survey instrument (a template) that can be adapted or adopted by state, provincial, regional, and task force agencies seeking critical assessment to determine if public awareness programming is effective in their jurisdiction. An intended outcome of this study will be to advance the state of knowledge for effective delivery of AIS outreach aimed at protecting water resources from the spread of AIS.

### *Background and Overview of the Issues*

Aquatic invasive species (AIS) are causing significant ecological and economic damage across the United States (Lodge, Lewis, Shogren, & Keller, 2009; National Invasive Species Council, 2001; 2005; Pimentel et. al., 2000; U.S. Congress, 1993). Loss of biodiversity, extirpation of already endangered or threatened species, and impacts on natural food webs and fish, water quality, and nutrient and contaminant cycling are some examples of ecological impacts. Economic losses due to impacts of AIS on sport and commercial fisheries and water-related industries are in the millions of dollars annually (Pimentel et al., 2000; 2005).

Spread of AIS can occur via a number of natural and human mediated mechanisms. Although commercial shipping, barges, commercial fishermen, wild bait harvesters, aquaculture, and recreational divers have all been identified as potential transporters of AIS, it is the 12.8 million transient recreational boaters who pose the greatest risk for overland transport to marine and fresh waters in many studies (Bossenbroek, Johnson, Peters, & Lodge, 2007; Bossenbroek, McNulty, & Keller, 2005; Carlton, 1992; Johnson & Padilla, 1996; Johnson, Ricciardi, & Carlton, 2001; Johnstone, Coffey & Howard-Williams, 1985; Kraft et al., 2002; Leung, Bossenbroek, & Lodge,

2006; Marangelo, Carlton, & Johnson, 1994; Padilla, Chotkowski, & Buchan, 1996; Schneider, Ellis, & Cummings, 1998). Once introduced into a natural waterbody, rarely is eradication possible. Consequently, prevention through outreach is critical to stem the spread of AIS.

Several conceptualizations to predict how AIS can be spread overland have been proposed. Often, modelers use zebra mussels (*Dreissena polymorpha*) as a “poster child” because these invasive mussels can cause harmful environmental and economic damage and can spread quickly due to their unique life history characteristics. Zebra mussels spread primarily by attaching to aquatic plants, boat hulls, nets, fishing equipment, or by floating in water as free-living larvae. Young zebra mussel larvae (veligers) naturally disperse via currents and waves, and are nearly invisible to the naked eye. On smooth surfaces, newly attached young feel like fine sandpaper. They can attach to any hard surface, including other zebra mussels forming barnacle-like colonies. Adults can survive for days out of water under certain conditions.

Native to Eurasia, zebra mussels became established in North America at Lake St. Clair after likely being discharged from ships’ ballast water (Carlton, 1992; Havel & Hebert, 1993; Hebert, Muncaster, & Mackie, 1989). Currently, their U.S. range includes most areas of the Great Lakes (except Superior), and the Mississippi River and its tributaries. A cousin of zebra mussels, quagga mussels were found in Lake Ontario in 1991 (May & Marsden, 1992). They spread to similar areas of the Great Lakes where they are now out-competing the zebra mussel. Meanwhile, zebra mussels and quagga mussels spread overland to more than 700 inland lakes. It is important to understand the

life history of invaders and how they spread via various pathways, because it allows AIS management to design and promote outreach to elicit the most effective outcomes.

While several models have become widely used by scientists to predict the arrival of zebra and quagga mussels and other AIS (Bossenbroek et al., 2007; Bossenbroek et al., 2005; Kolar & Lodge, 2002; Leung et al., 2006; Leung, Drake, & Lodge, 2004; MacIsaac, Borbely, Muirhead, & Graniero, 2004; Schneider et al., 1998), for the purposes of this discussion it may be easier to visualize the patterns of overland spread of invasive mussels using the following conceptualizations.

Early in the North American overland spread of zebra mussels, a “fireworks” versus “hub and spoke” phenomenon was proposed during zebra mussel training workshops held in the West (Dr. L. Johnson, personal communication, 1997). Once zebra/quagga mussels become established in a lake or river, that location provides a hub (or node) for potential spread. Subsequent spread along transportation corridors are essentially the spokes radiating out from the hub. Distances from the hub to a point on the periphery (the rim) are relatively short. If recreational watercraft used on those infested waters becomes contaminated, then moves to other nearby waters, those watercraft can cause new infestations due these non-native mussel’s invasibility and extent of propagule pressure on those waters (Drake & Jerke, 2009; Leung & Mandrak, 2007). Further spread fills in areas between the spokes or radiates out from the rim.

The “fireworks” model suggests a longer distance spread, perhaps thousands of miles, from the source location. One way this happens is via transport of recreational vessels or commercial equipment over long distances by commercial haulers and dealers (Gould, 2008). Another is when recreational boat owners from the Great Lakes trailer

their watercraft thousands of miles to major vacation destinations. Indeed, dozens of vessels and equipment have been intercepted across the West and elsewhere with live and dead zebra mussels and other biofoulants attached. Consequently, multiple Western reservoirs and rivers have been infested with zebra and quagga mussels likely through the long transport phenomenon (Britton, 2007; Western Regional Panel on Aquatic Nuisance Species, 2009; Zook & Phillips, 2009a,b). Both patterns emphasize the importance of the overland transport of recreational watercraft.

Many risk assessments have been conducted at local, state, or regional levels to determine environmental suitability for certain AIS (e.g., zebra mussels) in lakes, reservoirs, and rivers (e.g., Baker, Baker, & Mann, 1993; Doll, 1993; Drake & Bossenbroek, 2004; Kolar & Lodge, 2002; Ricciardi & Rasmussen, 1998). While assessing such environmental conditions is important, many are somewhat limited if not coupled with an assessment of the potential pathways, frequency and magnitude of introduction, and proximity to already infested waters. Environmental conditions along with pathway characterization can provide a much fuller picture of the overall risk of introduction and spread. Since not every introduction results in an infestation, the focus of prevention is on reducing the risk of establishment by minimizing the frequency and magnitude of the propagule pressure (Drake & Jerde, 2009; Drake & Lodge, 2006; Leung et al., 2004; Leung & Mandrak, 2007) within the key pathways for spread.

Overland transport of harmful AIS by recreational boaters and anglers has been recognized as a threat since the early 1990s. Outreach efforts have been conducted by federal, regional, and state agencies and organizations aimed at reaching boaters with prevention messages. While these efforts have ranged in emphasis and variety of methods

used, few efforts have assessed whether methods used are reaching boaters or changing behaviors based on their awareness, knowledge, values, motivations, and attitudes. Understanding where boaters get their information and what works best can help guide future development of AIS outreach. Assessment holds the key to understanding the underpinnings of human nature in order to target and foster sustainable behavior. It is critical to show whether investment in outreach can change behavior and prevent or slow the spread of AIS, then determine if expenditures of resources are justified based on the potential return on investment (e.g., a well-informed public, protection of water resources).

#### *Setting and Participants*

This quantitative assessment study was created from responses to mail surveys that were sent to 4,000 randomly selected registered boat owners in five states: California, Kansas, Minnesota, Ohio, and Vermont (800 from each state). States were chosen because each was interested in conducting an AIS boater outreach evaluation, and represented different regions of the country (fresh water, marine, inland, coastal). They also represented a range of AIS boater outreach efforts, and had a variety of AIS concerns.

#### *Assumptions and Limitations*

The scope of this study focused on reaching registered boaters with a mail survey. Several assumptions underlying this study are defined below:

- Human action can harm the environment; individual actions can lead to measureable impacts, both positive and negative.
- Cognitively, people relate to the concept of human-environmental impacts.

- Beliefs and attitudes among groups and individuals can change based on their situation, awareness, ascribed responsibility, expectancy of control, skill, and image of themselves.
- Value orientations related to beliefs, attitudes, and motivations are shaped by social constructs and are not mutually exclusive.
- Beliefs and attitudes can be influenced by life experiences.
- Values regarding the environment and society are influenced by changes in attitudes, beliefs, and changes in perspective over time.
- All segments of the adult population, like recreational boaters, are life-long learners receptive to education, which can change their meaning perspective on issues relevant to them.
- Values and attitudes on issues in general and specifically toward environmental issues, including AIS, may vary from region to region, in public and private arenas.
- Values, beliefs, norms and attitudes toward AIS are mental constructs, which can change over time, and may differ based on gender, age, religion, and ethnicity.
- Injunctive norms, and to a lesser extent descriptive norms, can influence human behavior.
- Carefully designed evaluation can provide a highly detailed and accurate reflection of public perceptions of natural resource-based conservation and social issues.

- Evaluation instruments, such as surveys, are accurate representations of respondent values, beliefs, attitudes and intention to act (motivation) because they are true expressions of voice from that population at that point in time.
- Mail survey responses are generally truthful; responses are expected to vary among states and regions; and behaviors reported by boaters are not intentionally overstated.
- No survey instrument is without some bias; mail surveys may elicit more socially desirable responses than situational surveys (e.g., face to face surveys), which can introduce different forms of bias.
- Questions were presented with as little bias as possible, based on survey design expertise provided by the University of Minnesota Center for Survey Research.
- Surveys were completed by registered boat owners.
- There were no false positive responses; results were no different than non-response (based on a follow-up telephone survey of non-responders).
- Due to high survey response rates and no difference between responders and non-responders, outcomes and impacts were extrapolatable to the larger population of registered boaters in each state.

Several limitations based on the study design are described below:

- Adult learners, including boaters, generally reflect on and relate to issues to which they have been exposed.
- Boater survey results only represent awareness, knowledge, attitudes, values, motivations, and behaviors for those state boating populations surveyed during the study period in 2000-2001.



- Results from each state's survey may be extended to neighboring states located within that region of the country (e.g., Kansas to Oklahoma); however, great care should be exercised when doing so because- as with any population- values, attitudes, and behavior may differ among populations or within populations even at small distances due to political, religious, or cultural issues.
- Survey results for some comparisons were not extrapolatable to the greater boating public in those states surveyed due to low frequency of response; in these cases, general trends were noted.

#### *A Note on Application of the Study*

Results of this study will apply directly to my work. As the AIS program coordinator for the University of Minnesota Sea Grant Program, I am responsible for conducting outreach and research on AIS. My area of work, in part, includes developing, implementing and evaluating the effectiveness of AIS outreach approaches, strategies, and methods. The ultimate criterion for assessing the success of AIS educator's work is the change in attitudes, understanding, and behavior of risk-prone audiences to help them prevent the spread of AIS. Awareness, learning and knowledge have only the *potential* for transforming and fostering societal behavioral change. Sea Grant has a unique opportunity to exemplify how an organization can change to deliver more effective AIS outreach, demonstrating its relevance and accountability by aligning programming with measurable outcomes and impacts.

Organizational change requires use of new approaches. Knowles (1990) suggests that promoting adult learning as problem-solving rather than research-based is a better approach to help transform adult learners. In this case, that would be better environmental

stewards, protecting lakes and streams, and taking actions to prevent and slow the spread of AIS. Critically reflecting upon current AIS approaches as well as contemporary theories and methods of social sciences (how learners learn, how educators teach) should provide further insights into the successes and limitations of traditional AIS outreach efforts.

### *Definition of Terms*

*Altruism* - Motivation to act in ways that benefit another, at some net cost to self (Schultz & Zelezny, 2003, citing Jencks, 1990).

*Assessment* - Process of determining, analyzing, and prioritizing needs, in turn, identifying and implementing solution strategies to resolve high priority needs (Altschuld & Witkin, 2000).

*Attitude* - Hypothetical construct that represents an individual's like or dislike toward an object, behavior or event that is composed of various forms of judgments.

*Aquatic Invasive Species* - Nonindigenous (or non-native) species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, or recreational activities dependent on such waters (from the National Invasive Species Act, 1996).

*Behavior* - Action or reaction of an object or organism usually in relation to the environment. Behavior can be conscious or subconscious, overt or covert, and voluntary.

*Belief* - Psychological state in which an individual holds a proposition or premise to be true; beliefs modulate the interaction of values and attitudes.

*Biospheric* - Value-based attitude focused on the well-being of living things such as plants, animals, and trees (Schultz & Zelezny, 2003).

*Community-Based Social Marketing* - A strategy based on social psychology that promotes behavior change at the community level influenced by direct contact with people within that community (McKenzie-Mohr & Smith, 1999).

*Conservatism* - Value-based attitude on traditional practices often characterized based on life goals such as devoutness, respect for tradition, humility, politeness, honoring parents and elders, and stability (Schultz & Zelenzny, 2003).

*Descriptive Norms* - Perceptions of how most people behave.

*Dual Coding Theory* - Cognitive learning model that allows evaluation that audio and visual information (graphics/text) is processed differently among individuals (Paivio, 1986).

*Ecology* - Interdisciplinary scientific study of the interactions between organisms and their interactions in the environment.

*Egoistic* - A value-based attitude focused on self, and self-oriented goals such as health, quality of life, prosperity, and convenience (Schultz & Zelezny, 2003).

*Ethics* - A set of moral principles governing an individual or group.

*Extended Parallel Process Model* - A popular fear appeal model that evaluates appraisals of an issue from messages based on perceived threat and perceived severity of the threat (Witte, 1992).

*Extrinsic Motivation* - Changing espoused behavior of an individual or group by external means using a promise of reward, praise, or avoidance of punishment such as laws, regulations, and incentives.

*Injunctive Norms* - Behaviors which are perceived as being approved (or disapproved) of by other people, which tend to be more effective than descriptive norms (Cialdini, Demaine, Sagarin, Barrett, Rhoads, & Winter, 2006).

*Intrinsic Motivation* - Changing espoused behavior of an individual or group by internal factors such as curiosity, enjoyment, and learning or education (cited as above).

*Learning Domain* - Adult learning domains including: instrumental (gaining of technical knowledge), communicative (gaining of practical knowledge) and emancipatory (gaining of knowledge resulting in behavior change) identified as ways “to understand human interests, knowledge and learning” (Cranton, 1994, p. 9).

*Meaning Perspective* - A frame of reference or a set of expectations that is based on past experience (Cranton, 1994), which can be an injunctive norm.

*Openness* - A value oriented around social change and tradition, it is comprised of life goals like creativity, curiosity, daring, living an exciting life, pleasure, and discovery (Schultz & Zelenzny, 2003).

*Outreach* - Refers to communication and education efforts intended to inform, raise awareness, improve understanding, and influence behaviors of target audiences (pathways) aimed at preventing the spread of AIS.

*Pathway* - A means by which AIS are transported from one location to another. Natural means are wind, waves, or currents. Human-mediated means include ballast water discharge, overland transport by boaters, or release by aquarists.

*Pedagogy* - The art and science of educating students or adults; often used as a synonym for teacher-focused education.

*Personal Norm* - The dimension of explicit and implicit rules that individuals use to determine and evaluate appropriate and inappropriate values, beliefs, attitudes, and behaviors based on a widely accepted practice.

*Program Evaluation* - To evaluate is to make an explicit judgment about the worth of all or part of a program by collecting evidence to determine if acceptable standards have been met (Andrews & Werner, 1988, as cited in Suvedi, 1988).

*Propagule Pressure* - Concept of invasion modeling focusing on the number of propagules for a given introduction and frequency which they are introduced (Williamson & Fitter 1996).

*Self-Efficacy* - A belief that one is capable of performing in a certain manner to attain a certain goal or outcome, which plays a critical role in how people think, feel, and behave.

*Self-Enhancement* - A value-based life goal that includes social power, authority, wealth, success, ambition, and influence to promote own interests (e.g., self-promotion) regardless of other's interests (Schultz & Zelezny, 2003, citing Schwartz, 1994).

*Self-Transcendence* - A value-based life goal that includes being broad-minded, helpful, honest, forgiving, and loyal which transcends the individual and instead promotes "the interests of other persons and the natural world" (Schultz & Zelezny, 2003, citing Schwartz 1994).

*Social Altruism* - A value-based attitude focused on other people such as children, family, community, and humanity (Schultz & Zelezny, 2003).

*Social Dilemmas* - Conflicts between the individual and his/her collective interests (Dawes, 1980; Yamagishi, 1994).

*Social Norms* - Dimension of explicit and implicit rules that groups use to determine and evaluate appropriate and inappropriate values, beliefs, attitudes, and behaviors based on a widely accepted practice.

*Social Influence* - Influence of social norms on individual behavior largely dictated by their need to maintain a favorable self-image and relationships with others (Cialdini & Trost, 1998).

*Theory of Planned Behavior* - An empirically derived behavior model that identifies determinants of behavior change recognizing that intention to change a behavior will not occur if the individual is unable to act upon it (Fishbein & Ajzen, 1981).

*Tragedy of the Commons* - An outcome of social dilemma conflict resulting in a “tragedy” as in when few people make a collective choice based on the belief of the “common good” (Hardin, 1968).

*Values* - Belief pertaining to desirable end states or modes of conduct that transcends specific situations and guides selection or evaluation of behavior, people, and events. Values are ordered by importance relative to other values forming a system of priorities (Schwartz, 1994).

*University of Minnesota Sea Grant Program* - A state-wide program to enhance Minnesota’s coastal environment and economy through outreach, education, and research concerning aquaculture, science literacy, aquatic invasive species, fisheries, tourism, and water quality.

### *Summary*

This comprehensive study was the first to assess and compare the efficacy of AIS outreach in different regions of the country. It was conducted to assess and improve the

effectiveness of AIS outreach by Minnesota Sea Grant and collaborating agencies, and organizations. A model survey was developed to measure boater awareness and behavior in five fresh water and marine states (California, Kansas, Minnesota, Ohio, and Vermont). Each state has a range of boater education efforts, boating opportunities, and AIS concerns. Results will be used to justify policy, management and outreach decisions at national, state, and local levels concerning the use of resources for AIS outreach. Additionally, policy makers, natural resource managers, and educators will use the survey results to guide future development and maximize efficiency and effectiveness of AIS outreach, thereby protecting water resources from the spread of AIS.

## CHAPTER TWO

### LITERATURE REVIEW

#### Part I: Aquatic Invasive Species

This literature review is divided into two parts. Part I is a review of the literature concerning aquatic invasive species (AIS), including an introduction, a historical overview of outreach, a summary of what had been evaluated until the time of this study, and a statement of need. Part II is a review of the literature on elements of environmental education and human dimensions research, with a focus on behaviorism- key issues germane to the discussion of AIS boater outreach.

#### *Introduction to AIS*

AIS threaten the nation's inland lakes, rivers, wetlands, estuaries, and oceans. Societal, environmental, and economic impacts due to AIS are heavy and widespread. Impacts can result in unemployment, damaged goods and equipment, power failures, food and water shortages, habitat degradation, increase in natural disasters, disease epidemics, and even loss of life (National Invasive Species Council, 2001; U.S. Congress, 1993). Next to habitat loss, invasive species pose the greatest threats to natural ecosystems (Wilcove, Rothstein, Dubow, Phillips, & Losos, 1998). Increasing global trade, transport, and travel will increase the likelihood that existing infestations will spread and new AIS will be introduced (McAusland & Costello, 2004).

AIS are non-native species that have been introduced outside of their natural historic range. Once released from the competitive controls like predation, inter-specific competition, diseases, and other environmental factors, these non-native species can become invasive. Not all non-native species are harmful; in fact, many in trade,



recreation, and production (e.g., aquaculture, agriculture, forestry, rangelands) provide aesthetic, educational, social, and economic benefits. Of those that are introduced, most die or maintain small populations. Others that thrive can cause a multitude of damages.

Executive Order 13112 defines invasive species as “a species not native to the region or area whose introduction (by humans) causes or is likely to cause harm to the economy or the environment, or harms animal or human health” (NISC, 2005, p. 3.). Czarapata (2005) estimates that about fifteen percent of introduced non-native species become established. Some estimate that only one percent are highly invasive (McNeely, 2004). Determining which species cause negative impacts and which do not is dependent upon political, scientific, financial, religious, and social considerations. Society uses these value propositions to determine what responses are appropriate in addressing those species of common concern. Societal consensus of what, how and where becomes the operative words. Understanding this complexity is a challenge in communicating and educating the public about what is invasive, why they should be concerned, and what the potential responses might be.

Ecological theory of colonization can be categorized as introduction, establishment, and spread (Williamson & Fitter, 1996). AIS spread naturally (e.g., wind, waves, currents, wildlife), and by human-mediated pathways. Spread can occur at various life stages of the animal, such as unfertilized, fertilized, and resting eggs, larvae, young, juveniles, or adults. Plants can also successfully spread based on evolutionary life history characteristics such as seeds, seedlings, rosettes, flowers, turions, rhizomes, and through auto-fragmentation (e.g., piece of plant breaks off). Depending upon the natural or human-mediated pathways, these life history characteristics can blend to create a

potential for becoming established and influence the likelihood that a species will become invasive in a new location (Myers & Bazely, 2003).

An ability to spread during several life history stages often gives species a competitive advantage over native species and even some invasive competitors. Success for species spread is dependent upon the fitness of the life history characteristics, conditions within the pathway(s), as well as the conditions of the environment where it spreads. If conditions are unsuitable, the species cannot adapt, and establishment is not successful. Conversely, if conditions are suitable or if the species can adapt, the probability for establishment, population growth, and spread is much greater.

Invasion ecologists consider life history characteristics collectively when assessing the invasive potential of an individual or group of organisms through natural or human-mediated dispersal, or both. They often refer to the invasibility of organism as dependent upon its overall propagule pressure. Propagule pressure can be thought of as the product of frequency and magnitude of a potential pathway(s) that allow spread. Since only a few established non-native species cause impacts, reducing or eliminating propagule pressure of those species within and among the pathways is the key for responding to AIS (Drake & Jerde, 2009). Understanding the key biological and ecological processes puts into context how potential management can respond to AIS.

Federal, state, tribal, agencies and local jurisdictions generally have the authority to establish and promulgate policy related to invasive species. As a consequence of the complex nature of invasive species management, a patchwork of jurisdictional authority, policy and management (sometimes conflicting) resulted (U.S. Congress, 1993). Executive Order 13112 on Invasive Species was issued in 1999 to establish a National

Invasive Species Council to improve federal coordination and response to the complex and rapidly increasing problem of invasive species.

In its five year review of the Order, the National Invasive Species Council (NISC, 2005) calls for detailed actions to improve policy and management through planning at international, national, state and local levels. The report emphasizes the need for “prevention, early detection, and rapid response, and sharing information to create a more proactive and effective invasive species strategy” (NISC, 2005, p. 4). With more than 20 federal agencies involved in AIS management, there needs better coordination of federal, state and local efforts (Government Accountability Office, 2002). To this end, management will need to adapt to be successful.

Adapting management strategies in response to the invasions process is critical (Lodge et al., 2009). These authors identify that general policy and management options available to society include: prevention; early detection, rapid response, and eradication; control; and human adaptation. As species spread, management options become narrower. According to Lodge et al. (2009):

Once a species is established, eradication is costly and sometimes impossible.

When the opportunity for eradication has passed, only two options remain: control of populations in selected locations, and adaption by humans, [sic] In the last decade, however, investments in eradication, control, and finally prevention have increased for natural ecosystems, and policy discussions in the United States and elsewhere increasingly feature prevention efforts, (p. 10)

Since species spread overland by pathways, effective management of AIS needs to focus more on prevention by targeting those pathways with public education, monitoring for early detection, rapid response, policy, and enforcement.

Various transportation- and commerce-related pathways have been identified that pose risks for unintentional transport and spread of AIS into fresh water, estuarine, and marine ecosystems in North America (Carlton, 1992; Claudi & Leach, 1999; Johnson et al., 2001; Johnson & Padilla, 1996; Johnson, Ricciardi, & Carlton, 2001; Johnstone, Coffey & Howard-Williams, 1985; Kraft et al., 2002; Lodge et al., 2006; Mills, Leach, Carlton, & Secor, 1993; Nico & Fuller, 1999; Padilla et al., 1996). In the Great Lakes, 181 non-native aquatic species have become established (Great Lakes Aquatic Nuisance Species Information System, 2009). Pathways for introduction and spread include maritime commerce, canals and waterways, organisms in trade, aquaculture, and recreational activities (Great Lakes Commission, 2007). Preventing the spread of AIS through public education at the point of origin offers the best strategy for preventing introductions (Great Lakes Regional Collaboration, 2005; U.S. Congress, 1993).

Several national and regional task forces, councils, panels, and others recognize that raising public awareness is a key long-term strategy for preventing and containing AIS (Aquatic Nuisance Species Task Force, 2008; Great Lakes Commission, 2007; Great Lakes Panel on ANS, 2004; Mack, Simberloff, Lonsdale, Evers, Clout, & Bazzaz, 2000; National Invasive Species Council, 2001). Of those pathways identified, overland transport by recreational boaters and anglers are implicated as a primary way AIS spread from infested to uninfested waters (Bossenbroek et al., 2005; 2007; Buchan & Padilla, 2000; Carlton, 1992; Hebert et al., 1989; Johnson & Carlton, 1996; Johnson & Padilla,

1996; Johnson et al., 2001; Keller & Lodge, 2007; Mills et al., 1993; Padilla et al., 1996; MacIsaac et al., 2004; Muirhead & MacIsaac, 2005). Potentially contaminated boats and equipment—frequently moved by resident and visiting recreational boaters and anglers—all pose such threats.

Recognizing the need for improved prevention efforts, the Great Lakes Regional Collaboration (Great Lakes Regional Collaboration, 2005) *Strategy to Restore and Protect the Great Lakes* called for programs that educate Great Lakes boaters and anglers on how to take preventative actions against AIS. It requested \$19.5 million annually for the next five years to support AIS outreach and evaluation targeting recreational activities. [Note: The author of this thesis was an invited participant and took a lead role on the Aquatic Invasive Species Strategy Teams' Recreational Activities writing team. Results of the draft thesis helped improve planning and development of the strategy and implementation plans.]

#### *A Historical Perspective of AIS Outreach*

Since zebra mussels were first found in the Great Lakes over two decades ago, Sea Grant and many federal, state, and tribal agencies, industry, lake, river, recreation and conservation associations promoted outreach aimed at preventing the spread of AIS by recreational boaters and anglers. Can efforts to promote AIS public awareness produce these results? Reaching the public concerning environmental issues has been a challenge. A report revealed the public's environmental knowledge, activities and behaviors are dismally lacking (National Environmental Education and Training Foundation & Roper Starch, 1998). Information can help people change their behavior. However, efforts that rely solely on providing information often have little impact on behavior. Can those

audiences that pose risk be reached? Most boaters and anglers are difficult to reach because often they are not affiliated with recreational or conservation organizations. Since established conduits for flow of information do not exist, the challenge is to find strategies and methods that can be used to reach them through communication and educational media.

In retrospect, a shot-gun approach was used to reach boaters and anglers since zebra mussels were discovered in the Great Lakes. While not exhaustive, the list below is extensive including communication, education, and incentives/disincentives used across the Great Lakes and nationally in attempts to reach boaters:

- Civil penalties for transporting AIS
- Road checks to enforce regulations
- Watercraft inspection/education
- Information in fishing, boating and waterfowl hunting regulation booklets
- Creel surveys
- Billboards along highways
- Signs at watercraft accesses and marinas
- Posters at bait shops
- Educational packages for lake associations
- Public service announcements (PSAs) on television, radio and newspapers
- Mass media coverage of AIS issues
- Conferences and workshops
- Fact sheets, cards, brochures, books and videos
- Hot lines or clearinghouses
- Magazines and newsletters
- Booths at sport shows
- Exhibits and displays
- Fishing contests, derbies, and regattas
- Internet websites

More recently, traveler information systems have been placed along the 100<sup>th</sup> Meridian in four states and elsewhere to promote AIS prevention messages among boaters and anglers passing along major interstate and state highways. While all of these methods may have been tried, their effectiveness was largely unknown. Critical to the

success of AIS outreach by agencies and organizations is to understand if communication and education are reaching recreational boaters, what methods are effective, and if pro-environmental behaviors are adopted.

#### *AIS Outreach and Evaluation Needs*

Timing and placement of messages affect whether people change their behavior accordingly. Reaching target audiences through a variety of media that they are exposed to will most likely increase their recognition of the issue and cause them to consider taking appropriate action; therefore, choosing the best medium is critical in reaching each audience. The effectiveness of current means to reach recreational boaters is largely unknown.

Awareness and knowledge may vary among individuals or groups of individuals- both locally and throughout regions. It may differ by gender, religion, or ethnicity. Less experienced individuals or groups may be less knowledgeable than those with more experience. Experienced recreationists may be more receptive to messages (because they understand how their actions contribute to protecting the resource they use). Messages will need to target groups in various stages. New participants in activities will likely need to be educated and active participants re-educated. Previous evaluations provide baselines or insights into the stage of development among boaters in a few states or locales, but the extent to which boaters changed in development was unknown.

Motivations based on values, beliefs, and attitudes strongly affect sustained behavior. Human behavior is largely influenced by message content and consistency. Messages targeting boaters will be somewhat different than those targeting other recreationists such as anglers, sailors, personal watercraft users, waterfowl hunters, and

seaplane pilots. Each recreational audience is likely to be at a different level of understanding, their risk for spreading AIS depends upon the equipment they use (e.g., duck decoys), and their actions based on skill development.

#### *Leadership on AIS Outreach Evaluation*

Mixed messages likely promote confusion, which tends to elicit inappropriate or ineffective action or no action at all. In the mid-1990s, the Great Lakes Panel on ANS's Information & Education Committee (Great Lakes Panel on ANS, 1997) recognized that message inconsistency may create barriers to behavior change among boaters, anglers and other water users preventing them from taking appropriate action to prevent the spread of AIS. Taking into account audience, type of equipment, and life history of the AIS in the region, the Great Lakes Panel on ANS (1999) developed and approved a set of simple, clear, and consistent voluntary guidelines for six types of recreational water users. They also determined that messages must be positive and avoid use of fear.

Recognizing needs nationally, the ANS Task Force's Recreational Activities Committee adapted those guidelines for use by inland, coastal, fresh water and marine recreational water users. Those guidelines were subsequently federally approved in December 2000 (Federal Register, 2000). These important first steps brought consensus on message content and media consistency for AIS outreach nationally. Equally important, these steps provided a cornerstone of equal footing for all states to promote AIS outreach aimed at fostering sustained behavior among boaters and other recreationists. Importantly, recreational activity guidelines regarding the spread of AIS provided a platform to promote and evaluate future effectiveness of AIS outreach at national, regional, and state levels. AIS outreach efforts will need to improve and become



more comprehensive. Creating AIS outreach efforts that meet the needs of each audience will position them to be most successful.

The first regional venue addressing AIS outreach was the Great Lakes Panel on ANS at a December 1996 symposium (Ann Arbor, Michigan). Participants identified evaluation of AIS boater education programming as key to performance and its effectiveness. Furthermore, participants recommended that the results of the evaluation (e.g., surveys) be extended beyond the Great Lakes region to regions where AIS transport and impacts pose a threat. Similarly, the Western Zebra Mussel Task Force and the Western Regional Panel on ANS emphasized the value of including AIS outreach questions on surveys to assess the state-of-knowledge of boaters, whose behavior is critical to stemming the tide of zebra mussels and other AIS in the West.

Another regional venue was the original meeting of the 100<sup>th</sup> Meridian Initiative Work Group in 1998 (Kansas City, Missouri). During discussions, several state and federal representatives expressed dismay that they had little information on which to base decisions about the methods most effective in reaching transient boaters in their regions. They were concerned that once aspects of the Initiative were underway, they would have no baseline information on which to: 1) gauge program effectiveness in raising awareness, or 2) assess any change in behavior. Several members attending this meeting stressed that boater surveys to evaluate various outreach methods are important to maximize the results of education. Recognition of deficiencies at regional levels helped raise the issue of AIS and evaluation nationally.

### *A Summary of AIS Public Outreach Evaluation*

While it is well-known that transient recreational boaters pose risks for spread of AIS, a survey conducted by Minnesota Sea Grant across three Midwest states showed that boater outreach programs and other incentives did change boater behavior (Exotic Species Programs, 1995; Gunderson, 1994a,b; Exotic Species Programs, 1995; 1996; Exotic Species Program, 2003; Invasive Species Program, 2009). In 1994, a comprehensive survey instrument was used for the first time to evaluate how boaters and anglers obtain their AIS information and from what sources. An important outcome of the survey was that results showed that the awareness level in each state corresponded to the amount of effort placed on AIS boater outreach. Consequently, many state, federal, and provincial agencies and organizations concerned with the spread of AIS began using the results of the survey to tailor more effective outreach.

In 1996, California Sea Grant, recognizing the zebra mussel threat and need for outreach, initiated a pilot project aimed at assesses awareness of boaters in the 12-county San Francisco Bay-Delta area. The project included an evaluation of the current level of awareness among boaters, distribution of a brochure, a series of workshops, and a re-evaluation of boater awareness using a mail survey. While the full results of this survey remain unpublished (J. Cassell, personal communication, 1997), this survey and other surveys like it provide important baseline information about the status of boaters' knowledge. They can be used for assessing relative risks of infestation associated with users.

Other boater surveys have been conducted on specific high-risk waters frequently visited by transient boaters (Balcom & Rohmer, 1994; Henning, Barrett, & Martin, 1997;

Havel & Stelzleni-Schwent, 2000). Balcom and Rohmer (1994) surveyed boaters accessing three high-risk lakes in Connecticut. They report a high level of awareness among anglers (95%) and recreational boaters (69%). These waters are within a few hours drive of heavily infested waters of the Hudson River, the Finger Lakes of New York, and Lake Champlain, and thus are at high risk.

Connecticut Sea Grant and the Northeast Sea Grant Network, in partnership with numerous state and federal agencies, have been promoting zebra mussel outreach. Similar to the results of the Minnesota survey, Connecticut Sea Grant survey results emphasize that boater awareness levels are directly related to the methods used and level of effort placed on programming.

In contrast, a 1995 Kansas Fishing License Survey showed that only 25% of anglers knew about zebra mussels. Non-resident anglers were more aware (43%) than annual resident license (25%) holders (T. Mosher, personal communication, July 15, 2003). Henning et al, (1997) similarly found through a boat access survey that only 41% of anglers were aware of zebra mussels. The Toledo Bend Reservoir forming the boundary between Texas and Louisiana, the site of the survey, is frequented by hundreds of boaters each week during fishing season. Although Toledo Bend was not infested, the nearby Mississippi and Atchafalaya rivers first experienced small localized infestations in 1992-93. Concurrent with the growing infestation, Louisiana Sea Grant partnered with the U.S. Fish and Wildlife Service and Louisiana Department of Wildlife and Fisheries to conduct boater outreach through brochures, signs at boater accesses, and their *Zebra Mussel Newsletter - Southern Region* aimed at promoting awareness and preventing the

spread. These efforts along with others in this region are likely the reason for the moderate level of boater education shown in that boater survey.

Other boater surveys conducted by Manitoba at Canada-United States border crossings showed that the level of awareness of zebra mussels was highest among Minnesota and Wisconsin boaters, followed by Illinois, Indiana, and Iowa (Williamson, 1994). Border crossing surveys continued through 2001-2004 indicating higher levels of awareness among boaters at around 60% (W. Ralley, personal communication, May 31, 2005). Throughout the period, most boaters visiting Manitoba were from Minnesota (44%-18%). A 1998-2000 survey by the 100<sup>th</sup> Meridian Initiative showed that awareness about zebra mussels was only 14% (318/2004) among boaters surveyed from nine states (D. Britton, personal communication, May 18, 2001).

These examples also serve an important purpose by determining the relative risks recreational boaters and anglers pose in their respective areas. Although results provide valuable information on the effectiveness of AIS boater outreach, comparing results can be limited by the inherent differences in survey instrument approaches, goals, time, and scale. While other survey studies may have occurred elsewhere; these examples provide insights into the state of AIS awareness in several regions at about the time of this study.

#### *A New Call for AIS Public Awareness*

NISC (2001) identifies prevention and control of invasive species will require changes in public awareness and behavior. NISC advocated that a variety of education, outreach, and training programs need to modify values and beliefs in order to motivate and prompt the public into taking necessary actions. Plans need to address the public's understanding of the problem and the actions warranted to protect water resources.

Through awareness, the public will understand the consequences of their actions and recognize the benefits of changing unsustainable behaviors.

Today, nearly all AIS experts recognize the economic, environmental, and recreational benefits of preventing and slowing the spread of AIS (Ruiz & Carlton, 2003; Great Lakes Regional Collaboration, 2005; Lodge et al., 2009). Identifying and prioritizing primary pathways and species can allow government, agencies, academia and their partners to justify investing resources in prevention (Leung, Lodge, Finnoff, Shogren, Lewis, & Lamberti, 2002; Simberloff, 2003). Despite calls to action and known risks to biological and economic security, managers tend not to make the necessary investment, however, until invaders have arrived rather than prevent new introductions (Bossenbroek et al., 2005). Rarely, are sufficient resource provided for AIS prevention through outreach. There is likely a negative reciprocal relationship between AIS education and risk reduction. Since insufficient resources and expertise are dedicated, AIS continue to spread, reinforcing to managers that outreach will not reduce risk of spread. Consequently, evaluation of AIS outreach efforts often fails to be a priority.

Although prevention is recognized as important, few management authorities choose to devote time, effort, expense, or expertise to make public outreach a priority. Even fewer are able to conduct comprehensive surveys that could provide baseline information in order to evaluate progress of future programming. Most state agencies are under considerable funding constraints prohibiting them from conducting evaluative programs, even if they deem them valuable.

More evaluation of AIS outreach is needed to showcase successes so that greater resources can be invested in outreach programs tailored for priority pathways. To

facilitate assessment, a model survey instrument is needed for state, provincial, and regional agencies and task forces to conduct evaluations on the effectiveness of their boater outreach. Showing potential successes of AIS outreach can have reciprocal positive impacts:

1. Demonstrate to natural resource managers, agencies and others that AIS outreach is worth investment to protect lakes and streams from the spread of AIS; and
2. Show boaters and other audiences that they are not only part of the problem, but part of the solution as a means to end- that being the adoption of individual behaviors that build a social norm of sustained prevention of AIS spread.

AIS are one of the social dilemmas of our time. Influencing social values by promoting problem awareness of the problem of AIS and providing positive feedback that reinforces personal and social norms is the key to getting ahead of the spread of AIS.

### *Summary*

Recreational boating poses one of the greatest risks for transporting of AIS to lakes, streams, and other waters of the United States. Many agencies have identified outreach as a key to preventing and slowing AIS spread. Several outreach methods and incentives/disincentives have been attempted, yet very few comprehensive studies have evaluated the efficacy of the methods and determined whether they influence boaters and anglers sufficiently to foster sustained behavior change at water accesses. Evaluation is needed as a critical prevention element, so that agencies, tribes, business, industry and organizations can make necessary investments. Understanding how AIS specific communication and education influences behavior can provide valuable insights into designing and tailoring future outreach aimed at preventing the spread of AIS.

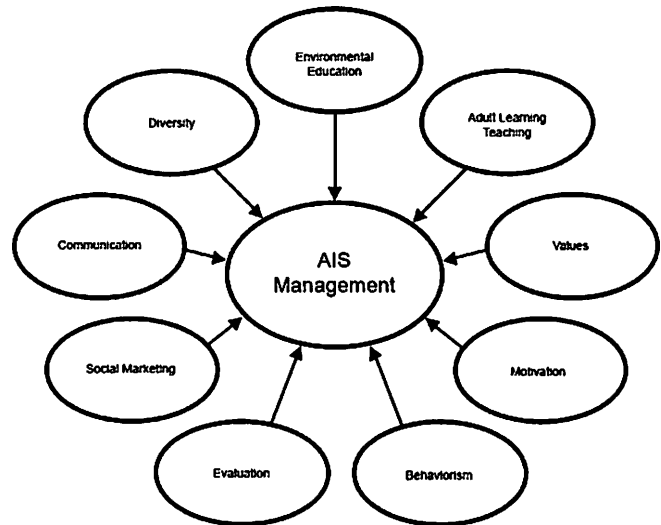
## Part II: AIS Management Meets Human Dimensions

### *Introduction*

The purpose of this study was to examine the efficacy of aquatic invasive species (AIS) outreach targeting boaters in five states. Preventing the spread of AIS by transient recreational boaters is a key goal in protecting lakes, rivers, and reservoirs.

Part II of this literature review examines the multiple and complex facets involved in everything from adult learning to sustainable behavior. Some AIS outreach assessments skirt the issues of peoples' attitudes, beliefs, and behaviors; consequently, little attention has been paid to reviewing these characteristics through a lens of AIS management. Other studies in environmental education and social science offer insights into the lack of sustained positive behaviors despite people's concern for the environment. Conversely, studies explaining why people sustain behaviors make it possible to motivate and empower them (water recreationists, boaters, anglers) to develop personal and social norms. Understanding behavior is a way to find clues as to which AIS outreach approaches have worked in the past, and use that information to develop approaches for the future.

This portion of the literature review is reflective of over 50 years of empirical research published in peer review journals and agency reports. Managing AIS is at the nexus of many fields of study (see diagram at right). This section of the literature



review summarizes studies from these disciplines that are most relevant to AIS outreach, emphasizing prevention through sustained behavior change. Although not a comprehensive review of any one educational or social science discipline, this review is intended to reveal how education and social science can be applied to improve AIS prevention efforts- targeting scuba divers, waterfowl hunters, aquarists, water gardeners, and recreational boaters.

Like other global issues such as climate change, integrating human dimensions research into AIS outreach has not yet been broadly applied. Values, beliefs, norms, and attitudes toward AIS are attributes largely unknown. Furthermore, there are few theoretical or empirical models being applied to people as potential pathways for the introduction and spread of AIS based on their behaviors.

Humans are at the root of many environmental problems, including AIS. Environmental education is accepted as being successful. Furthermore, pro-environmental behavior is linked to concern about the environment. So, if awareness is high, why aren't more individuals displaying pro-environmental behaviors? Boating, fishing, and hunting are traditions that people want to preserve and protect for future generations. Knowing that AIS threaten those traditions, why do boaters continue unsustainable behavior- not taking precautions to prevent the spread of AIS?

Human behavior is complex, involving life-learning, experiences, and personality. Often, AIS are framed as an environmental problem, which may diminish its relevance to the greater public. Even the word "environment" means different things to different people. Environment and the social movement are perceived differently today than in the 1960s. "Environment" can be a turn off if people do not feel personally connected.



Framing AIS in a broader social and economic context will pave the way for acceptance of the message that impacts will affect quality of life.

Society as a whole is the pathway for spread of AIS. Once awareness is raised, social influence can affect norms and govern behaviors within communities. Social norms begin with personal norms, which differ among individuals based on their psychology, gender, ethnicity, and religion. As individual behavior transforms into a social group behavior, group behavior becomes the genesis of injunctive and descriptive norms within the community. By nature, most people are conformists. Though reluctant to admit it, individuals temper their behavior to match how others act in a given situation. Motivation to conform relates to the overwhelming desire for acceptance by one's self (social identity) and by others within one's social spheres of influence. People more readily respond to family, friends and relatives making appeals concerning AIS. However, both personal appeals and media communications can motivate behavior as long as they are consistent with one's social identity or the image created for him/herself (Abroms & Maibach, 2008; Cialdini & Goldstein, 2004; Dolinski, Nawrat, & Rudak, 2001; Maibach, Abroms, & Marosits, 2007).

Behavior change is more successful when specific goals are motivating, sustainable, and build competence around skill development (Ajzen, 1985; Fishbein & Yzer, 2003; Klinger, 1980; Klinger & Cox, 2004; McKenzie-Mohr & Smith, 1999). Effective AIS outreach (education and communication) can build understanding that motivates behavioral action. Managing natural resources is more difficult when such behavior determinants are not clearly articulated or activated. Very different (and sometimes contradictory) approaches are sometimes used to influence behavior. For

example, natural resource managers may employ “public education” to “get the word out.” Creating a brochure or a Web site rarely influences or sustains behavior. An inadequate approach like this can create a perception that “the public doesn’t get it.” Then, natural resource professionals gravitate to laws and regulations in an attempt to force compliance. Forced compliance through disincentives (laws and fines) are important at influencing value-based attitudes (e.g., conservatism, egoistic), but may not be a strong influence on intrinsic or social altruistic values.

Can more effective approaches be applied to AIS outreach, translating to *sustained* behavior actions (e.g., social norms) that will prevent and slow the spread of AIS? If so, how do educators working to help natural resource management take this into account? What do they teach? Whom do they reach? How do people learn? Where do we reach them? Beyond this, how do we motivate them to a tipping point to act? How will we know it worked? As introduced above, contemporary advancements in environmental education and social science can provide needed clues.

Environmental educators generally create pedagogy based on information, awareness, knowledge, and demonstration of skills. Behavior psychologists assign motivations based on beliefs and attitudes. Both approaches lend themselves to AIS outreach. Other psychologists believe individuals learn through cognition, which forms understanding. Some social and communication psychologists test conceptual models designed to predict human behavior. Environmental psychologists use aspects of these approaches to build an understanding of barriers and incentives that hinder or drive desired pro-environmental behavior. A critical factor is having a thorough understanding of the people whose behavior is being targeted.

Transformation will likely require a paradigm shift away from traditional science-based literacy to something very close to environmental advocacy. This transition may create conflict within individuals (e.g., tension over theories-in-use) and agencies (e.g., science-based mission). The paradigm shift may be as foreign to natural resource professionals as AIS are in their new environment!

This literature review examines prevailing theories, conceptual models, approaches through individual and social learning, and behaviorism for potential application in natural resource management- specifically for AIS management. But first, understanding how valuing the environment gained acceptance in America provides some foundation and direction as to where environmental education is headed today.

#### *Rise of Environmental Awareness*

*“In wilderness is the preservation of the world”* - Henry David Thoreau

Environmental education is a relatively new discipline, although concern and awareness of human impacts can be traced back to the late 1700s in the United States. Land acquisition and development, agriculture, depletion of wild game species, urbanization, and human waste disposal prompted governmental entities to promulgate regulations to protect human health and environmental welfare (Kovarik, 2001).

Henry David Thoreau is widely recognized as the founding father of today’s environmental movement. Through his writings, he personalized his experience with and appreciation of nature. At that time, it was a departure from the traditional philosophy of humans over the environment. John Muir is often credited as the father of conservation. Whether Thoreau and Muir were either environmentalists or conservationists may be just

semantics. Regardless, their tenets were instrumental in placing public value on the natural environment and influencing public opinion.

Along with Thoreau and Muir, nature was captured in the early fabric of American culture in literature by Jackman, Emerson, Melville, Hawthorne, Twain, Cooper, and Leopold. They witnessed the transforming landscape and drew attention to the personal and societal value of nature; full appreciation of their (collective) vision was not well recognized during their lifetimes. Other cultural icons- Whitman, Dickenson, Frost, and Service- wrote poetically about nature. Artists such as Remington, Russell, Church, and Morris illustrated appreciation of nature. Adams exposed it through photography. They each created descriptive prose and symbols reflecting their love of the wilderness-the environment with all Americans thereby placing *value* on it.

That value for environmental protection and conservation transcended the sharing of artworks and grew into a social movement that informed policies, regulations, and management. Federal efforts resulted in establishment of national parks, as well as recreation, scenic, and wilderness areas. This emerging social value contradicted that of many entrepreneurs who believed that natural resources were exclusively for enhancing prosperity for themselves. In the 1800s, vast areas of the United States were undeveloped. Natural resources seemed inexhaustible. By the early 1900s, the Industrial Revolution brought economic prosperity countered by the worst human-caused environmental damage ever seen in North America. Signs of air, water, and land pollution were evident, but had little impact on working Americans.

Following WWII, economic growth in the United States soared. Cities grew, suburbs sprawled, and agriculture expanded in response to the demand to feed the 'baby

boomer' population. Further impacts such as housing developments, automobiles, and roads were visible by the 1950s. By the 1960s, environmental impacts from air and water pollution became evident, especially in metropolitan areas plagued by industrial and toxic waste. Garbage and trash littered cities. Oil spills from offshore rigs damaged coastlines. In 1969, the Cuyahoga River near Cleveland burst into flames due to untreated industrial waste- petrochemicals. Lake Erie was considered to be dying. Agricultural runoff spurred algae blooms in Lake Erie consuming oxygen and causing massive fish kills. More insidious impacts of pollution became relevant.

Rachel Carson's *Silent Spring* (1962) greatly influenced public opinion over unrecognized impacts of pesticide, DDT, on the environment. It increased social consciousness. Indeed, this was probably American's first revelation: pollution could be a problem when it was made visible. Within a decade, the environment was part of mainstream social consciousness. The movement became part of national political platforms. In 1963, President John F. Kennedy undertook an eleven state tour on conservation at the urging of Senator Gaylord Nelson (D-WI; 1963-1981), who continued to highlight environmental issues and make them a part of the political agenda. Public concern was growing, but not yet among politicians. While the political tour was not largely successful, it was a cornerstone for what would become Earth Day.

When Senator Nelson announced that in spring 1970 there would be a grassroots demonstration on behalf of the environment and all were invited, the response was characterized as electric. Over 20 million demonstrators participated in school and community events. Out of this movement grew a new social psychology based on personal responsibility and protection of the environment for the common good. The term

“environmental rights” emerged. The Environmental Defense Fund formed; environmentalists teamed with lawyers to file lawsuits against polluters. A new era of environmental litigation and policy dawned.

Mass media popularized “ecology” and “food chain” in the American lexicon. Education turned to science to explain ecology (Worster, 1994). Early in the movement, ecology meant many things to many people. Terms “ecological conscience” and “environmental awareness” were handled so loosely and abstractly that nobody was certain about their meaning (Moore, 1971). Society realized that humans could make the planet unsustainable. It recognized that “Mother Earth” has finite resources that need protection for future of generations.

Earth Day 1970 manifested a conservation ethic that would strongly influence environmental policy, management, and education into the 21<sup>st</sup> Century. The U.S. Environmental Protection Agency was authorized that same year. The passage of comprehensive legislation included, just to name a few: Clean Water, Clean Air, Resource Conservation and Recovery, Toxic Substances Control, Endangered Species, Wilderness, Solid Waste Disposal, Safe Drinking Water, National Environmental Policy, National Wildlife Refuge System and Super Fund acts. Meanwhile, the “Green Movement” grew in popularity across Europe and New Zealand, ultimately emerging into a global phenomenon.

The United Nations first took up the environmental issue by holding a Conference on the Human Environment Programme in Stockholm, Sweden, in 1972. By 1976, the UN adopted the Belgrade Charter (UNESCO-UNEP, 1976). It guided development of 26 environmental principles, including environmental education. The UN’s Educational,

Scientific and Cultural Organization issued a position statement on environmental education, recognized as a pivotal point known today as the Tbilisi Declaration (UNESCO, 1977). It declared the following environmental education objectives:

- *Awareness* - to help social groups and individuals acquire an awareness and sensitivity to the total environment and its allied problems.
- *Sensitivity* - to help social groups and individuals gain a variety of experiences in, and acquire a basic understanding of, the environment and its associated problems.
- *Attitudes* - to help social groups and individuals acquire a set of values and feelings of concern for the environment and motivation for actively participating in environmental improvement and protection.
- *Skills* - to help social groups and individuals acquire skills for identifying and solving environmental problems.
- *Participation* - to provide social groups and individuals with an opportunity to be actively involved at all levels in working toward resolution of environmental problems.

Those objectives have endured the test of time as core concepts for environmental literacy. Since 1977, several events such as the United Nations Conference on Environment and Development in Rio (UNCED, 1992), the Thessaloniki Declaration (UNESCO, 1997), and the World Summit on Sustainable Development in Johannesburg (United Nations, 2003) have continued to guide environmental education internationally.

Significant gains in environmental protection in the U.S. throughout the 1960s and 1970s resulted in a backlash in the 1980s. Over the next two decades, environmental

support waned as President Ronald Reagan (1981-1989) placed importance on the economy over the environment. During his eight-year tenure, many argue that existing environmental legislation and education was weakened or ignored. Conservatism marginalized environmental ethics- framing an environmentalist as being “too liberal.”

Science and policy, however, made technological breakthroughs in environmental cleanup in problem areas of the country like the Superfund and Brownfield sites. Technological successes improved government agencies’ ability to reduce impacts and protect the environment. Science, policy and waning of environmentalism seemingly took individual ownership over the environment and placed its responsibility in the hands of government agencies and the courts.

#### Role of Environmental Education

“Environmental education is rooted in the belief that humans can live compatibly with nature and act equitably toward one another. ” - NAAEE (2000)

Along with the significant policy gains of the 1960-70s, environmental education crystallized. Environmental educators articulated their role (Stapp et al., 1969).

Environmental education considered itself successful when citizens make reasoned choices and act congruently with their attitudes (Sivek & Hungerford, 1989/1990). Others defined learning targets as: “becom[ing] environmentally aware, knowledgeable, skilled, dedicated citizens who are committed to work, individually and collectively, to defend, improve, and sustain the quality of the environment on behalf of present and future generations” (Engleson & Yockers, 1994, p. 14). Carol Browner (1995), then Director of the U.S. Environmental Protection Agency (EPA), emphasized that environmental education has helped Americans reach a new understanding, but “to ensure a good quality of life for ourselves and our children, we must act as responsible stewards of our air, our



water, and our land” (p. 6). Studies continue to emphasize that developing environmental sensitivity requires spending some time outdoors (Siemer & Knuth, 2001) in order to foster environmental stewardship.

Does environmental education need to go beyond raising awareness to promoting an understanding and adopting pro-environmental actions? Part of the debate among educators and philosophers is over the significance of environmental sensitivity in creating pro-environmental behavior (Chawla, 1998). Evidence suggests environmental education might need to go further.

The 1999 National Report Card on Environmental Readiness reported that most people appreciate the environment but lack basic knowledge, understanding, and empowerment to help protect it (National Environmental Education and Training Foundation and Roper Starch, 1998). Despite a self-reported high level of awareness on environmental issues, less than one-third of Americans could correctly answer environmental questions related to energy, air and water pollution, and solid waste. The report concludes that the problem is most people are influenced by misinformation or outdated environmental myths.

While environmental education efforts are considered to be successful (e.g., Dunlap & Mertig, 1992), many suggest that education does not go far enough to reach critical goals (Ballantyne & Packard, 1996; Barrow & Morrissey, 1988-89; Blum, 1987; Day & Monroe, 2000; Gigliotti, 1990; Hines, Hungerford & Tomera, 1986-87; Iozzi, 1989; McKenzie-Mohr & Smith, 1999; Siemer & Knuth, 2001; Suvedi, Kruger, Shreshtha, & Bettinghouse, 2000). A key point of contention is that environmental education has not been strong enough to advocate for sustained behavior change or

evaluate of environmental impacts from learning. Few studies, if any, demonstrate that environmental education maintains or improves environmental quality (Hungerford & Volk, 1990; Volk, Meyers, Short, Wongsopawiro, & Meyers, 2006).

Though direct evidence is not well documented, environmental education has helped protect the environment over the past 40 years. Much credit needs to be given to the role of education in reaching those who have chosen to personally transform their behavior to help protect the environment.

Remaining a cornerstone, the Tbilisi objectives are as relevant today as ever. Building upon those objectives, however, is a more complex task than with traditional types of learning (Hungerford & Volk, 1990). These authors believe that environmental education is challenged with moving learners beyond typical learning objectives and bringing about emancipatory behavior:

Instead, we are faced with a set of objectives that paint a broader picture of behavior encompassing not only knowledge, attitudes, and skills, but also *active participation in society* [italics added]. The challenge is to translate the Tbilisi objectives into instructional reality, (p. 9)

### *Emerging Challenges*

Can AIS outreach with environmental education and natural resource management overcome the challenges? Societal issues are constantly shifting and complicating the challenges. Some issues worthy of discussion are introduced below:

- Environmental disorder - Society today is less reliant on or in touch with nature, thus perceived values are shifting.

- Technology - Public perception is that technology can solve all of our environmental problems and that individuals make little difference.
- Shifting demographics - Political, social, ethnic, cultural, and economic realities place stronger emphasis on non-formal and informal environmental education.
- Lack of above education infrastructure.

Challenge 1 - American environmental disorder. American society has rapidly become more disassociated with the natural environment. From the early 1900s, industrialization, urbanization, the loss of the family farm, commercialization, communications, technological advancements, and immigration have played roles in undermining the public's value of the environment. Children and their families connect less with nature further lessening the value they place on the environment. Richard Louv terms this the "nature deficit disorder" for what happens to young people who become disconnected from their natural world. His book "Last Child in the Woods" suggests strengthening the youth connection to the environment (Louv, 2006).

Louv's claims are supported by others including Hungerford & Volk (1990) and Kellert (1996), who emphasize that direct exposure to nature as children influences pro-environmental behavior as adults. Nature-based recreation is predicted to decline in the U.S. based on current trends, which may undermine the success of conservation-based efforts (Chawla, 1998; Pergrams & Zaradic, 2008). It seems reasonable to expect that the public's appreciation for the environment will shift from an intrinsic to an extrinsic value perspective. To counter this lack of appreciation from direct experience with nature, AIS outreach and environmental education will both need to respond to the shift in public values.

Hardin (1968) summarizes, “Education can counteract the natural tendency to do the wrong thing, but the inexorable succession of generations requires that the basis for this knowledge be constantly refreshed” (p. 1245). Unless we recognize the benefits of mutually agreed to coercion, society will suffer from the “tragedy of the commons” when the perceived or real benefits of individualism outweigh the needs of the commons (Hardin, 1968).

The “tragedy of the commons” theory was revisited from an invasive species context. Recognizing the tension between individual benefits and consequences to the commons, Reichard (2005) calls for more restrictive framework along with assessment of voluntary efforts. Windle and Chavarria (2005) agree that policies are weak and piecemeal, but make the case for more public education.

It is critical that AIS outreach be communicated so that resources can be dedicated toward such efforts, and the prevailing perceptions of autonomy and individualism (undisputedly dominant in U.S. culture) can be transformed by more socially-responsible values, attitudes, and behaviors. Understanding the value-based motivations behind what individuals and groups think about AIS can help frame a larger debate on how to advance AIS outreach.

Challenge 2- Reliance on environmental technology. Technology is welcome and can provide solutions to environmental problems. Rarely has technology alone solved a crisis. A case in point is littering. There is no technological solution. Policy makers may pass stronger littering laws. Litterers may need better and more access to trash and recycling bins. But, the individual still must take proper action. A related case in point, natural resource professionals and environmentalists may assume that constructing boat

wash stations will get boaters in compliance and prevent the spread of AIS. But perhaps boaters just need instruction in how to effectively clean their boats, motors, and trailers.

Technology presents an interesting paradox. On one hand, technology is offered as a solution to preventing AIS spread. On the other, technology-based solutions like boat washing stations become a moral issue because this does not require changes in people's values- an issue at the heart of AIS outreach. Put another way, reliance on technology removes the individual's personal responsibility for self-efficacy and frames it as "let technology fix it." Unfortunately, boat wash stations are not 100% effective even with trained staff (Exotic Species Programs, 1995; also cited in Jensen, 2006). Yet, beliefs remain so strong that technology is the solution that some people still seek the imperfect solution by arguing for placement of boat wash stations where they seem unnecessary.

Hardin (1968) emphasizes that searching for "solutions in the area of science only, the result will be to worsen the situation" (p. 1243). Instead of letting education be the long-term solution, a short-term solution is to let technology fix it. Morality becomes the issue when society's preponderance for reliance on technology misdirects behavior (Fisher, Bell, & Baum, 1984), in this case, away from effective inspection and removal actions by boaters.

Psychological relationships of other harmful or passive environmental behaviors have been discussed elsewhere (Geller, Winett, & Everett, 1982; Stem & Oskamp, 1987). By not promoting inspection and removal by boaters a concern is that there will be a loss of personal *relevance* and belief in their own *control* over AIS. Without those connections, promotion of technological solutions could fuel public apathy and complacency undermining the moral obligation of individual effective action. Realizing

that science and technology alone will not solve the issue shifts moral responsibility back to the individual. Information that increases knowledge and enhances skill can bring individuals to a “tipping point” for action (Schahn & Holzer, 1990; Chawla, 1998; Dweck, 1999; Gladwell, 2005). As AIS outreach progresses into this millennium, practitioners can adapt AIS-related pedagogy to address the disconnect between people and nature, to break down perceptions of reliance on technology, and to engage people in what ecology means to them.

AIS can be a vehicle through which outreach professionals and environmental educators meet mutual goals. AIS represent an opportunity to deepen public understanding of environmental literacy and make it relevant to them. Included in a vision of moving beyond traditional awareness embodying a sense of personal responsibility and action, must also take into account diversity and multi-culturalism. Strengthening AIS outreach and environmental education may mean bringing a more holistic meaning of the environment to a multi-cultural America.

Challenge 3 - Changing demographics. AIS outreach needs to adapt to rapidly changing demographics for natural resource protection. According to the 2000 U.S. Census Bureau, whites will soon be a minority. It is estimated that there are over 100 million people of color currently living in the U.S. Assuming demographic trends continue, 220 million people of color will live in the U.S. by 2050. Immigrants and their offspring will contribute to 60% of the population growth. By 2011, people of color will possess an estimated 25% of the buying power according to the Selig Center for Economic Growth at the University of Georgia. In addition to the economic impact, the potential for environmental impacts due to immigration are considerable. Environmental

education must recognize demographic shifts in our judicial system as well. Today, only 36% of the U.S. population is white male, while our Supreme Court is represented by only two females and two minorities.

Marcello Bonta, founder and director of the Center for Diversity and the Environment, believes that environmental education needs to embrace demographic changes to be successful. He cites that most environmental institutions are in a diversity crisis; it's "a homogeneous, unintentionally exclusive culture" (Grist Environmental News and Commentary, 2008). He proposes a four-point comprehensive strategy to diversify the environmental movement, including: 1) seeking partnership with labor, civil rights, and faith movements; 2) engaging youths by providing opportunities for "voice" within their communities and providing paid internships to help ensure that students enter environment careers from varied socioeconomic background; 3) unifying generations to cultivate emerging leaders to share experience, wisdom, and lessons from successful leaders; and 4) embracing multiculturalism- those values, attitudes, and religions that will foster greater understanding and break down stereotypes. Incorporating images of people of color and lower socio-economic classes (instead of mostly white, middle class) in communication and education media will help project relevance and inclusiveness. Indeed, culture holds communities together. Understanding and appreciating our racial and cultural diversity brings us together to form stronger communities (Takaki, 1993), which helps to address existing and future environmental issues, including AIS. AIS outreach that embraces cultural differences will likely be more successful if strategies, methods and messages are carefully crafted to account for social and religious attitudes and beliefs as they relate to competence of those taking preventive actions.

Challenge 4 - Lack of adult formal education. Beyond formal K-12 and secondary education, opportunities to promote environmental programs, including AIS, through non-formal and in-formal settings are limited. Most American adults rely upon previous first-hand experience with nature- land or water- as the basis for their appreciation of the environment. As discussed above, such experiences are declining. Most adult education continues through free-choice learning, such as visits at zoos, aquaria, environmental learning centers, as well as exposure through mass media communications.

Challenge 5 — AIS outreach caught in transition. Traditional views of teaching hold that knowledge is excellent, universal, and neutral. An assumption is that due to different learning styles (cognition), teaching needs to be customized for the individual learner. While endpoints may vary, state curriculum standards require that environmental education be taught K-12. Students are generally taught to understand the environment and demonstrate the skills learned, but they are not taught how to behave in a pro-environmental manner. Such teaching would be considered advocacy, which standards are not geared toward and school policies do not allow. Indeed, teaching toward the goal of changing adult behaviors creates challenges to institutions and programs way beyond just “getting the word out.”

AIS outreach focuses on self-learning and personal responsibility. In terms of application, however, AIS outreach is not treated as a priority, and efforts often lack the best methods (based on leading behaviorism approaches or theory) for promoting emancipatory behavior change. Practitioners of AIS outreach traditionally have expertise in resource management, fisheries or policy. In their defense, they are hired and trained



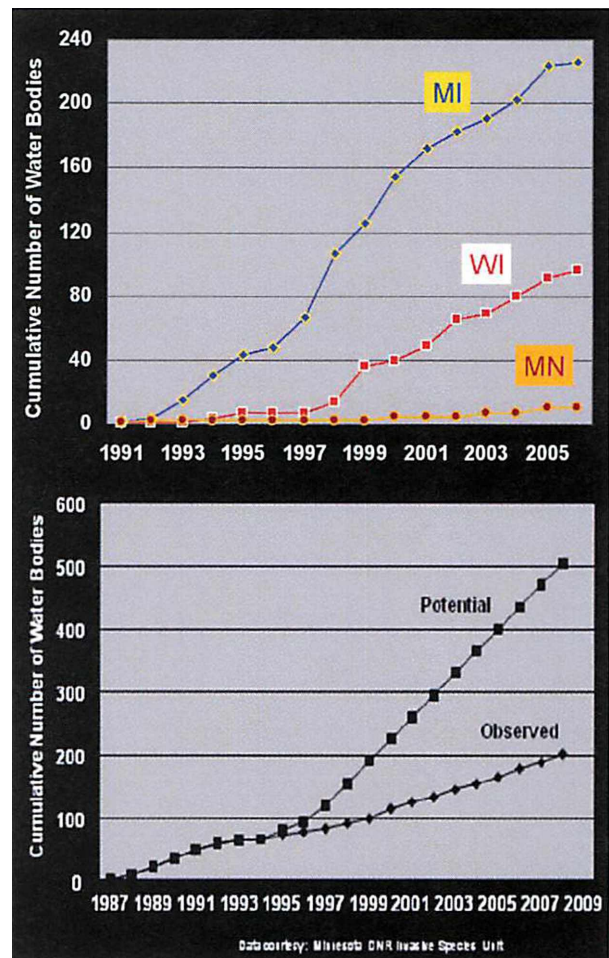
as content experts. Human behavior is not the area of expertise typically among these professionals. As with other issues such as climate change, most environmental education programs today teach toward knowledge (as one of the principles of environmental education), but rarely include changing behavior as a desired outcome (Kirk, Wilke & Rusky, 1997).

As a result, AIS outreach professionals typically use instrumental and communicative learning schemes to teach (see discussion on learning domains below).

Usually the outreach premise is: ‘If I provide the information, public awareness will be achieved.’ As discussed in this chapter, awareness does not necessarily result automatically in behavior change, including in boaters. This is confirmed by the rapid rate of spread of zebra mussels in several states (except Minnesota - see upper diagram).

However, it is important to recognize that Wisconsin has made significant recent progress in integrating behavior change theory through their Clean Boats, Clean Waters campaign.

Eurasian watermilfoil spread is also been much less in Minnesota than it would have been without a comprehensive approach (see lower diagram).



A related issue is that while boaters may understand the AIS problem, they have not been empowered to feel like they can make a difference in preventing spread. (For more discussion on empowerment through andragogy and experiential learning, see articles by Bandura, Brookfield, Dunlap & Van Liere, Festinger, Hallin, Karp, Rogers, Schwartz, and Thorndike). AIS outreach professionals gain insights and knowledge about delivery methods through reflective practice. By accessing social science (e.g., learning theory, behavior theory, application, evaluation) they can improve what they do. Robertson and Krugly-Smolka (1997) shed some light on the subject in their book, *Gaps Between Advocated Practices and Teaching Realities in Environmental Education*. The authors argue that environmental education needs to be taught with consideration for social, culture, economic and political issues reflective of human beliefs and behaviors. Armed with this suggestion, AIS outreach should consider hiring or consulting with social science experts to improve AIS adult education targeted behavior.

*Challenge 6 - Misinformation.* Misinformation undermines successes in AIS outreach by validating distorted perceptions (epistemic and sociolinguistic meaning perspectives- see Cranton, 1994) that ultimately can promote public apathy and complacency. Unfortunately, some natural resource professionals promote misinformation about AIS. Johnson and Carlton (1993) refer to this in their paper “Counter-Productive Public Information: The Noah Fallacy and Mussel Myths.” Common fallacies and myths include the following:

- The Noah fallacy maintains that it takes just a single pair of zebra mussels to cause an infestation. Not true. Based on invasion ecology it takes many introductions to create sufficient propagule pressure to allow for establishment.

- “It only takes one mistake.” Not true. With millions of potential introductions each season, if every introduction by recreational boater indeed caused an infestation, all of the lakes across the United States should be infested, but they are not.
- “Ducks will spread AIS anyway.” Not true. In reality, only small bivalves have been shown to spread by waterfowl; there is no evidence that any significant spread of zebra mussels and other AIS occurs by waterfowl. With nearly 13 million registered recreational watercraft in the U.S. that frequently move between waters, watercraft users are a *much greater* risk, as well as an element of AIS management that can be targeted and controlled.
- “The spread of AIS is inevitable” or “it’s only a matter of time.” Such beliefs are fatalistic and typically are based on fallacies and myths described above. Regardless, such perceptions undermine emancipatory behavioral change desired in targeted audiences, thus rendering people powerless in controlling their future. Such attitudes allow individuals an excuse to brush off their moral obligation to deal with reality. Reality is that if society does nothing, AIS *will* spread. Along connected waters, spread of AIS is likely; however, overland transport requires significant propagule pressure to result in established infestations.

Every communication opportunity with the public is critical. Misinformation can affect recall- influenced by suggestibility tests- demonstrating that social influence can strongly affect memory contagion (Roebbers, Schwarz, & Newman, 2005). It can also possibly influence non-compliance by visitors (Lackey & Ham, 2003). Choosing the right words is critical. For example, if you say that the spread of AIS is inevitable- that is

what will happen. Misinformation can influence perception of reality which can lead to false premises and faults in logical thinking (Kelly, 1988; Rand, 1967). Imparting misinformation, fallacies, or myths undermines successes in AIS outreach and jeopardizes the credibility of the messenger and the organizations they represent. To this end, Johnson and Carlton (1993) emphasize more careful and thoughtful promotion of messages to the public. Impacts of mixed messages are further discussed in the context of science, values, ethics, and public policy by Lodge and Shrader-Frechette (2003).

### *Meeting the Challenges*

Meeting the challenges of these issues will require innovative approaches reflective of a dynamic society and culture. AIS outreach and environmental education as a whole need to draw upon contemporary successes in human dimensions research. Indeed, models and approaches exist that can help AIS outreach accomplish its goals. Initially, AIS outreach needs to identify outcomes. Is the goal to inform or persuade? Is the desired outcome a specific action or a series of actions? How can approaches to natural resource management, AIS outreach, and human dimensions research intersect to produce achievable outcomes? Social sciences can inform the debate and guide development. As a discipline, AIS outreach should more strongly consider facets of behaviorism to help educators and communicators improve their practice.

### *Study of Behaviorism*

“Increasing knowledge alone will not significantly change attitude and values”- Iozzi (1989)

AIS outreach prevention starts with behavior. Contemporary approaches and empirically derived models of psychology based on adult learning and teaching, social

influence, and behaviorism can be used to empower pro-environmental behavior change by individuals.

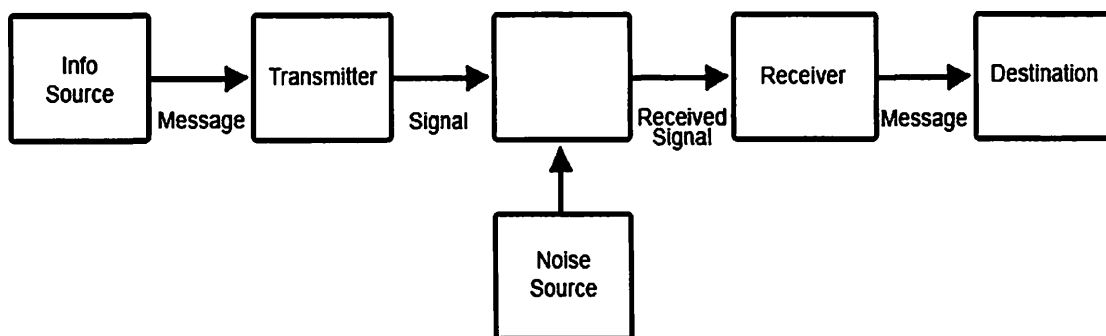
Four broad related fields of social science research are included here in an attempt to enlighten AIS outreach efforts. Areas identified are not intended to be exhaustive or comprehensive. They are examples, empirically proven in areas of human dimensions research, which could be applied to AIS outreach. While terms and approaches vary, a common thread is that they all embody the basic concept of human interaction.

For over a century- beginning with Pavlov, Thorndike, Watson, and Skinner- behaviorists used classical and operant conditioning to understand and measure learned responses. Often those conditioning experiments were conducted on animals as surrogates to humans to gain insights into human behavior. Those early theorists paved the way for further development of theories including aspects of learning and teaching, as well as behavioral theories and interventions. Theories of learning evolved into three areas: behaviorist, cognitive, and constructivist (also called humanistic) theory.

*Behaviorist theory.* Behaviorist theory of learning can be described as an expression of a positivist ‘scientific’ approach to learning derived from empirical or real world applications. Behaviorism is based on observed behavior changes. Classical behavioral research focuses on conditioning, which produces behavior patterns that are thought to be automatic. Positivism is based on the assumption that accumulating knowledge results in behavior change. Learned responses are generalized to be linear conditioned response or learned by association. Operant conditioning experiments showed that learning is about the increased probability of behavior occurring in the future.

B. F. Skinner believed that once a behavior is learned, the behavior does not necessarily need to be reinforced 100%, rather it can be effectively maintained through partial reinforcement schedules. Skinner's work and those of his contemporaries stimulated further research. And, behaviorists began to recognize that behaviorism is much more complex. As a learning construct, behaviorism at that time did not explain certain types of individual or social behaviors. As one example, researchers found that rats conditioned in a maze using food as the reward would choose to find longer successful routes rather than shorter unsuccessful ones. As another example, studies found that children do not imitate all behaviors that are reinforced; however, they have been observed expressing a behavior [they had not imitated] some time thereafter. These examples illustrate the complex nature of reasoned learning and behavior manifestation. Behavior models conceptualize fundamental learning relationships.

A model that gained traction based on a positivist approach was the "transmission-absorption model" (cited in Shannon & Weaver, 1963; model redrawn below). While seemingly still in vogue today, it has been shown to be inadequate in learning and behavior. More integrative models evolved to better characterize learning and teaching. Many studies have shown that learning is usually much more complex, non-linear, and often based on interactions of intrinsic and extrinsic situational variables.



*Cognitive theory.* Cognitive theory of learning evolved from behaviorist theory. Gestalt theory may be the best known cognitive theory for problem solving dilemmas using “the big picture.” Max Wertheimer and his students Kohler and Koffka used Gestalt theory to provide a holistic approach and expose patterns that contribute to learning. Cognitive theory takes into account both the need for scientific inquiry as well as thought processes in human behavior that cannot be quantified. Changes in behavior are observed and used as indicators to provide insight into what is happening inside a learner’s mind. It assumes that learning is the result of associating new information with previously processed information. As the theory holds, new information is compared to existing cognitive elements called “schema.” Schema can be combined, altered, and transformed as new information is accumulated. As an outcome, learning is not necessarily manifest in a person’s behavior just because of cognitive processes.

Well-known theorist Jean Piaget developed basic elements of cognitive theory beginning in the 1920s. However, the theory did not become popularized until the 1950s when Miller and Bruner founded the Harvard Center for Cognitive Studies. Basic elements of cognitive theory include: learning versus memory (e.g., dual store model), storage of new information (short-term and long-term), encoding to make sense of the stored information, and retrieval of the information so it can be used again. Encoding is an important element that can take place in the following ways:

- When new information is well-organized, it is easier to recall. Practicing the behavior improves retention.
- Learning new information within a certain context is easier to recall than in a non-relevant context.

- Linking meaningful information to prior schema can make new information easier to learn and recall (Cofer 1971, as cited in Good & Brophy, 1990).

Social cognitive theory can provide a theoretical grounding for AIS outreach. It is based on the premise that individuals will comply if they believe benefits outweigh costs (Bandura & Walters, 1963). Their research shows that people gather information about things that are important to them, which can help reveal how they think and communicate about these matters. Research-based outreach can develop strategies to affect behavioral outcomes by addressing attitudes, perceived norms, and self-efficacy taking these distal variables into account (Booth, 1996). If behavior outcomes are to be realized, engaging target audiences through strategic outreach in time and place-based, providing access to sources of information and services, and reinforcing desired behaviors through reminder prompts will be significant in helping them follow through on intentions to change their behavior. (For more on cognitive theory, see research by Donaldson, Kolb and Pask.)

Other approaches to cognitive theory can be applied. Paivio's Dual Coding Theory (Paivio, 1986) revealed that audio and visual information are processed differently among individuals, and when both are presented at the same time on the same subject, it is often easier to recall. By using a rapid sequence of images and words, he demonstrated that participants recalled better the order of words, rather than the sequence of images. Using visuals portraying behavioral norms combined with effective words or phrases can enhance cognition of AIS messages.

Constructivist theory. Constructivist theory builds on behaviorism and cognitivism in that it recognizes the multiple dimensions of learning while emphasizing that knowledge is a perceptual construct of learners. It uses internal or external social



constructs in context to make meaning and understanding of the information they acquire.

(For more on constructivist theorists, see research by Bruner, Freire, Holt, Knowles,

Kolb, Maslow, Pask, Rogers, Shor, and Vygotsky.)

Cranton (1994) describes constructivist theory this way: “learning is a process of construing meaning and transformational understanding” (p. 9). Constructivists assume an inherent desire of people to be lifelong learners and allow them to be empowered in a learner-centered context. They place value on the teacher-learner interaction. Learning in this context is a dialogue that modifies a learner’s schema (or meaning perspective) about that topic (Laurillard, 1993). Laurillard’s work is reflective of the work by Gordon Pask, who was a cyberneticist. Pask developed a systems approach to learning referring to two different kinds of learning- serialists and holists. Serialists learn by building sequentially block by block from the unknown until the void of knowledge is full. Holists fill the void of knowledge by exploring areas in seemingly random order. Examples of serialist and holists are learners or practitioners in science and communication, respectively.

Scientists tend to gather information in a systematic and logical framework in concordance with scientific method, whereas those working in communication generally take a wider view of a subject. Hudson’s work (1967) reinforces that learners interested in science technology are more convergent learners; they assemble knowledge through facts that converge on a central answer. Conversely, divergent learners such as those in arts and humanities might be predisposed to respond to a central stimulus that creates ideas or forms of expression, which is more holistic.

Habermas (1971) breaks down this learning schema into domains of knowledge, which provide a foundation for Mezirow (1991) and Cranton (1994). Cranton describes

three learning domains: instrumental, which concerns acquiring knowledge and often technical skills (behaviorist-positivist); communicative, which concerns meeting the needs of the learner (constructivist but can be linked to positivist and cognitive learning) and emancipatory learning, which relates to the humanistic and complex interaction of critical self-reflection resulting in meaningful change in perspective, beliefs and attitudes.

Cranton (1994) recognized that adult learning changes over time and can take place in diverse settings such as universities, colleges, vocational schools, business and industry, community action groups, continuing education, self-help programs, and literacy programs. Cranton's classification system is mentioned here because its particular framework seems to encompass the aim of environmental education, including AIS outreach- a challenge is applying this complex setting to bring about transformative learning through critical reflection, revise old or develop new assumptions, beliefs, or ways of seeing the world.

A few studies by others are worth noting. As a conventional teaching model, Bloom's Taxonomy of Learning (Bloom & Krathwohl, 1956) broke down learning processes into cognitive, attitudinal and psychomotor domains. Objectives of this model were: knowledge, comprehension, application, analysis, synthesis and evaluation. Gagne (1972) proposed a somewhat different taxonomy of learning along five categories: verbal information, intellectual skill, cognitive strategy, attitude, and motor skill.

Both taxonomies are useful in finding a starting point for instruction, or assessing where learners are in their development regarding AIS behaviors. Are learners informed? If so, have they synthesized that information and begun using it? Both approaches help ensure learners comprehend, understand, and build skill so that they are able to construct

new ideas. They allow practitioners to develop pedagogy using behavioral objectives. It is widely accepted that effective education must address components of learning such as schema, knowledge coding and representation, comparison with previous information, storage, and retrieval (Saettler, 1990).

The cognitive learning approach makes sense for AIS outreach because it breaks down the steps into its parts and facilitates development of pedagogy around those parts to help move learners along from simple to more complex prior schema (or meaning perspectives). This approach also lends itself well to teaching toward and addressing misperceptions, fallacies and correcting misinformation, a challenge discussed previously. Recognizing these models and facets to adult learning can play an important role in how we approach AIS outreach from raising awareness to targeting behavior.

Interestingly, Atherton (2005) posits that approaches to behaviorism research are constrained by attempts to imitate natural sciences. Use of rewards as measures of behavior in the real world fail to take into account cognitive process that in play such as people's abilities and motivations. Cognitive reinforcement can bring feedback information with it which makes it more significant to human learning. Behaviorist experiments that do not recognize this cognitive nature are missing key elements.

Effectiveness of AIS outreach could greatly benefit by researching multiple theories used in behavior studies. Examining the AIS issue from a wide range of possible action could form a mutually reinforcing package of prevention and containment policies and strategies. Positivism has its place at the scientific information-policy interface. When contextualized and integrated with constructivist approaches, AIS outreach could lead to success in terms of an aware citizenry, sustained behavior, and protected water

resources. The alternative is to settle for a positivist notion that likely will not work. If AIS public awareness has not worked, it is not due to empirically established fact, but likely an artifact of the epistemology of most outreach efforts with a traditional approach and structure.

Knowledge is defined as expertise and skills acquired by an individual through experience or education, what is known about a particular subject, or the theoretical or practical understanding of a subject. What is the state of knowledge about behavioral interventions? In the field of psychology, knowledge requires cognition, or ways an individual gathers and processes information. Cognition can be modeled as individuals, groups of individuals, and societies.

Unfortunately and despite a wealth of research, the relationship from knowledge to active sustained environmental behavior remains unclear. What is known is that knowledge of environmental problems is nearly always used as a predictor of environmentally responsible behavior (Ballantyne & Packer, 1996; Hines et al., 1986-87; Howe & Disinger, 1991; Hungerford & Volk, 1990; Iozzi, 1989).

As emphasized previously, an underlying assumption in education is that providing information will influence individuals or groups of individuals to change behavior. Ramsey (1979), Klingler (1980), and others identified the erroneous assumption in behaviorism that skills naturally evolve from knowledge. Iozzi (1989) states: “increasing knowledge alone will not significantly change attitude and values” (p. 5). Iozzi challenges education to move beyond just content to use constructivist theory of learning by focusing on the attitudes and values of the learner. It is presumed that this challenge should be extended to environmental and AIS education as well.

## Behavioral Interventions

“For every complex problem there is a simple solution ...and it is wrong. ” - H. L. Mencken

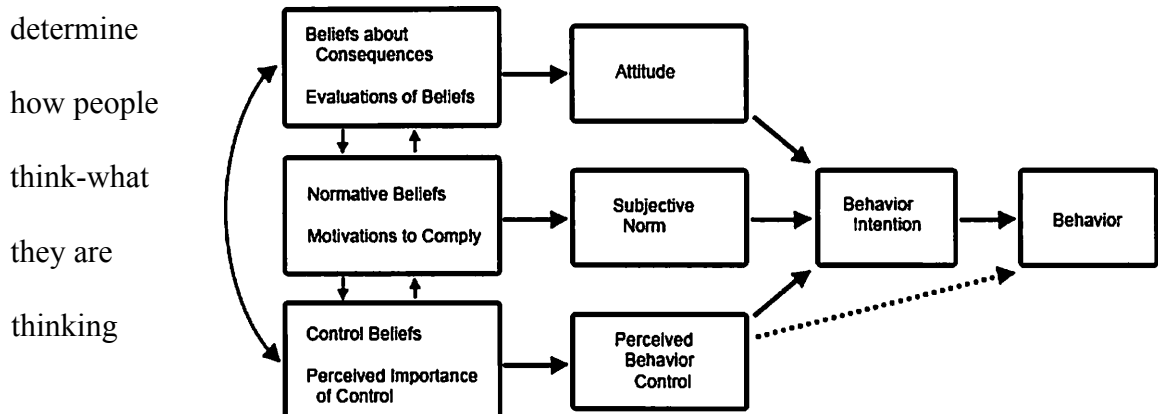
Many theories have been applied in behavior research leading to development of behavioral interventions. Certain variables have emerged as determinants in predicting and understanding individual behavior. Behavioral prediction models have shown that attitudes and beliefs (Ajzen & Fishbein, 1980) are determinants that can be used to change or maintain a given behavior. According to Ajzen and Fishbein's (1975) theory of reasoned action, the main determinants of a person's behavior are the strength of their intention and ability (capacity or skill) to act. Three factors interplay in determining behavior: 1) the behavior is altruistic (e.g., benefits them, family, business, society, environment), 2) the behavior is accepted as a social norm among others important to that individual or group, and 3) they believe they have the capacity or skills to act (self-efficacy).

In this context, “self” is highly individualized. Putting it another way, individuals search for creating an image of themselves which is consistent with their self-image and lifestyle. An individual will tend to ignore experiences inconsistent with their self-image (Geller & Lasley, 1985). Individuals that are more neutral than those extreme in attitude are more likely to change their attitude. Stephen Brookfield (1987; 1991) suggests that attitudes towards environmental awareness can be changed through reflective learning. Through an interrelated process, an individual questions a belief and changes (or potentially replaces) his/her attitude toward the belief based on previously held assumptions, ideas, schema, or ideologies. However, change in attitude can be shifted

when an individual is confronted with a discrepancy between their attitude and behavior (Dawes, 1980; McKenzie-Mohr & Smith, 1999; Yamagishi, 1994).

Sustained changes in mental schema are based on the cognitive and process ability of an individual (or audience). Ajzen and Fishbein (1980) refer to this as the “elaboration likelihood model.” If the outcome of the elaboration is negative, the individual will reject the information (or potentially even its source) and cling to a previous schema even more strongly. Efficacy of this model depends upon the success in targeting an individual’s belief system. Assuming an individual is receptive to the message (or the person delivering the message), it is much more likely that he/she will act in a desired manner. If on the other hand, the message does not resonate with that individual’s values, or they don’t have the capacity or skill, that individual may react along a continuum, from inaction to negative reaction. If passively or negatively received, resulting attitudes can range from the individual returning to their previous schema or associating a negative attitude to that schema, respectively. An element not fully addressed is how humans cognitively weigh the information both positive and negative and if the individual believes she/he can perform the desired behavior.

Ajzen (1985) extended the theory of reasoned action and developed the theory of planned behavior (TPB, see illustration redrawn below). TPB is an effective model to



and what they think they know. It is a model that can be used to test or verify reasons (intrinsic or extrinsic) for inaction and action within a target population. By measuring attitudes, beliefs, and self-efficacy (capacity, skills), outreach can target those schema with motivational messages aimed at bringing about desired behaviors. Measuring the relative strength of the influence on attitudes, norms, and self-efficacy and differentiate between those who act and those that do not act. AIS outreach can target individual's schema over time by influencing attitudes and beliefs. Targeting the attention of those that already hold beliefs can cause slight changes in predisposed positive beliefs that can produce strong intentions. Once beliefs are questioned or challenged, a reflection of the self-image changes attitudes (positive response, if there are perceived benefits), perceived personal and social norms and self-efficacy, which underlay the reasons for behavior. These applied psychology methods are used to change perceptions so that people believe differently about themselves and their behavior by reinforcing the desired positive relationship between belief and attitude.

As Ajzen (1992) states, barriers can be overcome, "by dealing with the receivers' enduring values, with receivers' ability to obtain desirable outcomes or avoid undesirable outcomes, or with the impression that action makes on others (often referred to as self-image)" (p.7). Differences among practitioners versus non-practitioners can be explained by comparing differences in beliefs, outcome evaluations, perceptions of efficacy, and motivations to comply (see model above). As discussed previously, differences in behavior are directly influenced by distal variables of culture, personality differences, age, gender, sexual orientation, race, and religion.

TPB is based on elements of beliefs, attitudes, norms and perceived control. Behavior in this context can be described as three main elements: action, target, and context. These are the elements that lend themselves to behavioral intervention effort among boaters and anglers. Applying them to boaters the: 1) actions are inspecting and removing AIS; 2) targets are all aquatic plants and AIS; and 3) context is the boat, motor, trailer and equipment at the water access. Any changes in these elements can influence the outcome of the targeted behavior. For example, if boaters and anglers take action that is not at the water access, they could spread those “hitchhikers” if they fall off the vehicle and find their way into another water body. Messages must be highly tailored to specific user groups at effective times and location so that the messages reach and relate to them. For most effective behavior intervention, it is critical that desired actions be reinforced consistently, and includes what AIS to look for and where.

A lesson in behavior intervention is to identify, promote, and model the desired action or behavior. According to the Fishbein and Yzer (2003), “one of the lessons we have learned is that the most effective interventions will be those prescribing specific behaviors (e.g., walk for 20 minutes three times a week) rather than behavior categories (e.g., exercise) or goals (e.g., lose weight)” (p. 198). In other words, replace the undesired behavior with specific actions that promote behavior change.

Importantly, if self-efficacy is an issue (e.g., do not have skills), targeted outreach and training to those not performing the behavior can build the skills and capacity necessary for those individuals to perform the intended behavior. Educated or trained with the capacity to act, those individuals are much more likely to take action than without that capacity. Once the goal of behavioral intervention is accomplished, frequent



communication is needed to reinforce target behaviors as social norms in order to sustain those behaviors within that audience.

Today, communication through mass media campaigns (traditional) and social networks (e.g., email, Web, RSS feeds, Twitter) can be used to reinforce behavior norms. Based on the theory of dual coding, individuals often use heurism as a route to processing information by short circuit and rapidly arriving at a solution (Cialdini, 2001; Kahneman, Tversky, & Slovic, 1982). Rather than processing through systematic or logical processes, they process through short cuts called heuristics. Heuristics are “rules of thumb,” educated guesses, gut-feelings, intuitive judgments, or simply common sense. They place judgment about things based on past examples (Tversky & Kahneman, 1973). The more exposures to the message, the stronger the influence on attitudes, norms and self-efficacy (see discussion of media priming theory, Fishbein & Yzer, 2003; see discussion of tipping points, Gladwell, 2005).

Another influence is social conformity based on peer pressure and conditions of authority often tacitly expressed. Conformity is an element for the successes (or failures) of society. Milgram’s work (1963; 1964) on group pressure and action, obedience to authority, and behavior obedience showed how conformity can be manipulated. Aronson and O’Leary (1982-83) demonstrated that combining communication media with active model behavior in a place-based situation can significantly increase a conservation activity raising it to the level of a community norm. Activating community norms through the influence of the susceptibility to conformity should be used more widely in AIS outreach- like that used by watercraft inspectors at water accesses aimed at influencing sustained prevention actions by boaters in many states.

Strategies to address audiences that are already influenced to act- those that are moderately or somewhat influenced- may be very different from strategies used to address those who do not act (Booth, 1996; Tyrrell et. al., 2009). This continuum of behavioral action suggests that a one-size-fits-all approach may not be effective in targeting an entire population. Application of these theories like those of Fishbein and Yzer (2003) and Hornik and Woolf (1999) can provide insights into developing and implementing AIS campaign and outreach messages that use persuasive behavioral determinants (e.g., inspect your boat).

These studies provide a more in-depth understanding of how learning works that can be used to address sustainability of actions. Commitment is key in framing intrinsic motivation. Repeated behavior over space and time can reinforce that commitment. Compared to everyday activities, pro-environmental behaviors may not be performed frequently, which minimizes the sense of accomplishment. Without positive reinforcement, an individual's commitment to the behavior fades. Short-term behavior change is inadequate. With regard to AIS prevention, sustained behavior change is necessary and must be assessed to determine which influences are the triggers for sustained behavior so that contemporary strategies can be developed and implemented.

Several intervention approaches have been modeled successfully in the United States and abroad (Booth, 1996; McKenzie-Mohr & Smith, 1999).

Teach Toward Environmental Values Rather Than Knowledge?

“The environmental movement should also be a human rights movement!” - Paul Hawken

As noted earlier, outreach efforts should not expect that ecology has or will have value with everyone. Why? Knowing individual's values and receptivity towards the

environment would benefit those engaged in environmental protection and management. Ecology and environment need to be carefully framed to help make the concepts relevant to society based on a spectrum of values.

Many studies suggest that environmental education in practice should address the affective dimension by teaching attitudes and values at the expense of environmental knowledge (Ballantyne & Packer, 1996; Gigliotti, 1990; Iozzi, 1989). However, efforts to characterize the nature and scope of environmental education ultimately promote as its goal responsible environmental behavior (Howe & Disinger, 1991; Hungerford & Volk, 1990). An unintentional side effect of not teaching explicitly toward an objective of pro-environmental behavior is that it is unlikely that sustained or even short-term behavior change will be achieved by individuals. Environmental education might benefit by applying constructivist principles of learning to individuals and social groups with diverse knowledge, attitudes, values, cultural, and behavior orientations (Ballantyne & Packer, 1996).

### *Motivations*

*“We ’re protecting [the environment] for our own sake because we recognize that nature enriches us... When we destroy nature we diminish ourselves. We impoverish our children.”- Robert F. Kennedy, Jr.*

A critical component of behaviorism is motivation. Motivation differs among individuals. Motivation depends upon the level (how much) and orientation (Ryan & Deci, 2000). Obviously, if the public is not aware of the AIS threat or does not understand how to prevent the spread, they are unlikely to take appropriate actions to protect lakes, rivers, and wetlands.

Motivations based on beliefs and attitudes strongly affect sustained behavior in adults (Atherton, 2009). Motivation can be characterized as intrinsic (e.g., achievement, affiliation, competence, power, attitude), extrinsic (e.g., incentives/disincentives, fear), or both (e.g., altruism, social or environmental altruism). Beliefs modulate between the interaction of values and attitudes. Schwartz (1994) identified that values are ordered by importance relative to other values forming a system of priorities. Value-based attitudes include biospheric, conservatism, egoistic, openness, enhancement, and altruism. Value-based attitudes, especially self-transcendence, have been shown to be important in activating intent for pro-environmental behavior (Schultz & Zelenzny, 1998). Human behavior is largely influenced by message content and consistency. Individual behavior can be influenced not only through direct appeals (Witte, 1992), but by close friends and relatives, and social norms within the greater community (Abrams & Maibach, 2008). These subjective norms combine with normative beliefs to influence motivations to comply.

Tanner (1980) identifies that significant life experiences support an individual's values and beliefs toward the environment. He explains that it is important to recognize the life experiences that act as determinants in motivating people to be environmentally responsible. Applying this emphasis to AIS education, then, it is important to understand people's intrinsic and extrinsic motivators related to human behavior. Palmer and colleagues (1993; 1998a,b) in a multi-country study along with Corcoran (1999) demonstrated that the most important determinant influencing formative experiences of environmental educators was a positive outdoor experience. Corcoran also noted that in the U.S. and U.K., the age group under 30 were least involved in practical conservation

and political activism compared to older groups. Palmer (1993) supports the contention that young adults (<30 years old) do not develop concern for the environment until they have taken higher education/adult courses. If the relationship of youths with the outdoors is indeed declining as has been suggested, what does it mean for the future of the environment? Age and other factors related to motivation are further explored below.

Altruism. Altruism is unselfish concern for the welfare of others; selflessness. Debate continues as to whether altruism is truly an outward expression of behavior that benefits another or society. Some psychological research (Krebs, 1982; Rushton, 1982) suggests underlying altruism are cognition and intentions (motivations). Batson (1987) suggests they are not mutually exclusive, but rather a benefit to the individual (internal gratification congruent with self-image) or external gratification (such as acts of appreciation). Explained in another way, if the costs to the individual are low (effort, time, money) and the benefit to the individual (or society) is high, the greater the motivation to act. What determines whether an individual takes action depends upon the situation (Colaizzi, Williams, & Vincent, 1984; Gentile, Naughton, & Kayson, 1986). Action traits such as kindness, volunteer time (see more below) or effort, resources, and money are altruistic behavior that often interact (Mischel, 1968) depending upon the individual's personality, setting, and that interaction.

Rushton (1982) believes that altruistic behavior is influenced by observing others and being reinforced by our actions. Individual self-image, social norms, and gender roles can also be determinants (Eagley & Crowley, 1986). Willingness to act is also strongly influenced by the familiarity with the setting in which the action will occur. So, altruistic behavior really seems to be based on an internal cost-benefit analysis where the

individual weighs the benefits conveyed and the setting. Defining the action and knowing what to do are the last steps in the decision making process.

Volunteerism. Volunteerism is another type of motivation (Unger, 1991). Being happy and positive are characteristics of individuals who volunteer (Howarth, 1976). Well-developed values embrace social consciousness, selflessness, responsibility, and trust. Volunteerism tends to depend upon social expectations, upbringing, education, income, education, age and gender (Eagley & Crowley, 1986). Volunteerism is generally thought to be an altruistic motive (Bar-Tal, 1976; Batson, 1987). It is an inclusion behavior that involves the need for association, self-reflection, and communication between people. Beyond these inherent human attributes, interest in inclusion is about prominence and recognition. While strong emotional arousal is not necessary, prestige and status can be key characteristics of this interpersonal need (Schutz, 1966). Most of these relationships are beyond the present study; however, the last two, age and gender, are of particular interest.

Age. Concern about the environment tends to be age-dependent (Palmer, 1993). Since the environmental movement is a relatively new cultural phenomenon, we might expect that the baby boomers who grew up during the rise of the environmental movement might be more receptive to environmental messages than senior citizens or a younger demographic (such as 20 year olds). Empirical environmental research seems to substantiate this claim. Bar-Tal (1982) suggests that there is a growing level of moral development with age, suggesting that there may be a predisposition of senior citizens, many who are grandparents want to leave a quality environment for the next generation. Older audiences are likely more sensitized to the environment through life-long

experiences (Finger, 1994). So, motivation for seeking environmental-based information among older generations is due more to social altruism than interest in acquiring the information itself. Other studies concluded that efficacy of social influence is very much age dependent (Roebbers et al., 2005; Roebbers & Schneider, 2004; Schwarz & Roebbers, 2006). These results could have implications for understanding how social contact influences behavior related to AIS based on age.

Age and willingness to pay. Schroeder, Penner, Dovidio, and Pilain (1995) identified that middle-aged adults are more likely to give more to charity than other age groups; however, this could be due to younger adults having less income and seniors on fixed incomes. The more education and disposable income, the greater likelihood that an individual will volunteer (Schroeder et al., 1995). It is reasonable to assume that the relationship of altruistic behavior transcends from social to environmental issues.

Gender. Compared to men, women are stereotypically viewed as gentle, nurturing, empathetic, and caring, but are they predisposed to volunteer? Several authors agree that the difference in socialization of gender leads to differences in attitude, knowledge, and place in society (Arcury, Scollay, & Johnson, 1987; Bern, 1981; Braun, 1983). According to Bern (1981),

gender schema theory proposes that the phenomenon of sex typing derives, in part, from gender-based schematic processing, from a generalized readiness to process information on the basis of the sex-linked associations that constitute the gender schema, [sic] ...sex typing results, in part, from the fact that the self-concept itself gets assimilated into the gender schema, (p. 355)

Within the context of social influence, gender behavior is driven by the roles and expectations of society (Eagley, 1987). Gender behavior may also be driven by the tendency of women to be more relationship-oriented than men (Cross & Madson, 1997).

Women more than men spend greater time volunteering to take care of the elderly (Taniguchi, 2006). How does this translate to a predisposition to take care of the environment? It depends. Van Liere & Dunlap (1980) pointed out that few efforts paid attention to environmental concern due to gender differences. Factors that influence behavior based on gender may be contradictory (Arcury et al., 1987; Hines et al., 1986-87). Schahn & Holzer (1990) found that women were more environmentally concerned in areas related to household behaviors (e.g., recycling, choice of green products), although men knew more about environmental problems. Although men may know more, their actual behavior might be governed more by behavioral intentions than by actions related to household chores like recycling, purchasing green products, or pesticide-free organic food. The authors speculate that the lack of regularly conducting those pro-environmental activities may result in higher level of self-reporting by men due to inexperience. This emphasizes the point that attitude and behavior are not always congruent.

GreenCom has developed and tested methodologies to promote a sustainable economy and environment, with an emphasis on gender (Booth, 1996). A study conducted in Ecuador had a positive impact on male farmers through crop diversification, soil maintenance, multiple-use forestry management, water conservation, and small animal management. While undeniably a success from several perspectives, women in farming households strongly influenced participation by men in pro-environmental behavior because it increased women's responsibility and work-load while the male



farmers were away at training courses and meetings. There was no evidence suggesting that women were any less predisposed about taking care of the environment; however, it emphasized that the unanticipated role of gender can influence support of pro-environmental behaviors based on socio-economic roles.

### Social Influence

“Belief like any other moving body, follows the path of least resistance.”- Samuel Butler

Environmental education must also consider social norms as determinants that influence behavior toward the environment. Norms are rules that govern appropriateness of values, beliefs, attitudes, and behaviors. Norms can be explicit or implicit, injunctive, descriptive, subjective, or personal. They are most influential when reflected frequently and openly.

Do social norms translate to environmental norms? Many studies attempted to gather information on attitudes toward nature in order to predict pro-environmental behavior. Dunlap and Van Liere (1978) proposed a New Environmental Paradigm (NEP) which embraced a shift from social paradigm model (e.g., nature is here for human use) based on the assumption that environmental problems will be solved through science and technology. The NEP approaches humans as part of nature, rather than in control of nature. NEP has been used to measure public awareness and attitudes (Geller & Lasley, 1985; Dietz, Stern, & Guagnano, 1998; Schultz & Zelezny, 1998; Stern & Deitz, 1994; Widegren, 1998) with varying success. As Lalonde and Jackson (2002) point out, the original NEP reflected the “ecological consciousness” reflective of environmental attitudes of the 1960s and 1970s. While supporting NEP as seminal work, they make the case that the NEP as a tool needs to be revised to reflect contemporary language and

conceptual content reflective of the public's greater understanding of environmental issues and their consequences.

Even today, the reciprocal association between knowledge and environmental behavior is not clear. The issue becomes more complex as it pertains to natural resources management. Challenges related to human dimensions are often common barriers to decision-making in natural resources management (Holling, 1995; Lee, 1999). Natural resource managers continue to be plagued by the lack of understanding of stakeholder values, attitudes, beliefs, and motivations which limit decisions and allocation of funding (Krueger & Decker, 1999). To develop the most effective interventions, natural resources management including AIS outreach must integrate science-based information with experience-based insights concerning environmental issues *with* human/social dimensions. Understanding human dimensions will help programs become more effective. This is especially true for AIS where collective behavior is paramount to preventing, controlling, and minimizing the impacts of AIS.

Cialdini and Goldstein's (2004) review of social influence literature (1997 to 2002) synthesis shows that behavior is motivated by perceptions of reality. Realities are based on external stimuli reacting to developing and preserving meaningful social relationships in order to maintain a favorable self-concept (altruism). Extrinsic motivators that target susceptibility and reward basic human needs could be used more widely in communication media to engender social influence processes concerning behaviors toward AIS.

Communication appeals can be strong social influencers. Witte's (1992) extended parallel process model (EPPM) is an appeal theory that builds upon previous drive,

parallel process, and subjective expected utility models. Such appeals have been applied in health education campaigns (Witte & Allen, 2000), but apparently have not been much in conservation education efforts. One study found that negative message appeals did not work well with woodland owners (Tyrrell et al, 2009). According to EPPM, individuals weigh appeals based on perceived susceptibility to the threat and perceived severity of the threat, which then results in one of three outcomes. Greater perceived susceptibility to a serious threat, the more motivated an individual is to a second appraisal. Perceptions of the threat are then used in assessments of the efficacy of the recommended response. If the appeal is perceived as irrelevant or insignificant, an individual will choose to ignore it and any subsequent appeals. If the appeal is perceived as relevant and significant, individuals may be fearful, motivating them to take action to alleviate their fear.

Perceived efficacy, which is based on self- and response-efficacy, determines whether an individual becomes motivated to control the threat itself or control his or her fear of the threat when they believe that the effective recommended response is to prevent or control the threat. Conversely, if an individual doubts the efficacy of the recommended response or does not believe that they have capacity or skill to act upon the recommended response, they are more likely to control their fear (arousal) through denial, defensive avoidance, or reactions.

EPPM suggests that perceived threat contributes to the extent of a response to a fear appeal whereas perceived efficacy (or lack thereof) contributes to the nature of the response (i.e., whether the danger or fear control responses are elicited). If no information with regard to the efficacy of the recommended actions is provided, individuals will rely upon past experiences, prior beliefs or information (accurate or not) to determine

perceived efficacy. To test this theory, social scientists manipulate the strength of the appeal in at least two different messages, validate the different strengths through manipulation checks, and assess whether stronger fear appeals produced strong outcomes. Such appeals are most effective in changing attitude when there is sufficient arousal, desire for control, and the individual possesses the skills to deal with that issue. Self-efficacy is an important determinant in a person's ability to deal with an issue (Bandura, 1982).

Abroms and Maibach (2008) developed a model that focuses on people (based on level of aggregation, individuals, social networks, population or community) and places (local or distal). They revealed five sub-determinants that influence decision-making with respect to human health (anti-smoking). Through evaluation of a focused media campaign, their research demonstrates that a branded campaign was a key to success in teen smoking prevention. Brands are powerful tools that encourage an image that is often exactly what an individual desires to be. This example and others recognize that individual behavior can be influenced by mass media. While this approach can be applied to human health, it is reasonable to assume that mass media branded campaigns could work to effectively communicate messages with an environmental protection theme.

What is clear is that motivations for behavior related to the environment can be murky. Behavior is determined by the interaction of an individual's life-long experience, setting, personality, predisposition, and other factors. What seem to underlie these behaviors are values and beliefs toward lakes and rivers, and why people who love lakes and rivers want to take care of them (Anderson, Kelly, Sushak, Hagley, Jensen, & Kreag, 1999). People desire a sense of belonging. Feelings of belonging can be associated with

people or the resources they treasure. To be successful then, AIS outreach needs to continue to tap into those feelings of individuals and groups so that they will be motivated to protect water resources. Motivations for action, attitudes and values, breaking down the barriers to behavior change, and other factors are part of another area of research called social marketing.

### *Community-Based Social Marketing*

*“Thinking is easy, acting is difficult, and to put one’s thoughts into action, the most difficult thing in the world.” - Goethe*

Community-based social marketing (CBSM) has been promoted to help natural resource professionals avoid outmoded “rational choice” models that depend upon “pouring in” information toward a more research-based integrated framework (McKenzie-Mohr & Smith, 1999). It is being applied with success in health care, crime prevention, and environmental protection.

CBSM represents a departure from traditional approaches to marketing by selling social messages instead of products. The genesis of social marketing traces back to the 1940s. Concepts and approaches did not gain much traction in U.S. society until the Vietnam War caused the public to rethink their social obligations (Andreason, 2003). Early product introductions based on conventional promotion and distribution resulted in the discovery of “a potentially very powerful social force” (p. 294).

Kotler & Zaltman (1971) coined “social marketing” to this new discipline when they threaded marketing and technology in application to social issues. Since its genesis, it has become a mature field demonstrating many successes in fostering social change. Andreason (2003) helps to clarify what social marketing represents:

Social marketing is the application of commercial marketing technologies to the analysis, planning, execution, and evaluation of programs designed to influence the voluntary behavior of target audiences in order to improve their personal welfare and that of society of which they are a part. (p. 7)

Concepts used in social marketing provide a framework for social science practitioners to foster community-level change offering them an opportunity to apply and test adult learning concepts, environmental education, psychology models, behaviorism, and approaches to intervention.

Social psychologists McKenzie-Mohr and Smith (1999) contend that CBSM is a way toward a sustainable future. Successes are based on its pragmatic approach that involves the following four steps:

1. Identify barriers and benefits to a sustainable behavior;
2. Design a strategy that utilizes behavior change tools;
3. Pilot the strategy, and
4. Evaluate the impact of the program once implemented across a community.

CBSM is not a departure from traditional approaches; in fact, it promotes a framework that can be easily aligned with environmental campaigns. What is different are the marketing strategies and how they are communicated. In their book, *Fostering Sustainable Behavior* (McKenzie-Mohr & Smith 1999), they make a strong case for messages needing to be detailed and specific. They emphasize that it is not sufficient to use generic messages such as “waste reduction,” “act locally,” and “conserve energy.” Rather, more effective messages like “compost food scraps,” “take the bus to work,” and “turn off lights” work because they promote specific actions that are memorable and

sustainable. Effective interventions are designed to change specific behaviors (Fishbein & Yzer, 2003).

But is CBSM sufficient? McKenzie-Mohr and Smith (1999) identify three reasons why people do not engage in target behaviors: lack of awareness, perceived or real barriers to carrying out the activity, and perceived benefits of continuing to engage in their present behavior. Values and attitudes vary within a community. What is a benefit to one person may be a barrier to another.

CBSM relies on research into understanding those values and attitudes so they can be broken down into components and targeted toward action behaviors. Understanding values, attitudes, and motivations of groups within the community (e.g., government, business, academia) seems to be key. An underlying element to a social marketing-based campaign is identifying any similar attitudinal attributes among audiences so that the strategies and tools promote synergy and extend the campaign across the community to develop social norms. The four methods for accomplishing this (which are not mutually exclusive) include the following:

- Increase the benefits of the target behavior;
- Decrease the barriers to the target behavior;
- Decrease the benefits of the competing behavior(s); and
  - Increase the barriers of the competing behavior(s). (McKenzie-Mohr & Smith, 1999)

It takes social science in a new direction placing practitioners in a more effective position to facilitate change. It could be argued that the lack in addressing barriers to behavior change (in previous environmental education efforts) is one reason

environmental education has produced mixed results in terms of promoting pro-environmental behavior. If barriers to behavior change are not removed, people will gravitate back to a previous behavior. Barriers can be addressed by applying conceptual tools of behavior change. Successes in applied CBSM demonstrate (by comparison) why efforts that rely on information dissemination do not effectuate behavior as designed.

CBSM lends itself well to environmental education. For most teaching models, particularly within formal K-12 education, behavior is beyond the scope of environmental literacy benchmarks. Without direct empirical evidence of intended or observed behavior change, how can we know if efforts have made a difference? Practitioners cannot assume that awareness, knowledge, attitudes, and skills automatically result in responsible behavior. Usually, they are simply correlates to assess pro-environmental behavior.

#### Communication and Learning Domains

"I went down to the crossroads, tried to flag a ride. Nobody seemed to know me, everybody passed me by."- Robert Johnson

Communication creates society. We listen. We speak. We communicate electronically or through print media. It is verbal, non-verbal, temporal, spatial, and complex. We communicate to make our lives better, to be social, and to share our culture and news. Business communicates to sell products and services. Governments communicate laws, policies, and consequences. Communication is inherently a two-way medium that builds communities, our culture, society, economy and our world together.

Recalling Cranton's model of learning domains, psychologists work to change or fix an operationally defined behavior based on an emancipatory domain of communication. Comparatively, communicators generally operate from a communicative domain. Generally, most researchers, science writers, university and agency staff operate



based on an instrumental domain of learning in their communication. These groups desire to be honest brokers of information. They provide just the facts leaving advocacy to individuals or specific groups. Usually, they avoid putting a spin on environmental messages, staying above the fray of politics and personal bias.

They tend to use an “ask the expert” model to extend the results of science to the public. This is a common practice among subject-oriented learning (Cranton, 1994). However, a stronger alternative model more common today is environmental scientists and social scientists working together. Social scientists focus outreach efforts to ensure that the messages reach the intended audience and that those targeted are receptive to the message. Recent developments in human dimensions research show that agencies and organizations are integrating an understanding of human traits, awareness, understanding, beliefs and attitudes into management processes and decision-making (Booth, 1996; Decker, Brown, & Mattfeld, 1987; Decker, Brown, & Siemer, 2001). Resulting outreach is more effective because social scientists are included designing the strategy.

Ehrlich (2002) identifies such multidisciplinary approaches as essential to the future of natural resource protection and sustainability. Decision-making in natural resources management, based on ecological issues, has evolved into a movement called “ecosystem management” (Christensen et al., 1996). Ecosystem management is designed to sustain ecosystem health and productivity while protecting ecological integrity. Further research is needed, however, to engage stakeholders and integrate what has been learned into effective processes for natural resource management (Johnson, 1999). When such institutional arrangements are created, adaptive governance over natural resources can avoid natural resource catastrophes and be effective environmental stewards (Dietz,

Ostrom, & Stern, 2003). For natural resources management, social science, and communication and education professionals, keeping up with the literature is a daunting task with so many ecosystem management and human dimensions research to try follow.

This discussion places environmental education at a crossroads. Educators and teachers can gain insights from communication and human dimensions research to improve environmental education. Communicators can gain insights from study of cognition recognizing that knowledge is a relationship between an individual and reality. Both educators and communicators can benefit by integrating and applying theories of cognition, social influence, and behaviorism. The opportunity to empirically test those principles, insights, strategies and models can help shape programs and campaigns targeting pro-environmental behavior and establish community social norms.

#### Program Evaluation

“Once again we are experiencing a survey revolution, the consequences of which are not clearly known.”- Don A. Dillman (2000)

Unfortunately, in the AIS arena few focused programs or campaigns have been assessed. Without assessments, progress may lag. Merging elements of natural science (e.g., knowledge of biological life-history) with insights from contemporary principles of social science, communication, and evaluation can help. Evaluation lags behind because of a negative stigma. Often, efforts are based on false assumptions subscribed to ineffective models, failing to identify clear endpoints, or underestimating the difficulty of changing community behaviors.

Others do not build evaluation into outreach because they lack capacity or believe that it costs too much. The fact is that evaluation can be easy if assumptions are validated upfront and it does not have to be costly or time consuming. To reach its goals, AIS

outreach depends on designing and implementing programs and campaigns based on sound understanding of human values, motivations and behavior among target audiences by “appeal[ing] to an individual’s personal interest or motivation for information” (National Oceanic and Atmospheric Administration, 2009, p. 37).

Due to the lack of formal infrastructure, AIS outreach for adults rely on formal, non-formal and informal education settings (schools, work, community programs, businesses, associations, non-governmental organizations) as well as electronic and print mass media. Then, targeting values, motivations and behaviors of specific audiences provides an opportunity to impact the spread of AIS in a given area.

Like some conservation programs in Africa and South America, an objective of AIS outreach is to increase appreciation of a target species by increasing recognition of it by the public. In contrast, conservation efforts tend to protect the “flagship species.” AIS outreach seeks to eliminate or control that “poster child” species (a.k.a., zebra mussels). Both conservation and AIS programs have caught the attention of media at local and international levels.

Minnesota has served as a leader in development and promotion of voluntary guidelines for recreationists. In 1991, Minnesota began using a selection of guidelines targeting specific boater behaviors (inspect, drain, dispose, spray/wash, dry). As a member of the Great Lakes Panel on ANS, Minnesota Department of Natural Resources led an informal assessment of Great Lakes AIS outreach efforts that revealed inconsistencies over which behaviors should be targeted. For example, recommendations for drying ranged from 2 to 21 days. If inconsistent messages are being communicated to boaters and anglers are likely to be confused and will not know what to do.

Overcoming this barrier to behavior change, voluntary guidelines were developed in 1996 for use Great Lakes-wide. They targeted six recreational user groups, including boaters and anglers. Brochures and other print media are commonly produced to convey AIS messages... but are those media the most appropriate in reaching the target audience? Was delivery sufficient? Do recreationists understand the messages? What role does media such as brochures, AIS WATCH ID cards, and mass media play in motivating behavior change? Today, social responsibility and accountability are essential issue to business and the communities that depend upon them (Barrett, 2002). Likewise, government agencies, academia, and non-governmental organizations must evaluate their AIS outreach efforts to determine what worked in order to tailor more effective programs for the future.

Verifying behavior change is different from assessing other behavioral determinants such as awareness, knowledge, and attitudes. Unless evaluation is built into programming, methods being used to evaluate indicators may not provide the desired information concerning outcomes and impacts. By deciding what indicators to measure upfront, outreach can be effectively aligned with evaluation. Typically, verifying behavior change requires study of a target audience over time such as through pre- and post-campaign evaluation. Whereas, assessing change indicators such as awareness, knowledge, and attitudes can be conducted over time or a priori (e.g., triangulation methods). Finding out if behavior change was achieved is an important first step; however, determining if the behavior change is sustained requires long-term attention (Great Lakes Panel on ANS, 1999; 2004; Great Lakes Regional Collaboration, 2005; Gunderson, 1994a; National Invasive Species Council, 2005).

In the field of AIS programs, natural resources management and social science indicators may include:

- Preventing new AIS species from being introduced into a jurisdiction by recreational boaters and anglers.
- Containing existing AIS species within a jurisdiction by recreational boaters and anglers.
- Reducing the cumulative number of infested waterbodies likely spread by recreational boaters and anglers.
- Positively influencing awareness, knowledge, understanding, attitudes, values, and behaviors by recreational boaters and anglers within and in comparison to other jurisdictions.
- Assessing best strategies, methods, and messages to reach boaters and anglers within an area or jurisdiction.

Establishing behavior target endpoints such as these helps focus efforts and provides feedback to the target audiences that establish or reinforce resulting changes in values, motivations, self-efficacy, and personal/social norms.

Last, evaluation requires that practitioners check their values and assumptions about information. Information alone is not an indicator of behavior change; rather it is a medium that carries messages. As emphasized throughout this literature review, contemporary social science shows that producing information does not necessarily influence behavior. If behavior change is the goal, simply informing the public is not good enough. Adult learners process information through cognitive processes. If information is neutral, it may or may not become part of the learners' knowledge base.

Information must be conveyed through media and educational settings that tap values, motivations, and self-efficacy of the target audience and persuade them into performing the desired action.

Persuasion is much different than coercion. To clarify, coercion is about influencing someone to take action despite their will where the perceived costs may outweigh the benefits. Achieving highest magnitude behavior change requires that persuasive messages be simple, easy, low cost (e.g., monetarily, resources, time) and perhaps most importantly, effective. Minimizing barriers and self-sacrifice associated with the barriers can leverage sustained behavior change for themselves (personal responsibility) and the common good (social responsibility). Once a community is persuaded to take action, there is the need for repetitive communications to reinforce and sustain the new behavior. Assessment can be guided by such models (Abrams & Maibach, 2008; Ajzen & Fishbein 1980; Fishbein & Ajzen, 1975; Fishbein & Yzer, 2003; McKenzie-Mohr & Smith, 1999; Witte, 1992) to examine how individual's attitudes and subjective norms lead to behavior intent as related to AIS prevention.

#### Summary

Many studies suggest that environmental education falls short of producing environmentally responsible citizens. Americans generally are concerned about the environment, but many lose touch with their reasons to protect it. This may lead to a *laissez-faire* attitude or inaction. In contrast, a study by Gunderson (1994a,b) showed that AIS outreach efforts can raise awareness among recreational boaters and change behavior where it is a priority and uses the best methods. Reasons boaters took action mainly were

because they felt empowered with individual and social responsibility. Compared with other environmental issues, AIS is one that they feel that they can do something about.

Boater values, attitudes, and beliefs appear to have been tapped, which developed into personal actions and norms. They accepted responsibility over AIS, especially in Minnesota. Boaters recognized that they are part of the problem and part of the solution. Thus, lack of responsibility and action may be due to lack of awareness of the issue or consequence, different value-orientations and motivations, lack of skills, misinformation and adherence to fallacies, or negative attitudes and beliefs. A deeper understanding of these relationships over time is needed to help improve AIS and other environmental education-related efforts. Through this review, several areas of environmental education, adult learning, values, motivation, communication, social marketing, and behaviorism were investigated and discussed in the context of AIS management.

Exploring behavior theory as a way to understand adult learning could provide greater insights into more effective strategies, programs and campaigns. While introducing strategies or methods may result in a particular individual or group to take actions, it is unlikely that most will unless there is increased knowledge, understanding, and desire to do so. In other words, there must be a pre-disposition to act. Pre-disposition for future actions is based on perceived loci of individual control. That pre-disposition is based on the self-reflective nature of previous actions, which combined should be congruent with an individual's self-image, attitudes, and values. However, even armed with these elements, a lack of further support through programs or networks (incentives, policies, prompts, communications, access to technology, policies, and other factors) may prevent the target audience from engaging in environmentally responsible behavior.

Social marketing provides a contemporary framework for examining and overcoming barriers to fostering sustainable behaviors.

Benefits of assessment were discussed both from a natural resource management and societal perspective. More studies need to employ methods from contemporary human dimensions research to explore the relationships of AIS awareness associated with pro-environmental actions taken by recreational boaters to benefit our lakes, rivers, wetlands, and oceans. Many organizations locally, regionally, nationally and internationally could use this information to help guide effective AIS outreach and communication.

Last, coupling natural resources management with contemporary human dimensions research can improve AIS outreach (education and communication) by targeting attitudes, beliefs, and values. Merging a behavior choice model, like theory of planned behavior (TPB), with cognition, social influence, and social marketing offers a powerful combination. Again, TPB is an excellent model to identify how people think. Success of behavior intervention is based on timing, location, and relevancy of finely tuned outreach for that audience. Finally, AIS outreach needs to consistently reinforce when to take desired actions, what to look for, and where.



## CHAPTER THREE

### METHODOLOGY

The purpose of this quantitative evaluation was to assess and compare the efficacy of AIS boater outreach in California, Kansas, Minnesota, Ohio, and Vermont using a comprehensive mail survey. This chapter describes the background on approach, survey design and administration, survey pretest, survey procedures, narrative survey description, data gathering, quality control process and analysis, survey response rates, and concludes with a summary of the process used. The survey instrument is found as Appendix A, survey cover letters and reminder postcard text as Appendix B, and IRB Human Subjects Exempt Review Letter as Appendix C.

#### Background on Approach, Survey Design, and Administration

In 1994, the Minnesota Sea Grant Program conducted the Exotic Species and Freshwater Boating Survey of licensed boat owners in Minnesota, Ohio, and Wisconsin (Gunderson 1994a,b). In 1999, Minnesota Sea Grant received a grant from the National Sea Grant College Program to conduct a Multi-State Survey to Evaluate the Effectiveness of ANS Boater Education Programming. Later that year, a team of experts began designing, primarily through monthly conference calls, a new model survey instrument based partly on questions from the 1994 survey. Similar questions were developed so that comparisons could be made between states previously surveyed. Survey design committee members (Table 1) included AIS outreach, communication, and management experts from each state, plus a researcher and a survey design professional. The committee devoted considerable time and effort to survey development, design, and

review, and were instrumental in the success of the project. They provided critical input into the project to ensure that it aligned with stated goals.

Lists of randomly selected registered boat owners, acquired in Excel format from each state, were provided to the Minnesota Center for Survey Research (MCSR). MCSR was contracted to assist with development and administration of the survey, and provide an initial data report. To identify the state of origin, each version of the survey was color-coded and given a unique series of identification numbers by the MCSR (Table 2), who administered both the survey pre-test and the full survey.

To improve survey response rates, organizations in each state were asked to provide letterhead and mailing envelopes. For surveys sent to California, Minnesota, and Ohio, the state's Sea Grant College Program served this role. For Vermont, the Center for Rural Studies at the University of Vermont served that role. No organization was identified in Kansas, so those surveys were mailed using MCSR mailing supplies including a letter from the MCSR director. Participating organizations collected surveys returned to them as non-deliverable mail and forwarded them to MCSR.

#### Pretest and Survey Procedures

A survey pretest and cover letter were sent to a random sample of 100 registered boaters from Kansas, Minnesota and Ohio in September 2000. The survey instrument was extensively revised following the pretest, particularly concerning questions about transporting and mooring. Final survey revisions were resolved and approved by the survey team for the MRSC.

An eight-page survey was finalized and administered from October 30, 2000 to March 26, 2001 using the Dillman method (1978; 2000). Surveys were mailed to 800

randomly selected boat owners from each state (4,000 total) with a cover letter from an organization in that state inviting participation in the survey which included a self-addressed, stamped return envelope. Dates for each mailing are listed in Table 3. California mailings occurred later than the other four states because of difficulty in acquiring the sample of registered boat owners from their state license agency.

One week after the initial mailing, a reminder post card was sent. Two weeks after the post card mailing, a copy of the survey, a reminder cover letter, and self-addressed stamped return envelope were mailed. A final post card was sent to all non-respondents two or three-weeks after the third mailing. Due to an unusually low response rate from Ohio, a fifth mailing was sent in March 2001 to all Ohio non-respondents, which helped improve the response rate.

#### Survey Description

Surveys included questions about respondent's awareness of state-specific AIS, the importance of taking precautions to prevent the spread of those species, known sources of AIS information, and boat use during the 2000 boating season. Specifically, it included questions including the length of time boat(s) were in the water before being moved to a different waterbody, length of time boat(s) were out of the water before being put in a different waterbody than it was previously used in, and distance between different bodies of water where the boat(s) were used. These and other questions focused on assessing the overall risk for spread of AIS by recreational boaters.

Additional questions asked about transport of boat(s) outside the state where the boat was licensed, moving boat(s) along connected waterways or along the coast from waters that were known to be infested into uninfested waters, steps taken to prevent the

transport of water or AIS from one waterbody to another, or reasons the boater did not take such precautions. Responses gauged the likelihood of boaters taking precautions in the future, whether AIS have caused problems for the boater or affected his/her recreational experience during the 2000 boating season, and respondent's willingness to spend additional money for boat or fishing licenses. Final survey questions sought background information on boat owners' radio station listening preferences, demographics (including gender, state of residence, zip code, and year of birth), and recommendations or other comments about the spread of AIS.

Each state's survey was identical except that the AIS listed in the first two questions were specific to that state. Survey design team representatives from each state selected the top six to eight AIS of concern in their state, being addressed through outreach, at risk for spread by boaters, and a desire to have that species evaluated (see Table 5).

Some AIS identified in each state are of national or regional concern, while others are of concern only within a couple of states. Zebra mussels and Eurasian watermilfoil were listed in all surveys- an indication of national concern- while quagga mussels were listed in all but Minnesota's, and purple loosestrife was listed in all but Ohio's. Spiny waterfleas and round gobies were listed for Minnesota and Ohio, white perch was included in Kansas and Ohio, and hydrilla was listed for California and Vermont. Other AIS of concern were Asian carp (Kansas), Chinese mitten crab (California), common carp (Kansas), *Egeria densa* (Brazilian waterweed, California), Eurasian ruffe (Minnesota), giant salvinia (California), goldfish (Ohio), northern pike (California), sea lamprey (Vermont), and water chestnut (Vermont). In terms of species unique to each state's list,

Minnesota had the least diversity and California had the greatest diversity of species, with four species not listed by any other state.

#### *Data Gathering, Quality Control Process, and Analysis*

All surveys were mailed by the MCRS, and returned surveys were counted to track sample status and response rates. Completed surveys were reviewed for response clarity to eliminate dual responses from single-answer questions and to record written responses to “other-specify.” Data quality control, along with questions concerning unclear or ambiguous responses, was handled by the project manager at the MSRC. Following editing and coding, each survey was keyed onto a data tape by a commercial data entry firm. Data cleaning systematically removed data entry errors. All files were examined to identify cases with paradoxical or inappropriate responses. Analyses conducted by the MCRS calculated the response frequencies and percentages for each question in the survey for each state. Percentage frequencies of actual responses were adjusted after eliminating non-responses of those who refused to answer, did not know, or were not required to answer a particular question. Question numbers were used as variable labels in the computer data files, which was submitted to Minnesota Sea Grant following completion of the contract with the MSCR. Further data analysis was conducted using SPSS and Excel.

#### *Survey Response Rates*

Survey response rates ranged from 38% for California to 66% for Minnesota for an overall average response rate of 53% (Table 4). Completed surveys were returned by 1,952 boat owners: 272 from California, 358 from Kansas, 496 from Minnesota, 389 from Ohio, and 437 from Vermont. An additional 56 boat owners refused to participate,

1,657 surveys were not returned, and the remaining 335 were eliminated from the sample due to reasons listed in Table 4.

#### Summary

A quantitative survey was used to measure elements of awareness, risk, understanding, attitudes, and behaviors among recreational boaters in five fresh water and marine states. These states were chosen because they have a range of AIS boater outreach efforts and a variety of AIS concerns. The survey was developed by a team of AIS and survey experts from each of the five states. Eight-page mail surveys were administered in California, Kansas, Minnesota, Ohio, and Vermont by the MRCS using a random draw of registered boaters obtained from each state. Each state's survey was identical except that the AIS listed in the first two questions were specific to that state. AIS selected were a reasonable representation of AIS being dealt with by federal and state natural resource management agencies at that time. Response rate was highest for Minnesota and lowest for Ohio, averaging 53%. Given the level of response, results are extrapolatable to the population of boaters in each state surveyed.

Results will be used to compare results with previous similar surveys delivered in Minnesota and Ohio and to provide a baseline for California, Kansas, and Vermont. Outcomes of the survey will be used by Sea Grant programs, state, federal and tribal fish and wildlife agencies, and non-governmental and other organizations to improve AIS public education and communication in the five states surveyed. Results may also be used in other states to develop or tailor AIS outreach. The survey will also be used as a model that can be adapted or adopted for use by any state, province, or regional entity to establish a baseline measure concerning the effectiveness of AIS outreach in their areas.

## CHAPTER FOUR

### RESULTS AND DISCUSSION

#### Part I: Results of 2000 Survey

Part I examines the results of the Aquatic Nuisance Species and Boating Survey conducted in 2000 in five states- California (CA), Kansas (KS), Minnesota (MN), Ohio (OH), and Vermont (VT). To provide analysis of this data, responses for each section of the survey will be presented, beginning with respondent demographics, awareness and attitudes, sources of information, behavior, and relative risks and impacts. Although “aquatic nuisance species” was used in the survey title and several questions, aquatic invasive species (or AIS) is used herein. Part II compares results of the 2000 survey to results of the 1994 survey. Part III provides discussion.

#### Demographics of Respondents

Registered watercraft varied by state in 2000 with California at 955,700, Minnesota at 793,107, Ohio at 407,347, Kansas at 102,424, and Vermont at 37,932 (National Marine Manufacturers Association, 2000). Surveys were returned by a total of 1,952 registered boaters ranging from 272 in California to 496 in Minnesota. Broken down by state, boater respondents averaged 50 years old or older (Table 6) with an average of 70% age 45 or older. An overwhelming percentage of respondents were male (average 88%) and lived in the state in which the survey was conducted. Boaters were asked if they used a boat or boats during the 2000 boating season. An average of 87% boater respondents used a boat during the 2000 boating season (Figure 1). Highest percent of boat use was in Minnesota (91%) and Vermont (90%), with Kansas having the

lowest boat use (80%). Respondents answering “no” to this question were asked to skip to questions toward the end of the survey.

Boaters who answered “yes” were asked what types of watercraft they used during the 2000 season. Small powerboats (< 20 feet long) use greatly outnumbered all watercraft in all states, while other types of boats used varied by state (Figure 1.1). Large powerboat (>20 feet long) use was next highest, followed by canoe/kayak, personal watercraft (jet ski), small sailboat (<20 feet long), duck boat, large sailboat (>20 feet long), pontoon, and small unpowered boat. More powerboats were used in Ohio and California than the other states. Use of canoes and kayak varied by state with Vermont and Minnesota being highest. Personal watercraft use was highest (over 20%) in California and Kansas and less than 10% in the other states surveyed.

All types of watercraft used in each state were of interest, because each represents a different risk in terms of spreading AIS. For example, recreational boat users, such as large powerboats and sailboats are not as likely to be moved as frequently from one body of water to another. However, the longer the time a watercraft stays on a waterbody, the greater the potential for the hull and rigging (e.g., trim tabs) to be colonized by, say, zebra or quagga mussels. Therefore, it poses a higher risk if moved to another waterbody. On the other hand, small watercraft may not be left on the water for periods of time as long as larger craft, but are likely to be more transient, based on their size. Small watercraft represent a lower risk individually for the potential spread of AIS, but as a pathway for spread they can be considerable given the number of watercraft within a given type (e.g. small powerboats).



Assuming that larger watercraft (e.g., large powerboats, large sailboats) tend not to be transported as often, it was expected that boat type (e.g., large powerboats) combined with boater knowledge, attitudes and behavior may offer differences in the overall risk posed for overland transport of AIS. Assessment of this risk was compromised, however, due to many more respondents than expected owning more than one watercraft. Therefore, assessment of relative risk by each boat type was inconclusive due to low sample size. To provide some insight into this issue, respondents who identified using only a single type of boat were used for data interpretation. Any discernible trends were still hampered by low sample size.

#### Boater Awareness and Attitudes toward AIS

Acknowledging an issue is the first step toward raising awareness. Boater awareness of six to eight AIS varied greatly by state. Zebra (*Dreissena polymorpha*) and quagga (*Dreissena bugensis*) mussels were the most recognized of the 18 species offered in all five states surveyed. Zebra and quagga mussel awareness was highest in states where these invaders were promoted extensively through outreach and mass communication. In Minnesota, Ohio, and Vermont, 9 of 10 boaters indicated they had heard about invasive mussels with over 70% having heard a “large” to “moderate amount” of information (Figure 2). This high level of awareness was expected because zebra mussels serve as the AIS “poster child” in the Great Lakes. Since 1988, their rapid spread and impacts resulted in widespread outreach and media attention. Conversely, 9 out of 10 Kansas and California boaters had not heard a “large amount” about these invasive mussels. Only 29% of Kansas and 19% of California boaters had heard a “large” to “moderate amount” of information. Kansas made some progress compared to 1995

when 25% of anglers knew about zebra mussels (T. Mosher, personal communication, July 15, 2003). Comparing Minnesota to Kansas and California, Minnesota boater awareness was 3-4 times higher. Some outreach combined with mass media coverage from national and regional news likely led to this level of awareness to these states.

Similar to zebra mussels, Eurasian watermilfoil (*Myriophyllum spicatum*) was well known in Minnesota and Vermont with more than 75% of respondents having heard a “large” to “moderate amount” of information, while it was virtually unheard of in the other three states (Figure 3). Minnesota and Vermont had promoted awareness of Eurasian watermilfoil to boaters for over a decade. A qualitative inventory of outreach materials from the other three states revealed little attention to this highly invasive plant. Purple loosestrife, not well known in any state, was recognized most in Minnesota, 34% had heard a “large” to “moderate amount” of information about it (Figure 4). Nine of 10 boaters in Kansas or California had not heard of purple loosestrife. The Ohio survey did not include purple loosestrife. Lower levels of awareness concerning purple loosestrife were not surprising since purple loosestrife is generally not spread by boaters; therefore, boaters were not directly targeted with outreach.

Minnesota and Ohio surveys, which included spiny waterfleas (*Bythotrephes cederstroemi*=*longimamus*) showed boater awareness was low with about 75% reporting that they had not received any information (Figure 5). This result was expected since, at that time, outreach about spiny waterfleas had not been a priority in either state. Spiny waterflea outreach was emphasized but limited to the Lake Superior and Erie coastline areas. It is reasonable to expect that public awareness would be higher in these areas; however, statewide lack of awareness diluted any higher awareness locales in either state.

In California, boater awareness concerning hydrilla (*Hydrilla verticalis*), Chinese mitten crab (*Eriocheir sinensis*), northern pike (*Esox lucius*), giant salvinia (*Salvinia molesta*) and Brazilian waterweed (*Egeria densa*) was low to very low at 21%, 22%, 38%, 1%, and 1%, respectively. In Kansas, boater awareness concerning common carp (*Cyprinus carpio*), Asian carp (includes three species: *Aristichthys nobilis*, *Hypophthalmichthys molitrix*, *Mylopharyngodon piceus*), and white perch (*Morone Americana*) was moderate at 47%, 54%, and 46%, respectively. In Minnesota, awareness concerning round goby (*Apollonia melanostomus*) and Eurasian ruffe (*Gymnocephalus cernuus*) was low at 8% and 11%, respectively. (Like spiny waterfleas, awareness concerning these invasive fish is probably higher in the Duluth-Superior area where both species have been widely promoted in outreach and mass media.) In Ohio, awareness concerning white perch, round goby, and goldfish (*Carassius auratus*) was moderately low to low at 21%, 32%, and 13%, respectively. In Vermont, awareness concerning water chestnut (*Trapa natans*), alewife (*Alosa pseudoharengus*), sea lamprey (*Petromyzon marinus*), and hydrilla (*Hydrilla verticillata*) was moderately low to low at 29%, 18%, 65%, and 9% respectively.

In summary, public awareness was considerably higher for AIS that had been made a priority and promoted in boater outreach for longer time periods. Length of time was dependent upon when the first infestation occurred and when outreach began targeting boaters in each state. Although other AIS may have been present longer (e.g., Eurasian watermilfoil, purple loosestrife), the public was most aware of zebra and quagga mussels. Zebra mussel and quagga mussel awareness was highest in Minnesota, Ohio, Vermont, followed by Kansas and California. In the two decades before the survey, these

mussels received much attention in the Great Lakes and Lake Champlain regions, as they clogged pipes used for drinking water, impacted food webs, and fouled beaches with their sharp shells.

Eurasian watermilfoil awareness was highest in Minnesota and Vermont, two states that aggressively promoted awareness through outreach about this invasive plant for over a decade. Since the late 1980s in these states, Eurasian watermilfoil has been widely recognized as interfering with swimming, and entangling propellers, which restricts boating, fishing, and waterfowl hunting. Since its first discovery in Lake Minnetonka in 1987, Eurasian watermilfoil has been a high priority issue in Minnesota. Lower public awareness on Eurasian watermilfoil was expected in other states, since outreach had not been highly promoted. Hydrilla awareness was low to very low in Vermont and California. Purple loosestrife awareness was low among boaters in all states. Outreach included purple loosestrife in Minnesota and Vermont prior to 2000, but it was not necessarily targeted at boaters, explaining the lower levels of awareness in those two states. Public awareness on the other AIS was relatively low, which suggests that more outreach needs to take place targeting recreational boaters in those states.

If AIS outreach is a low priority, it is likely that boaters will not take appropriate actions to prevent the spread of harmful aquatic invasive plants and animals. Low awareness among respondents from each state regarding specific AIS is likely an indication that little attention was paid to that species until it began to impact society, the environment, or the economy in that state. States that have Eurasian watermilfoil, hydrilla, or other aquatic invasive plants would benefit from making boater outreach a

priority, since these plants can be carriers of “hitchhiking” invasive fish, larvae, eggs, aquatic invertebrates, along with pathogens and parasites as well.

### *Importance of Preventing Spread of AIS to Boaters*

Respondents from different states shared similar views on the importance of boaters and anglers taking precautions to prevent the spread of AIS in each state. Very few indicated that taking precautions to prevent the spread was “not very” or “not at all important”- consistent across all states and AIS. For states in which fewer boaters indicated “very” or “somewhat important,” “don’t know” was also a frequent response. In other words, if boaters did not feel that it was important to take actions, they most frequently knew nothing about AIS.

Between 87-95% of Vermont, Minnesota, and Ohio boaters surveyed felt it was “very” to “somewhat important” to take precautions to prevent the spread of zebra and quagga mussels (Figure 6). While ranking lower, California and Kansas boaters, 57% and 65%, respectively, felt it was either “very” to “somewhat important” to prevent the spread; 40% and 33% reported that they “didn’t know” if it was important. Compared to zebra and quagga mussels, the perceived importance of preventing the spread of Eurasian watermilfoil was lower in all states except Minnesota and Vermont, where 95 and 89%, respectively, felt it was “very” to “somewhat important.” A vast majority in both Minnesota and Vermont felt it was “very important” to prevent spread of Eurasian watermilfoil (Figure 7). Between 38-47% of California, Kansas, and Ohio boaters felt it was “very” to “somewhat important” to prevent the spread of milfoil. Compared to levels of zebra mussel awareness in these states (Figure 6), interestingly, boater concern about the importance of taking action to prevent spread of milfoil was slightly higher.

Purple loosestrife had even fewer boaters yet indicating “very” or “somewhat important,” but more respondents reported that they “didn’t know” how important preventing the spread was (Figure 8). Minnesota boaters gave it the highest level with 72% of respondents reporting that taking action was “very” or “somewhat important.” (The Ohio survey did not include purple loosestrife). Likely related, loosestrife awareness (Figure 4) and boater concern about the importance of taking action was slightly higher among Minnesota boaters than those in other states.

The importance of preventing the spread of the other AIS varied among states. Spiny waterfleas were listed on Minnesota and Ohio surveys, but almost half of the boaters in both states “didn’t know” if it was important to take steps to prevent their spread (Figure 9). Similar to zebra mussels, milfoil and loosestrife, respondents thought prevention was important (Figure 9) even if they were not necessarily aware that spiny waterfleas was a problem (Figure 5). For hydrilla, Chinese mitten crab, and northern pike, 58%, 60%, and 63% of California boaters, respectively, felt it was “very” to “somewhat important” to prevent their spread. For giant salvinia and Brazilian waterweed, the importance of preventing spread was 45% and 46%, respectively. For common carp, Asian carp, and white perch, 47%, 41%, and 34% of Kansas boaters, respectively, felt it was “very” to “somewhat important” to prevent their spread. In Minnesota, a majority felt it was “important” to “somewhat important” to prevent the spread of round goby (56%) and Eurasian ruffe (57%). In Ohio, 50%, 56%, and 39% felt it was “important” to “somewhat important” to prevent the spread of white perch, round goby, and goldfish, respectively. In Vermont, 65% of boaters felt it was “very” to “somewhat important” to

prevent the spread of water chestnut, 56% prevent alewife, 80% prevent sea lamprey, and prevent hydrilla.

Respondent's attitudes about the importance of preventing the spread of specific AIS was high where awareness was also high. Where awareness was low, importance placed on preventing the spread of AIS was somewhat higher. This indicates that when boaters are made aware of AIS, they are much more likely to be motivated to take actions to prevent their spread.

#### *Sources of Information on AIS*

Since the late 1980s, many sources of AIS education and communication have been used to reach boaters across the five states surveyed. However, it was unknown how effective these sources have been in getting information to boaters, influencing their awareness, or willingness to take preventative action. To determine the extent of exposure to media efforts, boaters were asked to identify what sources of information on AIS (media) they recognized. Knowing where boaters receive information can help natural resources management agencies, Sea Grant, and other organizations more effectively allocate resources to choose those media. Respondents were asked to identify sources from a list of 22 potential sources or indicate they did not know. The most common write-in source for information was "word of mouth," which indicates that AIS have entered the lexicon of boaters as a communication medium upon which personal and group attitudes, beliefs, values and norms are socially influenced.

Recognition of these sources of information by boaters varied widely between states, but generally more Minnesota and Vermont boaters had heard of AIS from more sources of information (Figure 10). Ohio boaters recognized sources of information to a

relatively less extent across all sources. This was a bit surprising, since Ohio's coastline of Lake Erie was the first to be impacted by zebra mussels, resulting in extensive media coverage and the first outreach efforts in the U.S. Expectedly, California and Kansas boaters were less likely to have heard of AIS from all sources probably since comprehensive statewide AIS outreach efforts did not exist prior to the survey.

Overall, boaters reported recognizing sources of information at levels consistent with use in each state at the time (Table 7). Top five sources of information on AIS identified by boaters were: newspaper articles, magazine and newsletter articles, television news or programs, regulation pamphlets, and information at boat launches (e.g., signs). Among all states, differences in these top five sources can be explained by emphasized use. In Minnesota and Vermont, newspaper coverage, signs at water accesses, and information in registration pamphlets were emphasized more.

Signs also ranked highly as a source of AIS information. Signs were used to some extent in all states. At the time of the survey, Minnesota had over 6,000 signs posted across the state (J. Rendall, personal communication, 2000) and Vermont began emphasizing use of signs in about 1996 (M. Hauser, personal communication, 2000). In Ohio, magazine coverage was emphasized and registration booklets had contained AIS information just for a couple of seasons prior to the survey. Signs had not been emphasized and were only placed on the Ohio River (R. Sanders, personal communication, 2002), where zebra mussels had spread. Sign use in the mid-1990s in California and Kansas was limited.

Given the popularity of the Internet, this source was of particular interest to management agencies, academic institutions and others involved with AIS outreach.



Websites, however, were minor sources of AIS information for boaters in all states.

Similarly, billboards did not rank in top sources of information about AIS. Billboard use began in a few states and provinces in the mid-1990s, attempting to reach resident and non-resident boaters and anglers along key highways that had the greatest potential for intra- and interstate spread of AIS. Billboards ranked 16<sup>th</sup> out of 22 sources across all states surveyed. However, results from two states stood out. Between 25% to 35% of Minnesota and Vermont boaters statewide recognized billboards as a source for AIS information even though few billboards had been used. By comparison, very few if any billboards had been used in California, Kansas and Ohio (see more discussion about billboards below).

So, of these sources of information extended to boaters, which were the most effective according to them?

#### Best Sources of Information on AIS

Boaters were asked to identify the four sources of information that were their best sources of information on AIS (Figure 11). Boaters tended to answer based on what they had been exposed to in each state. Top sources (in descending order) were: newspaper articles, TV news and programs, regulation pamphlets, magazines and newsletters, signs at marinas or boat launches, and boat registration materials. Sources of information identified by boaters least frequently as “best sources” were: books, conferences or meetings, educational videos, and hotlines or clearinghouses (data not shown).

Minnesota and Vermont “best sources” were similar: newspaper articles, signs at boat launches, regulation pamphlets, TV news or programs, magazines or newsletters, and boat registration materials. Other sources identified by Minnesota and Vermont

boaters were radio programs and public service announcements on television, as well as brochures and fact sheets. Top sources for California boaters were TV news or programs, and newspaper articles. Many visual-type communication media (e.g., signs television, newspapers, etc.) played important roles cognitively by extending information about AIS to boaters.

#### Sources of Information about AIS Infestations

Sources of information concerning the location of AIS infestations were similar (Figure 12). Most states had a dominant source. Minnesota and Vermont respondents who boated on infested waters most frequently knew the water was infested through signs at boat launches and media sources. Friends or relatives were also a frequent source of knowledge on infestations for boaters, particularly in Ohio, and regulation pamphlets and brochures or fact sheets were also important. In California, media and signs were again main sources of information of information on infested waters for boaters. In Minnesota and Vermont, signs at boat launches were the single most important source of information on infestations for boaters, and in Ohio, media and friends/relatives were similarly important.

For over a decade, Minnesota used up to three signs at water accesses, one of which identifies the waterbody as infested. Kansas boaters differed in that no single source was commonly identified as a main source. Watercraft education/inspectors ranked low in every state except Minnesota. At the time, Minnesota was the only state among those surveyed which had a watercraft inspection program. Beginning in 1992, watercraft inspectors stationed at select water accesses provided important information to

boaters concerning locations of infested waters. Some education occurred at water accesses in Ohio and Vermont, but no statewide inspection program existed.

As discussed previously, assessment of relative risk by each boat type was difficult to interpret based on low sample size. However, comparing boat type and sources of information about infestations revealed a couple of trends (data not shown). Large powerboat owners in Ohio and Vermont indicated that they knowingly use their watercraft on AIS infested waters more often than large powerboat owners in the other states. This is likely due to more opportunities for large powerboaters to access Lake Erie and Lake Champlain, respectively. Small powerboat owners in Minnesota, Ohio, and Vermont stated that they knowingly boat on AIS infested waters more often than small powerboat owners in the other states.

Small boat owners arguably have the greatest potential to spread AIS based on their behavior. A majority indicated that they moved their boats frequently up to 50 miles during the previous season. Large powerboat owners in California, Kansas, and Ohio posed threats by moving their boats- a majority having moved their large powerboats up to 150 miles during the previous season in Kansas and Ohio, and up to 500 miles in California.

In summary, sources of information from which boaters knew what waters were infested with AIS varied by state and sources emphasized. Generally, key sources were: signs at water accesses, media, friend or relative, regulation pamphlets, brochure, fact sheet, flyer, and watercraft inspectors. Websites and hotlines were rarely identified as sources of information about AIS infested waters for boaters in any state.

### *Boating and Relative Risks for Spreading AIS*

Magnitude of boaters as an overland pathway was compared by state. Estimated number of times boats were moved was based on the number of registered boats (National Marine Manufacturers Association, 2000). Estimated mean number of moves per boater was calculated by dividing the estimated total number of moves between waterbodies by the number of registered boats in each state (Table 8). Minnesota and California boaters led states surveyed with an estimated 4.4 to 5.3 million overland moves annually, and Vermont boaters had the fewest moves at just over 127,000. The highest average moves per boater occurred in California (5.6), followed by Minnesota (5.5), and Kansas (5.4). Ohio (3.8), and Vermont (3.4) boaters did not report as much overland movement. These data represent the worst case scenarios for potential propagule pressure by overland boat movement, *if no preventive actions were taken by those boaters.*

Boats moved along connected waterways or along a coast *from* infested *into* uninfested waters are of concern because they likely spread AIS (e.g., zebra mussels attached to hulls). Only a small percentage of boaters (0%-6%) in all states knew if they had moved from infested waters to uninfested waters (Table 9). Compared by state, Ohio boaters (6%) knew most, and Kansas boaters (0%) knew virtually nothing, if they had moved infested to uninfested waters. For waters where boaters knew of AIS infestations, the most common AIS identified was zebra mussels (18 responses) followed by Eurasian watermilfoil (17 responses), Chinese mitten crab (4 responses), hydrilla, round goby, white perch, and other (all at 2 responses). Caution must be used when interpreting these results due to the low sample size. However, results suggest that the magnitude for AIS

spreading along contiguous waterbodies is great. As an example, this pathway is the reason zebra mussels invaded uppermost navigable regions of the Mississippi River and its tributaries. Other AIS hitchhiking rides on watercraft could very likely spread in a similar manner.

#### *Most Boaters Pose No Risk for Spreading AIS*

Boaters who do not take precautions and move their watercraft frequently between waterbodies pose the greatest risk for overland transport of AIS. Those who do not move their boat, pose no risk at all. The good news is that large proportions (42%-63%) of boaters in each state surveyed did not move their boats to different waterbodies during the 2000 boating season, especially in Ohio and Vermont (Figure 13). These boaters probably kept their watercraft at a marina, cabin or other location for the season. It should be noted that several other survey questions asked boaters about whether or not they moved their boat to a different waterbody. Since the response rate to this question was highest, it is likely the best reflection of behavior based on boaters surveyed.

#### *Other Boaters Do Pose Risks for Overland Transport of AIS*

Boat movement between waterbodies is one of the key pathways for the overland spread of AIS, if boaters are not taking appropriate precautions. Several factors determine the risk of spread, including: length of time the boat is *in* the water, length of time it is left *out* of the water, as well as the frequency and distance of moves. As mentioned above, most boaters pose no risk for spreading AIS, because they do not move their boat. They moor their boat or use their watercraft on only one waterbody during the season. Of the boaters who do move their boats, the vast majority in each state (roughly 70-80%) left their boats *in* the water for less than a day; 19-29% of boats were left *in* the water for

longer periods of time (Figure 14). This segment of the boating population represents definite risk for spreading AIS if they do not take actions to prevent spread of AIS. Little variation occurred among states surveyed, although California boaters (29%) tended to leave boats *in* the water for more than two days.

Risk for AIS movement based on the time boats were left *in* the water and the number of actual moves by category revealed the potential for propagule movement (Figure 14.1). Boats left *in* the water for more than a day pose greater risk, especially if moored on waters infested with zebra or quagga mussels because boat hulls and motors are more likely to be colonized by these barnacle-like animals. Guidelines for boater promote inspect, drain, and dispose of unwanted bait in the trash. Following those actions, boaters can either wash/rinse or dry their boat and equipment for five days or more. If boaters fail to conduct the inspection process and choose drying alone, they pose greatest risk for spread if launched in uninfested waters. Among boaters who left their watercraft *in* the water for five or more days (5-14 d + <15 d), Minnesota had the largest number (201) who moved their boats after five days; followed by California (190), Vermont (180), Ohio (151), and Kansas (108). From this perspective, Kansas boaters were about half as risky as Minnesota and California boaters in terms of potential for introductions of AIS. These results emphasize that there is a small but very high risk of propagule pressure on uninfested waters, if boaters leave their watercraft *in* the water for greater than five days *and* do not take precautions to prevent the spread of AIS.

As a corollary question to “*in the water*”, respondents were asked how much time their boats were left “*out of the water*” Voluntary Guidelines for Recreational Boaters, developed by the Great Lakes Panel on ANS and approved through the Federal Register

as national guidelines state that boats and equipment should be left *out* of the water for at least five days, following the inspect and remove, drain, dispose, and wash/rinse actions.

More boaters left their watercraft *out* of the water for 5-14 days (36-57%) before moving it to a different waterbody (Figure 15). Results suggest that boaters are either receptive to AIS prevention messages, or they already tend to leave their boats *out* of the water for this time anyway, independent of exposure to AIS messages. Either way, while many boaters are taking recommended time to dry their watercraft between moves, a sizable portion moved their boats to other waters in fewer than 5 days, especially in Minnesota. This behavior alone would not provide sufficient drying time to kill larger “hitchhikers,” if drying is the only precautionary action taken. This is a reason why “inspect and remove” is the first guideline promoted to boaters in AIS outreach nationally.

From 30% (Kansas) to 52% (Minnesota) of boats were moved after they had been *out* of the water for less than 5 days. Minnesota boaters were most likely to move their boats within a shorter period of time, likely because geographic distances between thousands of lakes and miles of rivers are shorter in Minnesota. They were also the least likely to leave their boats *out* of the water for 5 days or more, which could pose greater risk for spread of AIS, particularly zebra mussels, than in other states. Conversely, Kansas boaters were most likely (70%) to leave their boats *out* of the water for 5 or more days. Risk of AIS spread based on actual number of boat moves, based on the time periods watercraft were left *out* of the water, reveals the potential for propagule pressure (Figure 15.1). These results reveal the actual potential for propagule movement overland based on the length of time a watercraft was left *out* of the water.

In Minnesota, about 10% of respondents reported using their boat on different waters within the *same day*, and within *2-4 days*, moving it an average of 6 times and 8 times, respectively, during 2000 (Figure 15.2). In all other states, fewer than 6% of respondents reported the same average use in the same time periods. Twenty-six percent of Kansas boaters reported using their boat an average of 7 times on different waters within *5-14 days* during 2000. Boat movement within *5-14 days* in all other states was between 16% and 19%. For all states, between 5-12% of boater respondents reported using their boat an average of 4 times on different waters within *15-30 days* during 2000. Least risky boaters were those who reported using their boat an average of two times within *30 days or more*, which ranged from 2% of Vermont boaters to 17% of California boaters during 2000.

Overall risk of boaters spreading AIS based on the period of time a boat was *out* of the water can be examined further. First, boaters who *never move* their boats are at no risk. Second, leaving boats out of the water for *more than 5 days* following an inspection and removal actions reduces or may eliminate risk for overland transport of live AIS. Total percentages of boaters in each state who reported using their boat within *one day* and *2-4 days* reveals only a small segment of the boating population actually at risk for spreading AIS. For all states (except Minnesota), highest risk is by 9-10% of boaters who use their boat within *one day* and *2-4 days*, which occurred an average of 6-8 times during 2000. In Minnesota, a greater proportion of boaters have a high potential for transporting AIS because about 20% reported using their watercraft within 4 days about 6-8 times during 2000. Importantly, these results reveal that a relatively small segment of



the boater population in each state pose risks for moving AIS, *if they are not taking action to prevent the spread.*

Table 10 shows the estimated number of times boats were moved between waterbodies at three time intervals of *out* of water (drying time). Within four days, Minnesota moved the most with over 2.2 million boat moves, followed by California with over 1.3 million, and last, by Vermont with 0.06 million. While many boaters move their watercraft often, an even greater number kept their boats *out* of water for more than 5 days. Although the survey did not identify on what days of the week boaters move their boats, it is reasonable to assume that most of them did so only on weekends. Therefore, promoting 5 days as a guideline for action is a reasonable request, given that a large proportion is already doing it.

The estimated total number of moves between waterbodies (from Table 8) divided by the >5 days category (from Table 10) reveals that 36% of Ohio boaters, 50% of Minnesota boaters, 25% of Kansas boaters, 45% of Vermont boaters and 25% of California boaters already adhere to recommended 5-d drying. These results are encouraging because “dry for 5 days” appears to be becoming a personal or social norm for AIS prevention in the states surveyed (and hopefully beyond).

#### *Risky Boaters Based on Distances Moved*

Distance moved is important to consider when attempting to manage the spread of AIS. Understanding movement helps predict where AIS might spread next when they are first introduced or established in a region. Across all states surveyed, 71% of the time boaters moved 50 miles or less ranging from 60% in California, 64% in Ohio, 67% in Kansas, 75% in Minnesota to 83% in Vermont (Figure 16). Minnesota and Vermont

boaters tended to move over the shortest distances. Fewer boaters moved more than 151 (14% in California being the highest). The total number of moves for each distance category provides a sense of the potential propagule pressure based on reported movement (Figure 16.1). At ten miles or less, nearly double the numbers of boats were moved in Minnesota compared to Vermont, followed by California, Ohio, and Kansas, respectively. A similar pattern is revealed for the 11-50 mile range where Minnesota led Vermont by two times the number of boat moves. In Kansas, however, mid-distance moves were even more common than they were in Vermont.

As a case in point, management of AIS spread in Kansas might use the results that show a majority of boat movement is 11-50 miles. To effectively manage the risk of spread by boaters, dedicating resources to AIS outreach, monitoring or early detection, or enforcement in close proximity to AIS infestations would make sense. Even though there were relatively few long-distance moves, 31 states and 3 provinces were visited by boaters whose trips originated in surveyed states (Figure 17). During the 2000 boating season, more boats were taken out-of-state from Ohio (30), followed by Kansas (25), Minnesota (23), Vermont (17), and California (14).

Behavior patterns derived from this study was expected as most destinations by boaters are within a reasonable driving distance to waters within each state and to states with a reputation of quality boating and angling. As supported by others, two phenomena emerge: short and long distance moves for potential overland spread of AIS. Dr. Ladd Johnson, University of Laval, Quebec, during several Sea Grant-sponsored workshops in the late 1990s (discussed previously), described the two as “fireworks” versus “hub and spoke.” Fireworks are longer distance pathways for spread over hundreds or thousands of

miles, whereas hub and spoke pathways are more localized, where a single AIS infestation can result in secondary or tertiary spread from the original loci. These concepts are important for developing and targeting comprehensive AIS outreach based on the strongest potential biogeography (Muirhead & MacIsaac, 2005).

#### Boaters' Level of Knowledge about AIS Infested Waters

There is no risk of AIS transport by boaters unless boats are used on infested waters. Those who boated on waters ranged from 7% in Kansas to 67% in Vermont (Figure 18). Higher levels in Ohio and Vermont are likely due to the popularity of fish and boating on Lake Erie and Lake Champlain, respectively. Lake Champlain's zebra mussel, Eurasian watermilfoil, and water chestnut infestations received much media and outreach attention. Lake Erie's zebra mussel along with a host of other AIS, also received much attention.

Interestingly, California and Kansas boaters who boated less frequently on AIS infested waters showed the highest frequency of not knowing whether or not they had boated on infested waters. Conversely, Vermont and Minnesota boaters who more frequently spent time on AIS infested waters, showed the lowest levels (9% and 15%, respectively) of not knowing that the waters were infested. Results track well compared with the general levels of awareness on AIS identified in each state, as well as sources for information on infested waters (see Figure 12). Evidence shows that a large portion of the boating population pose real risks for AIS spread, especially if they do not know the waterbody is infested.

## Understanding Behavior of Boaters and AIS: Past

A key objective of this study was to determine if boaters were cognitively receptive to the prevention messages, whether those messages were congruent with their attitudes and beliefs, and whether they were motivated to act on that information. As stressed earlier, transient boaters are a higher risk for moving AIS than non-transient boaters (those who did not move watercraft). Boaters may have all the information they need, but due to perceived or real barriers (e.g., attitudes, beliefs, self-efficacy) may not be motivated to act (e.g., tipping point) on that knowledge. Recalling Ajzen's (1985) theory of planned behavior, the main determinant of a person's behavior is the strength of their intention (beliefs, attitudes) and ability (capacity or skill) to act.

Of respondents who did move their boats, those who took action to prevent the spread of AIS varied greatly from Kansas to Minnesota (Figure 19). Over 90% of Minnesota and 82% of Vermont boaters reported taking special steps to prevent the transport of AIS between waterbodies. Only 45.5% of Ohio boaters reported taking action, which was a surprise since this is an area of the Great Lakes where zebra mussels were first found and outreach on AIS had begun. While California and Kansas had no comprehensive AIS outreach efforts prior to this survey, over 40% of California and 30% of Kansas boaters reported taking actions. These reported levels of behavior are encouraging and likely result from effective outreach efforts in each state, plus heuristic "short cut" effects of national and regional mass media coverage on AIS.

As an example, Asian carp received much media attention across the Heartland due to their "flying" ability. Silver carp may jump out of the water when disturbed by watercraft (motor noise and vibration). Disturbing a large population can create a frenzy

of “flying” 30 to 50 pound fish often striking and injuring recreationists. In California, other AIS such as Chinese mitten crab received much media attention in the mid- to late 1990s when they marched up the Sacramento and San Joaquin Rivers posing ecological, economic and human health threats. Within the group who did move their boats, both Minnesota and Vermont demonstrated a majority of respondents who said they took steps against transporting AIS. Put another way, boaters are part of the problem, but where public AIS outreach has reached them, they are willing to be part of the solution.

#### Understanding Attitudes and Beliefs of Boaters about AIS

Understanding attitudes and beliefs is key to linking motivations to actions according to Ajzen (1985). The reasons boaters did not take action varied, but for most boaters in all states who did not take action, the most common reasons were they “didn’t know what to do” or believed they had “not boated on infested waters” (Figure 20).

Concerns among management authorities are that boaters may have an attitude or belief that AIS are not worth the effort- one that reflects lack of self-efficacy or self-control. Actually, a majority of boaters did not take action because either they: did not boat on infested waters (range 3-21%), or did not know what to do (range 4-37%). Not knowing what to do was lowest in Minnesota (4%) and Vermont (8%).

Only 1-8% of boaters across all states reported not taking action because “no boat washing equipment was available.” Not having boat washing equipment available was a slightly more prevalent response in Kansas (6%) and Ohio (8%) and least prevalent in Minnesota (1%) than in the other states. Careful consideration should be given when promoting boat wash stations (Jensen, 2006). A belief that boat wash stations are the answer when very few are available could shift attitudes of perceived control over the

issue by taking out of their hands the “do-it-yourself inspect and remove” control belief, thus undermining their relatively strong self-motivation to comply. As discussed previously, as very few boat wash stations are available, most have been discontinued due to lack of use by boaters, and they are not 100% effective at removing aquatic plants (Exotic Species Programs, 1995; as cited in Jensen, 2006).

Very few respondents (1-3%) believed that “taking steps wouldn’t help,” that “[AIS were] not a problem,” or that “they didn’t have time.” (None of the 496 Minnesota responses identified these issues as an excuse for not taking action.) Overall, evidence reflects a very low level of apathy and complacency among boaters toward the important issues of AIS. The greatest challenge in AIS boater outreach is to effectuate target behaviors by replacing past behaviors with new behaviors stressing- in this case- what they need to do. Embodying a positive attitude would likely enhance self-efficacy among boaters. Knowing their actions can make a difference contributes to a positive attitude, and this perceived control will likely result in behavior change in the future. Guidelines developed by the Recreational Activities Committee of the ANS Task Force serve as a cornerstone for promoting a positive self-image among boaters and other recreationists. All guidelines begin with positive action-oriented verbs (e.g., inspect, dispose) not negative action words (e.g., never, don’t) that are weak motivators for developing injunctive norms.

#### Understanding Behavior of Boaters and AIS: The Future

At least 69% of boaters or higher in every state reported that they are very likely to take precautions in the future to prevent the spread of AIS between waterbodies (Figure 21). In all states surveyed, 96% said they were “very” to “somewhat likely” to

take precautions if they boat on infested waters in the future. Results were near 100% in Minnesota and Vermont; only a couple of boaters in Minnesota and Vermont reported that they would be “not very likely” to take action.

Key evidence about the potential efficacy of AIS boater outreach is revealed by comparing what boaters report they did (Figure 19) to what boaters report they will do in the future (Figure 21) as shown in Table 11. As expected, the differential among Minnesota and Vermont boaters grew nominally (2-5%). However, intention for future actions greatly increased in California and Kansas by nearly 40%!

Intention for future action among Ohio boaters showed a 26% increase over past actions. In 1997, Ohio was the third state to enact an AIS statewide plan so the lower intention rate is notable. Many best outreach media were less emphasized in Ohio, especially signs at water accesses (Figure 12). Apathy and complacency was low among Ohio boaters that did not take action (Figure 20). Insights from social science suggest that behavioral determinants- self-efficacy and motivation- probably were not met. During the 1990s, phrases intended to motivate boaters such as “slow the spread” and “it only takes one mistake” were frequently used in outreach materials. Descriptive norms such as “boaters are spreading them and your action is needed” are not as strong as injunctive norms. Also heard many times was a “learn to live with them” attitude. While well-intended, such messages weakly encourage conformity because they erode or contradict the perception of personal or group control.

Minnesota and Vermont consistently promoted “prevention” messages and uniform guidelines for boaters during the 1990s. Injunctive norms support a stronger motivational message such as “take action and prevent the spread of AIS” by targeting

behavior determinants. These messages are stronger behavior determinants- suggesting that self-efficacy and motivations- were largely met. No clear causal relationship was established through this study; however, evidence presented here and is intended to help explain why fewer Ohio boaters were less motivated to take action compared to Minnesota and Vermont. What is clear is that tapping into values, beliefs and attitudes is critical to bringing majority of boaters to a tipping point for positive behavior change with regard to AIS prevention.

#### Frequency of Actions Taken by Boaters to Prevent AIS Spread

Of those who took action, boaters were asked to identify which of seven actions they took to prevent the spread of AIS (Table 12). Draining water from boats and bait buckets was the most common action with 73-86% of those respondents “almost always” taking this action. Only 1-4% responded that they “never did it”. Visual inspection, removing aquatic plants and animals from boats and equipment, and allowing the boat to dry for at least 5 days were the other most frequent actions taken. The least frequently performed actions were flushing the boater motor with tap water, and rinsing boats with high-pressure and/or hot water. Except for California boaters, who indicated that they flush their motors more frequently, 34-55% of boaters in other states never took these steps. Visual inspections were common actions in Minnesota (83%) and Vermont (76%), where this action had been promoted heavily to boaters.

Top prevention activities for large and small powerboat owners most often identified as “almost always” were: draining water, removing plants and animals, and drying watercraft for five days. This indicates that boaters are well-positioned to adopt the national voluntary guidelines based on behaviors they are already taking. With



motivational messages aimed at bringing about desired proactive behavior, outreach efforts targeting attitudes, beliefs, and self-efficacy seem to be working.

#### Frequency of Actions Never Taken by Boaters to Prevent AIS Spread

Of those boaters who never took steps to prevent the spread of AIS, differences varied greatly by state (Figure 22). Generally, Kansas, Minnesota, and Vermont boaters who never took action did not: flush motor with tap water, or rinse boat with high pressure and/or hot water. Kansas, California, and Ohio boaters who never took action did not: conduct visual inspection or remove aquatic plants and animals from equipment. Between 9%-16% of boaters in all states that never took action did not avoid the release of unwanted bait. These results were surprisingly low since an angler survey conducted by the Great Lakes Sea Grant Network in 1999 showed that 48% of anglers across five states dump left-over live bait into the water on an average of 5.1 times each season (Jensen, D. A. and colleagues, unpublished).

Between 7-14% of boaters in all states reported never taking action to allow the boat to dry at least five days. Between 1-4% of boaters in all states indicated that they never took action to drain water from boats or bait buckets. The most likely reason boaters never took action is because they did not know exactly what they were supposed to do. Another likely reason is that they forgot, making prompts (as suggested in social marketing) an important element of any outreach activity. Outreach and communication strategies targeting boaters who are already motivated to act-those that are very or somewhat influenced- may be very different than the strategies best used to address boaters who never act (recall Booth, 1996). In these cases, strategic approaches gleaned

from psychology literature suggest that using messages of social conformity, acceptance, and authority may be most effective as persuasive behavioral determinants.

#### Behavior Change Translates into Relative Propagule Pressure

Reducing the frequency of introductions, hence potential propagule pressure (e.g., frequency of “seeding”), is a goal of AIS outreach aimed at preventing and slowing the spread of AIS. To calculate the reduction in propagule pressure (Table 13), the number of registered boats was multiplied by the percentage of boaters who took precautions. The resulting estimated number of moves can then be subtracted from the estimated numbers of total moves (Column 1 from Table 8) leaving an estimated number of moves by boaters who did not take actions. Because of boaters taking actions, potential introductions were greatly reduced. Propagule pressure was reduced from about 4.1 million to 288,400 in Minnesota, from 117,000 to 11,000 in Vermont, from 1.1 million to 425,000 in Ohio, from 3.6 million to 2.1 million in California, and from 315,000 to 236,000 in Kansas. Results show the tremendous reduction in propagule pressure as the result of AIS boater outreach targeted not only at raising awareness but changing behavior to prevent the spread of AIS.

#### Influencing Motivations of Boater Behavior on AIS

Various strategies have been used to encourage boaters to take actions to prevent the spread of AIS. The top five factors that had already influenced boaters to take action to prevent the spread of AIS were: a sense of personal responsibility, a desire to keep [AIS] out of our lakes or streams, desire to prevent damage to their boat or equipment, signs at accesses, and talking with friends (Table 14). Desire to keep AIS out of lakes and streams, sense of personal responsibility, and signs at water accesses were highest in

Minnesota and Vermont. Desire to prevent damage was highest in Vermont, followed by Minnesota and Ohio. Signs at accesses were within the top factors overall, although it varied greatly among states depending on the emphasis placed on signage. Talking with friends, etc., and information in fishing and boating regulation pamphlets ranked next highest, particularly in Minnesota and Vermont where information in fishing and boating regulations has been published since the early 1990s. Media sources, magazine or newsletter articles, brochures, and AIS WATCH ID cards also ranked higher in Minnesota and Vermont where these media are widely used in AIS communication and education.

Laws and regulations, television/radio public service announcements, enforcement checks on roads or launches, creel surveys and watercraft inspection-education programs, and fines were not as strong motivators among boaters, except in Minnesota, where these media or disincentives have been in place and emphasized since 1992. (Conversely, boaters in the other states who were not exposed to these could not be motivated by them to take action.) Another exception concerning this was Vermont, where laws and regulations and television/radio public service announcements were slightly stronger influences compared to level of motivation among Ohio, Kansas and California boaters.

Across all states, least effective in getting respondents to take action included presentations to sporting associations, conferences and workshops, Internet Websites, the 100<sup>th</sup> Meridian Initiative (to prevent the westward spread of AIS), and traveler information along roads. This may be simply because most boaters have no interest in joining such associations, clubs or events. Suggesting that they get information from those sources implies that they are members or might join.

It is important to note that if media sources, TV and radio public service announcements were combined, it would have ranked as a top source for information. In retrospect, it was probably unreasonable to expect that boaters could distinguish between paid or unpaid (public service announcements) spots or articles. Television, radio, and newspapers should have been listed as separate categories.

Results of what already affected boater behavior closely matched responses to factors that “would be very effective” in prompting them to take action (Table 15). These factors were: a desire to keep [AIS] out of our lake or stream, a sense of personal responsibility, signs at marinas or launches, desire to prevent damage to boat and equipment, and fishing and boating regulation pamphlets. Again, desires and responsibility reflect personal and social norms, or motivations congruent with their values.

Disincentives like laws, regulations, fines and enforcement again ranked in the middle, with 42-68% ranking them as “very effective” in getting boaters to take action to prevent spread. Likely reasons for respondents ranking presentations to sporting associations, and conference or workshop lower among “very effective” motivators are that most boaters do not belong to sporting associations, nor do they attend conferences or workshops on AIS.

To summarize issues related to motivation, results suggest that an integrated use of AIS communication and education can influence social networks (e.g., talking with friends/acquaintances), attitudes (e.g., altruism, responsibility) and values (e.g., biospheric, egoistic, self-enhancement, self-transcendence), and motivation (e.g., regulations, enforcement, fines). Boaters, especially in Minnesota and Vermont, are open

to AIS outreach. Intrinsic motivations based on values, beliefs, attitudes, and personal norms should continue to be integrated into AIS outreach messages because they are strong motivators for fostering sustained behavior change.

Challenges to sustained behavior change are beliefs based on the premise that previous misinformation is true. Misinformation can change meaning perspectives, which in turn modulate values and attitudes, which affect actions and reactions of boaters, who may choose not to take action in a sustainable manner. Message consistency, then, becomes critical because of its potential to influence behavioral determinants.

#### Use of Billboards to Communicate about AIS

Billboards began to be used in a few states, including Minnesota and Vermont in the mid-1990s, as an attempt to reach resident and non-resident boaters and anglers along key highways. Billboards ranked sixteenth out of twenty-two sources across all states surveyed (Figure 10). Only a few billboards had been used previously, yet 25-35% of Minnesota and Vermont boaters recognized them as a source for AIS information (Figure 10). By comparison, very few if any billboards had been used in California, Kansas, or Ohio. Billboards ranked fifteenth overall as a medium that “already led [them] to take action” to prevent the spread of AIS (Table 14) and ranked sixteenth as a medium that “would be very effective” in prompting them to take action (Table 15). However, 26-32% of Vermont and Minnesota boaters, respectively, felt that this medium would be “very effective” (Table 15). Results from Vermont and Minnesota boaters provided the first piece of evidence that billboards are a viable communication source for AIS information that can influence boater behaviors, if promoted more widely (Jensen, 2009).

## Motivating Non-Compliant Boaters into Compliance

Ironically, factors identified by compliant boaters (Table 15) and non-compliance boaters (Table 16) as being “very effective” at influencing them to take action are similar. However, preventing boat damage, laws and regulations, and enforcement checks were identified as more important among this small subset.

These results provide some insight into the values and attitudes upon which motivations are based. Such motivations vary among boaters and are not linked (assumed biospheric or social in nature). While these results provide some insight, one must be cautious in drawing conclusions because of very small numbers of respondents who reported that they were unlikely to take precautions. Therefore, those behavior determinants that influence compliance among non-compliant boaters remain largely unknown.

## Boating and Types Used in 2000

Another factor in identifying boaters with risky behavior is the type, size and power of the boat they own or use. According to Gould (2007), consumers are purchasing larger and more powerful boats at least in Minnesota. Advances in new technology (e.g., four stroke engines, global positioning systems), sound reduction, and improved safety have positioned boating as one of the most popular recreational activities with nearly 13 million boat owners in the U.S. Common reasons why Americans recreate outdoors are fun, fitness, and family.

Along with the benefits are the intended consequences of our outdoor recreation heritage. Since the early 1990s, dozens of watercraft have been intercepted by state agencies, business, and members of the public with live and dead zebra mussels attached

to boat hulls, some in states and provinces far from the origins of the infestations in the Great Lakes and the Mississippi River. Based on these sightings, large powerboats and large sailboats were deemed a higher risk for long distance dispersal.

Boat type in the five states surveyed somewhat reflected national boat type demographics. Over 60% of boaters owned a single small powerboat, but the next most common type of single-owned boats were large powerboats (10% of boaters) and other boat types ranging from 0-7% (Figure 23). Results did not produce meaningful comparisons between boat types within states, especially risky behavior by large powerboat or sailboat owners, who were considered at higher risk for transport of AIS due to reported interceptions on highways across the nation.

#### Boater Knowledge of AIS Infested Waters as a Motivation

Understanding what has and will influence boaters to take action at water accesses is a key to triggering desired behavior by boaters now and in the future. Many factors had already motivated boaters to take action (Table 14). Assessing risk of boaters who knew they had been on infested waters indicates that in all states, at least half took precautions. Most boaters, especially in Minnesota (96%) and Vermont (86%), boaters were more likely to have taken action if they knew the waterbody was infested (Figure 24). They were less likely to have taken action in California (79%), Ohio (63%), and Kansas (55%). Note that inferences are weaker for California and Kansas due to low respondent numbers. However, trends follow a pattern of awareness of behavior in each state. Taking precautions while on infested waters remains of utmost importance to preventing the overland spread of AIS.

## Impacts of AIS on Boaters by State

Relatively few respondents (boaters and non-boat owners) indicated that AIS had affected their recreational experience (Figure 25). Responses varied among the states, with Vermont experiencing the greatest impact (29%), and Kansas the lowest (3%). Of these, small and large powerboat owners were affected in all states (Table 17). Of the affected powerboat owners, responses were similar from California, Kansas, and Minnesota. Fewer large powerboat owners (77%) compared to small powerboat owners (89%) were impacted in Minnesota. Fewer Vermont large boat (71%) and small boat owners (76%) were impacted. Ohio boat owners were least affected. Respondents who were impacted were provided an open-ended question to qualitatively assess types of impacts boaters experienced, as well as any associated costs due to maintenance or damage. A summary of those responses is provided below.

For California boaters who responded to the open-ended question (n=19), AIS causing the most problems were Chinese mitten crab (5), hydrilla (4), and Eurasian watermilfoil (1), Brazilian waterweed (1), and water hyacinth (1). Complaints included: mittercrabs commonly stealing bait, which increased associated costs due to purchase of supplemental bait; aquatic plant mats having impaired navigation through canals and waterways; clogged motor water intake vents; and jet pump/impellers for personal watercraft. One California boater offered the following testimonial on impacts: “mitten crabs constantly eat bait while fishing for striped bass and sturgeon. I have had to double my bait purchase [from] \$12 to \$24 per trip. ” Another stated that aquatic invasive plants “fouled prop and stopped water in the vents. Cost [me] time and water pump. ” (Boater did not identify if the pump had been repaired or replaced.) Nevertheless, these



and other impacts exemplify real damages that Californians were experiencing with regard to AIS. Among the few Kansas respondents (n=9), aquatic invasive plants were identified as impacting fishing (4) and detracting from their visual experience while hiking (1), and carp were identified as hurting game fish production (2).

For Minnesota boaters who responded (n=46), the incidence of AIS causing problems included Eurasian watermilfoil (39), zebra mussels (4), purple loosestrife (2), and curlyleaf pondweed (1). Most Minnesota boaters complained that Eurasian watermilfoil clogged waterways, restricted recreationist's ability to maneuver a boat, fish, sailboat, swim, water ski, or paddle a canoe. Several respondents noted that milfoil commonly gets tangled in fishing gear, which causes the loss of lures. Others said it clogged their motor water intakes, tangled propellers, caused "excess torque and strain on motors," and destroyed fishing beds. One shoreland property owner identified a need to "rake daily the loose vegetation that floats into/on our shore" Three respondents reported that zebra mussels cut fishing lines and another noted it is "hard on kid's feet walking in [the] river-smelly". Another three respondents identified snails as having also become a problem. It is unknown whether these snails were native or non-native AIS; however, recent spread of Chinese and banded mystery snails make them likely candidates.

Among Ohio boaters impacted by AIS (n=41), reports of problems were zebra mussels (21), round goby (20), white perch (6), and Eurasian watermilfoil (2). Complaints mentioned impacts of zebra mussels on fisheries, fouling of boats and motors, adding control efforts using anti-fouling paints or physical removal, and the interference with swimming. Zebra mussels, round gobies, and white perch were

identified most as causing impacts on fishing and fishing experiences. One Lake Ontario respondent commented that fishhook waterfleas clogged rod guides. Such situations cause the loss of hooked fish impacting anglers fishing experience.

Two Ohio testimonials reinforced impacts due to invasive fish: “hard to catch game fish when you encounter large schools of goby or white perch.” Another stated, “white perch & round goby have reduced take of yellow perch and walleye in Western Lake Erie.”

Similar to Minnesota, Vermont boaters (n=126) were impacted by a variety of AIS. The number of reports indicating “harm caused” were Eurasian watermilfoil (72), zebra mussels (50), sea lamprey (14), water chestnut (6), and hydrilla (2). Specific complaints mentioned interference with boating, hazardous swimming, poor fishing experiences, loss of lures, and clogged water intakes for boats and houses resulting in increased repair costs. Impacts due to zebra mussels identified by Vermont boaters were: cut feet and hands while swimming or recreating (22) or damaged boats, motors, and clogged raw water intakes (12). A couple of boaters noted that they chose to decrease visitation to infested waters, put more effort into frequent lakeshore clean up, and had experienced decreased property value. One Vermont respondent offered as a testimonial:

[I] had a 14' Alumnicraft [boat] just for fishing. The few times used in 1998 it was too much work going into Lake Champlain from the boating access. I ruined my trolling motor and spent \$145 on repairs to my 9.9 horse motor all because of milfoil. Sold the boat.

In summary, the percentage of respondents impacted by AIS in 2000 varied by state, types of AIS causing harm, and distribution of infestations of popular waterbodies.

Eurasian watermilfoil impacted a large proportion of respondents in Vermont and Minnesota, compared to other states surveyed. Zebra mussels impacted more respondents in Vermont and Ohio, as well as few in Minnesota. Chinese mitten crab along with several aquatic plants caused important impacts to California boaters while angling. Aquatic plants and carp were perceived as causing problems in Kansas. AIS impacts on recreational boaters can be generalized to three categories: navigation, fishing, and swimming. Several AIS were identified as impacting fisheries. Many boaters identified impacts of certain AIS (e.g., Eurasian watermilfoil, zebra mussel, hydrilla, water chestnut) clogging motors and cooling systems. Many respondents identified human health problems created by zebra mussels' sharp shells (e.g., cuts people's feet and hands). Importantly, a couple of respondents noted decreased property value (unspecified) due to AIS increased lakeshore cleanup maintenance.

#### Boater's Willingness to Pay

Although moderate to low levels of boaters were directly affected by AIS, most were willing to pay (WTP) more for licenses and boater registration to fund AIS prevention efforts in all states (Figure 26). Approximately 70% were WTP at least the minimal \$1 more; response ranged from 65% in Kansas to 78% in Vermont. A majority of respondents in all states except Kansas were willing to spend up to \$2. A narrow majority of Vermont respondents were willing to spend \$4 to \$5 more. Between 4% and 18% were WTP \$6 or more, except in Vermont (28%).

#### Willingness to Pay Lower Mean Bound Analysis

Identifying the characteristics of boaters who would be willing to pay (WTP) for AIS prevention programs is important for natural resources management agencies to

determine how to design, plan and fund those programs. Turnbull's (1976) methods were used to calculate a conservative estimate of WTP a priori based on lower bound means (LBM) using data from Figure 26 (amounts and percentage yes). Turnbull's LBM is calculated using the following formula:

$$\text{LBM} = \pi_0 (p_0) + \sum_{i=1}^k \pi_i (p_i - p_{i-1})$$

where  $\pi_i$  are percentages of respondents who support a given amount  $p_i$ , whose initial bid is  $p_0$ , and  $k$  is the number of bids offered after the initial bid  $p_0$ . Estimates calculated by using this approach are conservative since the model does not attempt to interpolate WTP between categories of WTP offered in the survey. Estimates for LBM for each state are shown below:

$$\begin{aligned} \text{California LBM} &= .13(1.00) + .10(2.00) + .07(3.00) + .21(5.00-4.00) + .10(10.00- \\ &6.00) + .08(10.00 \text{ or more}) = \$1.95 \text{ per license} \end{aligned}$$

$$\begin{aligned} \text{Kansas LBM} &= .20(1.00) + .15(2.00) + .10(3.00) + .16(5.00-4.00) + .03(10.00- \\ &6.00) + .01(10) = \$1.18 \text{ per license} \end{aligned}$$

$$\begin{aligned} \text{Minnesota LBM} &= .13(1.00) + .13(2.00) + .12(3.00) + .22(5.00-4.00) + 0.9(10.00- \\ &6.00) + .08(10) = \$2.03 \text{ per license} \end{aligned}$$

$$\begin{aligned} \text{Ohio LBM} &= .15(1.00) + .12(2.00) + .07(3.00) + .22(5.00-4.00) + .10(10.00- \\ &6.00) + .03(10) = \$1.52 \text{ per license} \end{aligned}$$

$$\begin{aligned} \text{Vermont LBM} &= .09(1.00) + .12(2.00) + .06(3.00) + .24(5.00-4.00) + \\ &.14(10.00-6.00) + .14(10) = \$2.71 \text{ per license} \end{aligned}$$

Boating and fishing license renewal periods vary from state to state, so these results need to be considered for each type of licensing period. Also, it is recognized that the "\$10 or

more” ranges listed has no upper limit; it goes to infinity. However, a conservative estimate of \$10 was used to calculate a more reasonable LBM.

To summarize, a majority of boaters in all states surveyed were willing to spend more on boating and fishing licenses if the additional money was used to fund activities to prevent the spread of AIS and reduce their harmful effects. Their WTP ranged from a low of \$1.18 in Kansas, to \$1.52 in Ohio, \$1.95 in California, \$2.03 in Minnesota, with the highest being Vermont at a \$2.71 increase for a boating or fishing license. Establishing or augmenting a user fee for boaters and/or anglers provides a valid alternative based on user opinions in each state.

Combining registered boaters from Table 8 (National Marine Manufacturers Association, 2000) with registered anglers in each state (U.S. Department of Interior, Fish and Wildlife Service and U.S. Department of Commerce, 2001, p. 108), the following revenue could be generated to support AIS programming based on WTP:

	Registered Boaters		Registered Anglers x 25% <sup>1</sup>		Total WTP		Potential Revenue
California	955,700	+	(1,865,000 x 0.25)	X	\$1.95	=	\$1,421,950
Kansas	102,424	+	(404,000 x 0.25)	X	\$1.18	=	\$240,040
Minnesota	793,107	+	(1,560,000 x 0.25)	X	\$2.03	=	\$2,401,707
Ohio	407,347	+	(1,081,000 x 0.25)	X	\$1.52	=	\$1,029,567
Vermont	37,932	+	(171,000 x 0.25)	X	\$2.71	=	\$218,648

<sup>1</sup> assumes 25% overlap of angler licenses with boater licenses; actual percent overlap not determined.

#### Potential Use of Radio to Communicate on AIS

Since zebra mussels first invaded the Great Lakes, radio has been a medium used to target recreational boaters with prevention messages. Most vehicles towing watercraft have radios and many smaller watercraft also have radios on board for listening out on the water. Radio has the potential for reaching tens of thousands for boaters and anglers

with AIS prevention messages. The survey revealed radio listening preferences from six categories (Table 18). While listening preferences varied greatly across all states, of particular interest were preferences specific to boaters in each state who did not take action (non-compliant respondents).

Those who were unlikely to take precautions to prevent the spread of AIS reported listening to oldies and classic rock stations across all states surveyed (Figure 27). Listening preferences varied highly within states. In Kansas, country was most popular followed by new age/alternative rock (tied with oldies/classic rock). In California, talk radio ranked second followed by new age/alternative rock. In Minnesota, country ranked second followed by public radio and classical (tied). In Vermont, country also ranked second followed by classical and public radio. Many Ohio boaters prefer talk radio and public radio followed by oldies/classic rock.

Small sailboaters tended to listen to oldies/classic rock followed by public, talk radio, new age/alternative rock, and classical (Table 18). Oldies/classic rock was more preferred in Minnesota, Vermont, and California. Talk radio was more preferred in Ohio and Kansas.

Large sailboaters tended to prefer oldies/classic rock followed closely by classical and public radio. More Vermont large sailboaters prefer new age/alternative rock. More boaters like country in Ohio and classical in California. Large sailboaters tended not to listen to country (except Ohio) or new age/alternative rock (except Vermont). Talk radio was not popular in Minnesota and California for this audience segment.

Personal watercraft users' listening preferences varied by state. Country and oldies/classic rock were generally preferred, followed by new age/alternative rock and

talk radio. Few personal watercraft users listened to classical and public radio. Duck boat users preferred country and oldies/classic rock, followed by public and talk radio. Talk radio was preferred in California for this audience segment. Few duck boaters preferred country in Vermont.

Small powerboaters consistently preferred oldies/classic rock across all states, followed closely by country, then talk, public, and new age/alternative and classical. Similarly, large powerboaters consistently preferred oldies/classic rock, followed closely by talk, and country. Few large powerboaters listened to public and classical radio.

Kayaks and canoe users also consistently preferred oldies/classic rock, country and public radio (except California). Few kayakers and canoers preferred talk, followed by classical and new age/alternative rock. More California kayakers and canoers preferred talk radio than other states.

Pontoon users preferred country slightly over oldies/classic rock, except in Ohio where they much preferred oldies/classic rock. Few pontoon users preferred new age/alternative, public and classical radio.

## Part II: Comparison to 1994 AIS Survey

The current study was designed to complement a similar survey conducted by Minnesota Sea Grant in 1994 (Gunderson 1994a,b). Objectives of that survey were also to: 1) evaluate the effectiveness of AIS boater outreach efforts in three states (Minnesota, Ohio, and Wisconsin); 2) determine how to best reach boaters; 3) help define the risks boaters pose for spreading AIS; and 4) find out what boaters know about AIS. Survey methods were similar to the current study, except an 11-page mail survey was sent to 2,400 randomly selected registered boaters in three states. Overall, the response rate

averaged 56% with Minnesota at 64%, Wisconsin at 59%, and Ohio at 44%. Several elements common to both surveys were compared here including: awareness of AIS, sources of information, greatest influences on boater behavior, risks for spreading AIS, and precautions taken by boaters to prevent the spread. Results of the comparison between the two surveys provide a longitudinal analysis of boater populations in Minnesota and Ohio based on boater behaviors during the 1993 and 2000 boating seasons.

#### *Awareness of AIS of Concern*

Surveys indicate that Minnesota boaters remain more knowledgeable about AIS than Ohio boaters. In 1994, 91% of Minnesota and 29% of Ohio boaters felt it was important to prevent the spread of Eurasian watermilfoil. In 2000, 91% of Minnesota and only 32% of Ohio boaters felt it was important to prevent the spread of milfoil. In 1994, 80% of Minnesota and 70% of Ohio boaters felt it was important to prevent the spread of zebra mussels. In 2000, 87% of Minnesota and 70% of Ohio boaters felt it was important to prevent the spread of zebra and quagga mussels. Concerning spiny waterfleas in 1994, over 50% of Minnesota and 30% of Ohio boaters felt it was very important to prevent the spread. In 2000, 48% of Minnesota and 30% of Ohio boaters felt it was important.

#### *Sources for Information*

Sources of information were consistent between surveys and among states. Ranges in percentages between states reflect differences in emphasis for AIS outreach through a specific medium. Key sources for AIS information were: newspapers, television, magazines, regulation pamphlets, and information at boat launches:



Newspapers - 1994 - 92% in Minnesota and 84% in Ohio compared to

2000 - 83% in Minnesota and 77% in Ohio

Magazines - 1994 - 70% in Minnesota and 74% in Ohio compared to

2000 - 75% in Minnesota and 65% in Ohio

Television - 1994 - 90% in Minnesota and 73% in Ohio compared to

2000 - 78% in Minnesota and 53% in Ohio

Reg. Pamphlets - 1994 - not assessed

2000 - 85% in Minnesota and 55% in Ohio

Boat Launches - 1994 - 82% in Minnesota and 32% in Ohio compared to

2000 - 80% in Minnesota and 25% in Ohio

In Minnesota, newspapers, television, and information at boat launches ranked highest. In Ohio (and Wisconsin), more boaters indicated that they get AIS information from magazines than Minnesota boaters. Magazines ranked high in Minnesota, but this medium was not a major target. Ohio (and Wisconsin) ranked signs a little lower; at the time, neither state used much signage concerning AIS at public launches, whereas signs were used extensively in Minnesota. By the mid 1990s, over 6,000 signs had been placed at public water accesses across the state (J. Rendall, personal communication, 2000).

#### Effective Sources of Information

To compare attitudes towards select media, boaters were asked how effective those media were in getting them to take steps to prevent the spread of AIS. Again, responses establish a relationship between what they've been exposed to and what they think affected them most.

Direct comparison of what was most effective in influencing boaters is somewhat confounded by the slightly different manner in which questions were posed in 1994 and 2000 surveys. Nonetheless, media and disincentives that ranked highest in 1994 also ranked high in 2000 (Table 15), including: signs at water accesses, information in fishing and boating regulations, brochures, etc., and watercraft inspection ranked highest.

Signs at Accesses - 1994 - 77% in Minnesota and 50% in Ohio compared to  
2000 - 76% in Minnesota and 56% in Ohio

Reg. Pamphlets - 1994 - 63% in Minnesota and 59% in Ohio compared to  
2000 - 68% in Minnesota and 54% in Ohio

Brochures, etc. - 1994 - 61% in Minnesota and 58% in Ohio compared to  
2000 - 49% in Minnesota and 45% in Ohio

Inspection/Education - 1994 - 63% in Minnesota and 48% in Ohio compared to  
2000 - 41% in Minnesota and 29% in Ohio

Success of watercraft inspections in Minnesota is directly related to laws and regulations in the state. It would be expected that efficacy in other states (without authority in statute) would be lower.

Interestingly, ranking relatively lower were laws and regulations along with fines and road checks in Minnesota and Ohio. Minnesota has promoted laws and regulation, imposed fines and used road checks much more extensively than Ohio, yet the level of perception concerning influence rose considerably in both states:

Laws and Regulations - 1994 - 53% in Minnesota and 34% in Ohio compared to  
2000 - 61% in Minnesota and 50% in Ohio

Fines - 1994 - 57% in Minnesota and 30% in Ohio compared to

2000 - 57% in Minnesota and 54% in Ohio

Enforcement Checks - 1994 - 48% in Minnesota and 24% in Ohio compared to

2000 - 59% in Minnesota and 43% in Ohio

Mass media, especially newspaper and television, were the most important sources of information for boaters in states surveyed in 1994 and 2000. Signs and information at boat launches were also very important sources, along with magazines, particularly in Wisconsin and Ohio. Due, in part, to extending results of the 1994 survey, by 2000 at least 40 states and provinces were using signs at water accesses to reach boaters with AIS prevention messages. Information about AIS printed in fishing and boating regulations, along with watercraft inspection and education, also ranked as key sources. Road checks ranked lowest, especially in Ohio, where they do not have them.

#### Boats on Infested Waters

According to Gunderson (1994b), 22% of Minnesota and 44% of Ohio boaters knew they boated on infested waters. During the 2000 boating season, 31% of Minnesota and 45% of Ohio boaters knew they were on infested waters. The higher awareness in 1994 and 2000 amongst Ohio boaters compared to Minnesota is likely due to popularity of fishing on Lake Erie where zebra mussels and other AIS received much attention.

#### How Boaters Knew Waters Were Infested

Top sources of information from which boaters knew waters were infested with AIS remained consistent. In 1994, 87% of Minnesota and 19% of Ohio boaters responded that they knew which waterbodies were infested because of signs at water accesses. In 2000, 82% of Minnesota boaters and 14% of Ohio boaters received information about

infestations from signs (Figure 12). Mass media sources remained important sources of information about infestations for Minnesota and Ohio boaters. In 1994, 56% of Minnesota and 86% of Ohio boaters got their information about infested waters from newspapers. In 1994, 43% of Minnesota and 75% of Ohio boaters knew waters were infested by information they received from television. In the 2000 survey, mass media were lumped together and only 35% of Minnesota and 56% of Ohio boaters indicated they had received information about infested waters from this source. In 1994, 69% of Ohio and 49% of Minnesota boaters knew about infested waters based on “word of mouth”. In 2000, 29% of Minnesota boaters and 48% of Ohio boaters had heard about it from a friend or relative. These results reveal how to best reach boaters with information about infested waters.

#### Actions Taken Reported by Boaters

Gunderson (1994b) reports that a “high percentage of boaters in all three states indicated that they almost always made visual inspections of the boats and drained water from livewells and bilges” (p. 2). Minnesota recognized early that aquatic vegetation including Eurasian watermilfoil is the key pathway AIS can spread overland by boaters. To interrupt this pathway, Minnesota targeted efforts using boater outreach, watercraft inspection, and policy/enforcement. Minnesota boaters responded to the message- 75% reporting that they almost always removed vegetation and zebra mussels. Only 51% of Ohio boaters almost always took this action. Gunderson reported about 50% of boaters always disposed of unwanted live bait elsewhere (not in the water), and about 30% almost always let their boat dry for ten days before going to another waterbody.

Over the six-year period, behavior changed considerably. In 2000, 80% of Minnesota boaters reported “almost always” taking action to remove aquatic plants and animals from equipment compared to 61% of Ohio boaters (Table 12). Concerning release of unwanted bait, 58% of Minnesota boaters and 38% of Ohio boaters reported avoiding release of unwanted bait into the water. Also in 2000, 43% of Minnesota boaters reported “almost always” leaving their boat to dry for at least five days compared to Ohio boaters at 62%.

#### Potential High Risk Behaviors

One of the most important aspects of behavior assessed is whether or not boaters pose risks for overland transport of AIS based on their behaviors. Results showed that boaters in all states do pose risks with a high frequency of movement between waters in short time periods. Combining frequency with magnitude of the overland boat pathway, lakes and rivers are at potential risks for heavy propagule pressure.

These risks are present only if boaters are not taking precautions to prevent AIS spread. The good news is that a large proportion of boaters in Minnesota and Ohio did not move their boats within short time periods. In 1994, 54% of Minnesota and 75% of Ohio boaters never moved their boats to different waters within five days (Gunderson 1994b), compared to 43% of Minnesota and 57% of Ohio boaters in 2000 (Figure 13).

The bad news is that 20% of Minnesota boaters reported using their boats on different waters within 24 hours (<1 d) during the 1993 season, whereas only 5% or less of Ohio boaters used their boats in this manner during 1993. During the 2000 season, 25% of Minnesota and 14% of Ohio boaters behaved in this manner (Figure 15). In 1993, 23% and in 2000, 27% of Minnesota boaters used their boat on different waters within 2 to 4

days (Figure 15). In 1993, 9% and in 2000, 27% of Ohio boaters used their boat on different waters within 2 to <5 days. Results of this comparison indicates that boaters in both Minnesota and Ohio are moving in greater numbers and more frequently between waterbodies in shorter periods of time than in 1993, exacerbating the possibility of moving AIS, if precautions are not being taken to prevent the spread of AIS.

#### Motivation for Actions Taken

Evidence suggests that boaters continue to be receptive to AIS prevention messages and are largely motivated to take preventative actions, especially in Minnesota. Motivations for action were consistent between surveys and states. When asked what influenced boaters most (1994) or what had already led them to take action (2000; Table 14), several categories stood out:

Personal Responsibility - 1994 - 82% in Minnesota and 56% in Ohio compared to

2000 - 88% in Minnesota and 55% in Ohio

Out of Our Lakes - 1994 - 88% in Minnesota and 63% in Ohio compared to

2000 - 85% in Minnesota and 53% in Ohio

Prevent Damage - 1994 - 38% in Minnesota and 55% in Ohio

2000 - 55% in Minnesota and 46% in Ohio

Signs at Accesses - 1994 - 68% in Minnesota and 31% in Ohio compared to

2000 - 72% in Minnesota and 26% in Ohio

Comparing top motivations, actions increased among Minnesota boaters and decreased among Ohio boaters for reasons that are unclear. For Ohio boaters, zebra mussels continued to spread during this period; posting signs at water accesses remained a widely

unused strategy across the state. This may be part of the reason Ohio boaters were less influenced by signs at accesses.

While damage to boats and motors occurred as a result of the extensive infestation of zebra mussels in Lake Erie (F. Snyder, personal communication, 2002), outreach to mitigate impacts may have been so effective that preventing damage became less of an issue. In other words, Ohio boaters may have considered AIS as a “been there, done that” issue. Among Minnesota boaters, personal responsibility and keeping AIS out of lakes and streams remained a priority consistent with communication and outreach messages. Preventing damage rose considerably, perhaps reflective of the increased zebra mussel infestation in the Mississippi River in the late 1990s, which damaged motors by clogging cooling water intakes. Additionally, the spread of Eurasian watermilfoil to a few more Twin Cities metropolitan area lakes may have caused impacts to Minnesota boaters.

Results indicate that boaters- especially in Minnesota- are open to AIS outreach messages and value lakes. Self-efficacy and prevention strategies need to be used in AIS outreach messages aimed at fostering sustained behavior change among boaters.

#### Behavior Intervention

Providing boaters with all the AIS information does not ensure that any positive behavior change will take place, as discussed in Chapter 2, Part II. Information alone does not elicit desired behaviors. Boaters who reported being very influenced to take action are shown below:

1994 - 70% in Minnesota and 33% in Ohio

2000 - 90% in Minnesota and 46% in Ohio

Awareness among Minnesota not only increased, 20% more boaters reported an intent for behavior change over six years. By comparison, behavior intent among Ohio boaters increased only by just over 12% during that period. Reasons for the disparity is likely due to Minnesota putting more resources into outreach and implementing strategies based on the results of the 1994 survey. Minnesota also chose stronger, more targeted language in outreach messages, suggesting to boaters “if you take action, you can prevent the spread of AIS.” Messaging in several Ohio outreach publications used less direct intent, stating, “if you take action, you may slow the spread.” From an environmental psychology perspective, Minnesota’s message is more motivational than that in Ohio, possibly driving the disparity in behavior change for this period.

Minnesota boater outreach efforts framed the issue differently than Ohio outreach did. Minnesota made AIS relevant by urging protection as a value, replacing previous behaviors with desired behaviors, and basing AIS prevention guidelines on self-efficacy messages encouraging self-control over AIS. While not directly assessed through this study, efforts to target behavioral determinants through modulation of attitudes and beliefs seemed to be effective. According to Ajzen and Fishbein’s (1980) theory of reasoned action, the main determinants of a person’s behavior are the strength of the intention and ability (capacity or skill) to act. Results of both studies support the contention that AIS outreach, especially in Minnesota, has influenced values (altruism, biospheric) motivating boaters to act on their intention to protect lakes and streams-outdoor heritage they deeply enjoy. This is reflected in responses indicating a high level of desire to be personally responsible for their actions and to keep AIS out of “my” lake. It would seem that such values and motivations have developed beyond personal norms,



as it has become a more widely accepted social norm among varying segments of boaters in each state. Minnesota has framed AIS so that behaviors related to AIS are consistent with boaters' self-image and lifestyle, as Geller and Lasley (1985) contend. Individuals who lack control in changing their behavior are more likely to ignore information inconsistent with their own attitudes and beliefs.

#### Impacts of AIS on Boaters

Based on the 1994 study, few boaters experienced direct impacts due to zebra mussels, Eurasian watermilfoil, or other AIS. For all states, only five respondents identified damage and cost of repair caused by zebra mussels. Eight reported decreased property values, with two identifying zebra mussels as the cause, and four claiming Eurasian watermilfoil (J. Gunderson, personal communication, 2000).

Based on the 2000 study, boaters in all states experienced impacts. Comparison of the two studies suggests that impacts increased for boaters in Minnesota and Ohio. Thirty-nine Minnesota boaters indicated that Eurasian watermilfoil and four pointed to zebra mussels. Twenty-one Ohio boaters identified zebra mussels as causing impacts, and two identified Eurasian watermilfoil caused impacts.

#### Why Boaters Did Not Take Action

For boaters surveyed in 1994 and 2000, the main reason they did not take action was because they "did not know what to do" or they "had not boated on infested waters." "Didn't know what to do" is one of the most significant results of this study because it reveals that AIS communication and education must continue to reach boaters in each state and support a belief of susceptibility and self-efficacy through messages of self-control based on skill. It also reveals that there is disparity among states in

communicating guidelines to boaters with instruction on what they should do.

Comparing results of both studies gives states an understanding of which media to use, and how to more effectively market prevention messages to boaters and recreationists.

Another challenge is promote pro-environmental behavior, motivating boaters to take actions regardless of whether they know that a specific waterbody is infested or not. Prompting boaters to follow guidelines each time they are recreate is the type of personal and social norms to promote. Promoting “clean boating” as a routine effort will help protect lakes and streams from the spread of AIS.

These results challenge us to work effectively on the instructions and directives in AIS outreach efforts. But, these respondents are a small segment of boaters who seemingly work from a personal value perspective of self-enhancement. They may tend to have a renegade or “cowboy” mentality in which no authority is going to tell them what do to. Such values reflect the need for enforceable laws and regulations incorporated into a comprehensive AIS program.

Similar to Gunderson (1994b), results from all five states show that very few boaters (1-3% depending upon state) reported that “[AIS are] not a problem,” “[they] didn’t have time,” or “[taking actions] won’t help.” In fact, not one Minnesota boater responded that they did not take action due to these reasons. Of those who did not take action across Minnesota, Wisconsin, and Ohio in 1994, 43% “did not boat on infested waters;” 39% “didn’t know what to do;” only 3% said that “[AIS] were not a problem;” and 2% said their actions “wouldn’t help.” Across all five states, of those who didn’t take action in 2000, 49% “didn’t know what to do;” 33% “didn’t boat on infested waters;” only 3% that “AIS were not a problem;” and 3% indicated that their actions “wouldn’t

help.” These results suggest that regardless of region and time, boaters view themselves as part of the solution. They are not apathetic and complacent as some agencies and members of the public suggest. Less than 5% of boaters in both surveys felt that AIS were “not a problem”, “it wouldn’t help”, or “didn’t have time” which suggests that laws and regulations should be used as a disincentive to target this non-compliant demographic and reinforce compliance by those who do take action.

### Summary

Minnesota and Ohio AIS outreach efforts show distinct progress toward changing behaviors of boaters to prevent the spread of AIS. Minnesota dedicated greater resources and emphasized and used more media compared to other states surveyed. Since 1991, Minnesota has addressed AIS through a program of management, monitoring, regulations and enforcement, as well as prevention focused on outreach. Somewhat surprisingly, Vermont boaters responded quickly to AIS communication and education messages. Vermont emphasized AIS outreach in the mid 1990s and it seems to have paid off with 82% of boaters reporting that they took action to prevent the spread. California and Kansas programs show great promise in that both have a baseline on which to build an effective AIS outreach campaign and measure progress in the future. Most effective sources of information were newspapers, magazines, television, information in boating, fishing and waterfowl hunting regulation pamphlets, and information at boat launches.

Comparing the two states, Minnesota has made public outreach a high priority since the early 1990s using a greater variety of communication and educational media tied to road checks to enforce regulations and watercraft inspections at water accesses across the state. Disincentives, such as enforcement events along with the possibility of

finest based on regulations, were widely covered by the mass media on television, radio, and newspapers. Besides media coverage and watercraft inspection, other key conveyers of information included signs at water accesses; information at marinas and bait shops; emphasis on the cover of fishing regulation pamphlets; information at meetings, workshops, and conferences; fact sheets and identification cards; booths at sport shows and fairs; education training packages for lake associations; and use of some billboards. Over the same period, Ohio used many of these same best methods, except for watercraft inspectors. They also did not pass laws making transport of aquatic plants, prohibited species, or contaminated water unlawful. Ohio did not emphasize the use of media, especially paid advertising in mass media, or signs at water accesses.

Comparing important sources of AIS information, those that were important in 1994 in Minnesota and Ohio remained important or grew in importance by 2000. In 1994, most important sources of information identified by boaters were newspapers and television. In 2000, newspapers continued to rank first in Ohio and second in Minnesota according to boater respondents. In 1994, Minnesota boaters ranked signs third most important, while Ohio ranked them low. In 2000, signs ranked first in Minnesota, an increase with Minnesota boaters, but remained low with Ohio boaters. In 1994, when respondents were asked how what would be the most effective way to reach them, Minnesota and Wisconsin boaters ranked signs at accesses first. In Ohio, boaters ranked them third, indicating the Ohio boaters are receptive to wide use of signs placed at water accesses. In 2000, Minnesota boaters again ranked signs first, while in Ohio they remained surprising low (20%). Boaters in all three states ranked information in boating and fishing regulation pamphlets the second most effective strategy.

Both surveys found that the potential for overland transport of AIS is likely by recreational boaters, if they are not taking preventative action. Depending on the timeframe, roughly 15-30% of boaters in Minnesota and Ohio move their boats frequently within five days.

Percentages of boaters that knowingly boat on AIS-infested waters increased between 1994 and 2000. In 1994, 22% of Minnesota and 44% of Ohio boaters knew they were on infested waters. While in 2000, 31% of Minnesota (11% increase) and 45% of Ohio (1% increase) boaters knew.

In 1994, signs at water accesses ranked first in Minnesota (87%) and a distant fourth in Ohio (19%). In 2000, respondents again ranked signs first in Minnesota (82%) and 16% in Ohio, indicating that Ohio did not emphasize use of signs, otherwise boaters would have recognized it as an important source for information. Newspapers and television ranked highest in both states in 1994, especially newspapers in Ohio (86%). In 2000, these media remained in the top two sources at 56% among Ohio and 35% among Minnesota respondents.

Results show that boater education efforts were effective in both Minnesota and Ohio. Across each state surveyed, the level of knowledge increased proportionally to the level of dedicated resources to promote AIS boater outreach. Awareness, knowledge, and behavior differed between Minnesota and Ohio. At the time of both surveys, Minnesota had dedicated more resources and used a greater variety of methods in efforts to reach boaters compared to Ohio. In both 1994 and 2000, AIS communication and education efforts in Minnesota remained consistent and were primarily directed at Eurasian watermilfoil and purple loosestrife, but included others such as zebra mussels, Eurasian

ruffe, spiny waterfleas, and rusty crayfish. By 2000, Minnesota placed even more emphasis on zebra mussels and the use of signs, media sources (newspapers, television, radio- especially paid advertising), and watercraft inspectors. Minnesota boater responses validate these as the best sources for AIS information. Efforts in Ohio continued to focus on zebra mussels primarily and relied on outreach such as dissemination of information at conferences/workshop and boat/sport shows.

### Part III: Discussion

Overland transport of AIS by recreational boaters poses one of the greatest risks for spreading of aquatic invasive plants and animals (Bossenbroek et al., 2005; 2007; Buchan & Padilla, 2000; Carlton, 1992; Havel & Stelzleni-Schwent, 2000; Johnson et al., 2001; Johnson & Padilla, 1996; Muirhead & MacIsaac, 2005; Padilla et al., 1996). Reducing propagule pressure has been identified a determinant for establishment (e.g., Drake & Jerde, 2009; Drake & Lodge, 2006; Leung, Drake, & Lodge, 2004). Preventing the establishment of AIS is the most cost-effective approach to meet the AIS challenge (Ciruna, Meyerson, & Gutierrez, 2004). Despite risks, few efforts have positioned AIS outreach as a priority and integrated it as part of a comprehensive effort to prevent and slow the spread of AIS by boaters.

Minnesota is widely considered a model addressing AIS through a statewide program beginning in 1991 (Exotic Species Programs, 1993). Recently, other states including Wisconsin and Maine adopted aggressive AIS outreach campaigns focused on prevention. No published comprehensive studies have evaluated and compared the effectiveness of such efforts. Public AIS outreach must complement management efforts

to be able to demonstrate that prevention through outreach can work to stop new AIS introductions and control spread of existing AIS.

Empirical evidence concerning boater behaviors substantiates recognition by several authors that boaters can spread AIS. However, Gunderson (1994a,b) demonstrated for the first time that AIS outreach can not only raise boater awareness, but it can change behavioral intent. The present study builds upon that 1994 survey study, providing further empirical evidence that AIS outreach can effectively increase awareness and reduce risks for overland transport by boaters, thereby increasing the effectiveness of AIS management.

Results based on mail surveys of recreational boaters in California, Kansas, Minnesota, Ohio and Vermont show that proactive AIS public education- using the best methods and making AIS relevant- can influence proper clean boating behavior. Minnesota and Vermont invested more resources in AIS public outreach programs and used a greater variety of effective methods than other states surveyed. This study again showed that signs at marinas and boat launches, newspapers, magazines, television, radio, and information in regulation pamphlets should be widely promoted.

Watercraft inspection was an important source for information in Minnesota. Minnesota was the first state to institutionalize watercraft inspection. Recognizing the benefits, other states have adapted similar programs including Wisconsin, Iowa, Maine, and others. In the West, 81% of states surveyed are using watercraft inspections (Zook and Phillips, 2009b). Given the potential for biogeographical spread of AIS from recreational boaters, watercraft inspection-education is an effective means to reach tens of thousands of boaters during the boating season.

This study can help guide management decisions about many aspects of AIS outreach. AIS management needs to gain more of an understanding of how AIS boater outreach can work to prevent the spread of AIS. While Minnesota and Vermont placed greater emphasis on AIS outreach efforts, resulting in high levels of behavioral intent, respondents' intentions for future actions based on past actions increased in California and Kansas by over 40%. Resulting intent to act rose to over 94% in all states. This indicates that motivations of recreational boaters to protect lakes and streams in those states had not yet been fully engaged.

Minnesota and Vermont boaters were most aware of AIS issues and reported taking action (90% and 82%, respectively) at water accesses to prevent AIS spread. Ohio boater awareness was relatively high, with less than half (45%) taking actions to prevent AIS spread. Even so, this represents an increase of 12% since 1994. Although AIS boater awareness was generally lower in California and Kansas than in other states surveyed, boaters in those states regularly took appropriate actions at water accesses (40% and 30%, respectively) to prevent the spread of AIS. Another sign that AIS education works is evidenced by the 20% increase in Minnesota boaters who took action compared to respondents in a similar Sea Grant survey in 1994 (when 70% took action). In Minnesota and Vermont, where prevention messages have been consistently promoted, 4 out of 5 boaters almost always conducted visual inspection and removal of aquatic plants and animals.

Johnson et al. (2001) investigated six pathways for potential spread of zebra mussels by transient recreational boaters. They found that zebra mussel attachment to aquatic vegetation was by far the greatest risk for spread. These results benefit AIS



management because they reinforce that incentives and disincentives to address spread of AIS is appropriate. Furthermore, policy, enforcement and outreach should be expanded to include movement of aquatic vegetation to all states nationwide. AIS management would benefit by AIS outreach to raise boater awareness about the potential seriousness of moving aquatic vegetation between lakes.

Results from the present study demonstrate that inspection and removal combined with other actions can reduce or nearly eliminate propagule pressure due to overland transport by transient boaters. Since these actions include drying and hot water to disinfect equipment, use of chemicals to disinfect boats seems unnecessary.

Often, boat wash stations are promoted as the “silver bullet” to disinfect boats. While boat washing is an appropriate action, it should not be substituted for primary action strategies being promoted- especially inspection and removal. Boat wash stations cannot clean the inside of boats or personal watercraft impellers, anchors and lines, fishing lines and downrigger cables- these need to be inspected and cleaned by hand. Livewells and bilges are not as easily inspected. Seven out of 10 boaters drain water from boats and bait buckets, which considerably reduces risk for spread of invasive fish and plants. However, the frequent use of watercraft within short periods of time could move invertebrates, including zooplankton or their resting eggs (e.g., ehippia).

Havel & Stelzleni-Schwent (2000) found a similar frequency of watercraft use. Seven out of 10 boaters visited different lakes within three days. Sixty-two percent of live wells sampled contained water. Of those, 38% of livewells contained zooplankton and other invertebrates. Survivorship tests with *Daphnia lumholtzi* (an invasive zooplankton) and *Daphnia parvula* indicates that they can remain viable for at least 3 days (0% by day

7). Consistent with the current study, boat movement could spread invasive zooplankton over short distances and possibly long distances (Havel & Stelzleni-Schwent, 2000).

Boat wash stations initially used in the Great Lakes region were discontinued (Jensen, 2006, citing B. Brownson, G. Nybeck, C. O'Neill, and J. Rendall, personal communication, 1996) because they were not 100% effective, especially at removing aquatic vegetation, and boaters either refused to use them (Exotic Species Programs, 1995) or rarely used them. Reasons for not using them were time delays at accesses and lack of training. Reasons agencies may be reluctant to use them includes traffic safety problems, and expense to construct or purchase, operate, maintain, and provide adequate liability (Jensen, 2006). If protection of a waterbody is the goal, then every private and public access on a waterbody would need a station installed- otherwise protection would be a leaky sieve. It is likely that rinsing livewells could improve efficacy in preventing the spread of zooplankton (Havel & Stelzleni-Schwent, 2000).

Why boaters and anglers tend not to use boat wash stations suggests a discrepancy between attitude and behavior. While they recognize AIS as a serious issue, boaters and anglers do not perceive the seriousness of not washing their boat between waterbodies (Hockett, McClafferty, & McMullin, 2005); therefore, they would not be highly motivated to use boat wash stations. Based on past experience and testimonials from others, boat wash stations likely have limited application. Two examples for use are when only a couple of accesses need protection on a waterbody or are used as an AIS outreach tool. Unless the barriers for use can be overcome, it is unlikely that AIS management can rely upon boat wash stations unless they are available at most water accesses and

promoted through AIS outreach to inform boaters and anglers over the severity of the risk for not washing their boats.

This study draws distinction to several studies (Scott & Willits, 1994; Stern, Dietz, & Guagnano, 1995; Widegren, 1998) indicating a weak relationship between environmental consciousness and pro-environmental behavior. As mentioned previously, an underlying motivation to taking care of lakes is concern over their welfare (Anderson, Kelly, Sushak, Hagley, Jensen, & Kreag, 1999). Predictors of stewardship among boaters and anglers are ownership, commitment, awareness of the consequences, and perceived seriousness of the problem (Hockett, McClafferty, & McMullin, 2005). To help boaters and anglers be better stewards then, AIS outreach needs to continue to tap into those feelings of individuals and groups so that they will be motivated to protect water resources. Another approach is to reinforce that uses of the water is a privilege, not a right, and linked to responsibility (Klessig, 2001). Motivations for action, attitudes and values, breaking down the barriers to behavior change, and other factors are part of another area of human dimension research-social marketing.

One purpose of this study was to evaluate the relationship of AIS awareness, understanding, beliefs, attitudes, and behaviors, and try to find meaning or insights based on empirically tested models. High levels of awareness about AIS, where made a priority, were not surprising. From a cognitive point of view, this study showed that there is a strong relationship between boater awareness of AIS and the importance of preventing the spread. Many of the top media and education materials promote preventative actions, describe and depict graphically exactly where to look for AIS and show what boaters need to do. Providing information in multiple cognitive modes supports aspects of dual

coding theory (Paivio, 1986). Some media used images of boaters conducting inspection and removal aimed at activating social norms. It is reasonable to assume that the best sources of information on AIS for boaters are the best for cognition; results can help guide decisions on what media to use to improve and extend AIS outreach to boaters and other recreationists. For example, strong associations were made by boaters with specific media (e.g., signs at water accesses) and word of mouth which ascribes to elements of models using direct appeals and influence of close family and friends (Abroms & Maibach, 2008).

Few studies related to the impacts of AIS on recreational boaters. While some anecdotes from this study provide insights into economic impacts, they could not be quantified due to low sample size. Vermont (29%; n=126) and Ohio (12%; n=41) boaters reported being impacted usually due to zebra mussels. Similar to this study, Vilaplana and Hushak (1994) indicate that 13% of Ohio boaters were impacted economically; most costs were due to expenses for protective paint (average \$94), increased maintenance (\$171), and insurance costs (\$207). Few AIS caused noteworthy harm in both studies but the impacts caused by those species can be substantial when taking into account impacts on the environment and society (Perrings, Williamson, & Dalmazzone, 2000). Understanding greater societal impacts should serve as motivator to boaters and others who embody more social values to get them to prevent the spread.

Evidence presented through this study suggests that boater behavior was largely a product of personal motivation, attitudes, and beliefs, which implies doing the right thing for the common good. Others were motivated due to their concern over the welfare of lakes and streams. These responses are not surprising-behavior change based on

communication media that engender social influence processes, helps to maintain a favorable self-concept (Cialdini & Goldstein, 2004). Boaters reported being self-empowered to take action; knowing what to do and that action makes a difference helps to avoid anxiety and fear, which can otherwise lead people into inaction.

Some agencies, lake associations and others claim that AIS outreach should use fear to motivate recreational boaters into taking action to prevent the spread of AIS. From an environmental psychology perspective, such an approach needs very careful consideration. Fear of the unknown elicits an emotional response. While fear and anxiety can be motivational factors for behaviors in certain circumstances (Witte, 1992; Witte & Allen, 2000), Tyrrell et al. (2009) found that scare tactics and negative messages were the least successful as part of a conservation strategy in affecting behaviors. No studies were found that evaluated fear appeals to arouse perceived susceptibility and perceived threats of AIS. While AIS outreach likely influenced moderate levels of awareness and behaviors reported by California and Kansas boaters, it is likely that they were influenced by heuristic effects from national mass media coverage. Evidence is lacking about how heurism can modulate attitudes and beliefs as behavioral determinants related to AIS.

Cognitively, boaters understand the threats of AIS. Motivations primed through communication and education can influence self-efficacy and increase self-control over AIS prevention. This is not surprising since empirical evidence based on the theory of planned behavior (Ajzen, 1985) indicates that barriers for behavior change can be overcome when beliefs, norms, and self-efficacy are targeted as behavioral determinants. While not empirically tested in this study, boaters demonstrated conformity to the conditions of Ajzen's theory. They indicated an awareness of their beliefs about

consequences, attitudes, and perceived value of behavior control regarding the welfare of themselves, lakes and streams, and ascription to personal responsibility. Attributes of boaters indicated an inference to environmental consciousness representative of biospheric and altruistic values. Others, motivated to protect water resources from damage, may be more ascribed to egoistic or self-enhancement values. Based on past behaviors, a large portion of boaters reported that they would be willing to take action in the future consistent with pro-environmental behaviors. Boaters seem to have very real concern about lakes, rivers, and streams and are willing to back up those concerns by changing beliefs, intentions, and behavior.

The high percentage boaters reportedly taking action (90%), associated with the 40% increase in intent to take action in several states, is not surprising. Community-based social marketing (CBSM) research suggests that rates of behavior change are higher when barriers to behavior change are removed, self-efficacy is positively perceived, and positive impacts to the resource (based on their actions) can be realized (McKenzie-Mohr & Smith, 1999). Most boaters recognize the threats posed, understand the consequences of inaction, and are willing to take the long view on protecting valuable water resources from the harmful impacts of AIS. CBSM suggests that rates of behavior change are lower when compliance benefits society, but lacks immediate benefit to the person. This study suggests that boaters do not strongly ascribe to such personal values. To the contrary, most boaters in this study recognize that their actions benefit them intrinsically (e.g., my personal responsibility) and extrinsically (e.g., desire to keep AIS out of our lakes and streams), and to prevent damage. It is important to recall that lakes are strongly valued as resources belonging to the entire community, over which everyone is given ownership

and a sense of personal responsibility. Behavior change can be effectuated by promoting simple actions that are easy, effective, and convenient. AIS outreach needs to continue to tap values and motivations, and evaluate its effectiveness targeting boaters and other recreationists.

If recommendations include use of chemicals (which incur some cost and are viewed as not environmentally friendly) or promote the use of boat wash stations, the recommendations may be viewed as inconvenient or contrary to boaters' values. For example, what if boaters refuse based on their values to use of chemicals like bleach? A concern is that if boater attitudes are negatively influenced by such recommendations or they become confused about what to do, they may begin to believe that taking any action is not worthwhile or may stop taking action altogether.

For nearly two decades in Minnesota and Vermont, guidelines have stressed empowerment and taking actions that make a difference, reinforcing compliance through disincentives necessary to sustain behavior change among boaters. In both states, propagule pressure was reduced by 92-94% due to boater actions. Taking these results further, one can easily argue that AIS outreach does protect the environment. Combined with the 1994 study, this study provides empirical research that was previously lacking. More valuable insights were gained about boater AIS awareness, knowledge, attitudes, beliefs, and behaviors than for any audience at risk for spreading AIS studied to date.

## CHAPTER FIVE

### SUMMARY AND CONCLUSIONS

Effective management of aquatic invasive species (AIS) starts with human behavior. Evidence from this study shows that public outreach can be effective in managing the spread of AIS helping to protect and maintain environmental and economic sustainability. Outreach can be effective and efficient in changing awareness, knowledge, attitudes, and behaviors of recreational boaters, where it is made a priority, and where the best means are used to convey messages that motivate them to take actions. Boaters can be highly motivated to take action if they know what to do. Regardless of region, over 90% of boaters were willing to take actions in the future to prevent the spread of AIS- lowering the frequency of introductions by over 92% in two states. Recognizing the importance of these results and the shortage of information concerning AIS-related behaviors, social science research filled knowledge gaps from learning and cognition to behavioral interventions. Findings reported here help position AIS outreach at a new nexus for developing more effective and efficient AIS outreach, management, and policy.

AIS are one of the most significant threats to the United States. Globalization of international markets bring as an unintended consequence- new potential AIS to our doorstep. Dynamics in trade will cause shifts in frequency and magnitude of existing and new pathways for potential introduction and spread of AIS. Once over the threshold (pardon the pun!). these species can spread and achieve high numbers, displace native species, harm habitats, and degrade natural and managed areas. Impacts will be very high in total societal, environmental, and economic costs. Nationally, economic costs due to invasive species are over \$100 billion annually (Pimentel et al., 2000; 2005).



With over 12.8 million registered boats in the U.S. in 2000, recreational boaters represent one of the most serious pathways for overland spread of aquatic invasive plants and animals to the nation's marine and fresh waters. Recreationists have likely spread the zebra and quagga mussel, New Zealand Mudsnail, spiny and fishhook waterflea, round goby, rainbow smelt, Eurasian watermilfoil, curlyleaf pondweed, and hydrilla- just to name a few. Understanding the risk of AIS spread by each recreational pathway is critical to guiding management activities. AIS can spread by recreational boaters, anglers, sailors, divers, personal watercraft and pontoon users, waterfowl hunters, seaplane pilots, and others. Aquatic hitchhikers can cling to the outside of boat hulls, motors, and trailers. They can be carried in water entrained in bilges, livewells, motors, and bait buckets or entangled on fishing lines, downrigger cables, nets, ropes, and anchors.

Once it was recognized that zebra mussels, first found in the Great Lakes in the late 1980s, could be spread by the overland movement of recreation boats, environmental education responded by reaching out to boaters. The Great Lakes Sea Grant Network, working in collaboration with state and federal agencies, began to conduct AIS outreach. Those efforts are generally thought of as successful. Many means of outreach were attempted from brochures to conferences and disincentives (e.g., laws, fines). No comprehensive evaluative studies were published that show outreach can prevent or slow the spread of AIS.

This study was conducted in 2000 to assess and improve the effectiveness of AIS boater outreach by Sea Grant and collaborating agencies and organizations. A model survey was developed to measure response by boaters to AIS outreach in five fresh water and marine states (California, Kansas, Minnesota, Ohio, and Vermont), which have a

range of boater outreach efforts, and a variety of AIS. Survey objectives were to measure: boater awareness, attitudes, beliefs, risks for transport of AIS, and what methods are most effective in reaching them. Importantly, it assessed boater's prevention behaviors and determined if boater outreach can be effective in influencing and fostering sustained behavior to prevent the spread of AIS. A survey design team of AIS educators, managers, communicators, and survey experts developed and administered a mail survey to 4,000 randomly selected registered boaters in five states (53% of 1,952 boaters responded). Results from each state were compared to each other and to a similar survey in 1994.

Comparison of Minnesota and Ohio results from 2000 and 1994 indicated progress, while providing baselines for the other states. Using the model survey developed through this study in other states or regions can save about 70% of overall survey costs. Survey results not only benefitted those states directly surveyed, but also benefitted other states, provinces and organizations. Coupled with insights gleaned from social science literature, survey results revealed effective approaches, methods, and tools to effectively deliver AIS outreach aimed at protecting against the spread of AIS.

#### Summary of Research Findings

Compared to a similar study in 1994, survey results from five states including California, Kansas, Minnesota, Ohio, and Vermont in 2000 revealed AIS boater outreach can be effective and efficient at raising awareness and can positively influence desired behavior. Effectiveness of outreach depended upon whether it was made a priority, and whether it framed value on personal actions that are effective in preventing spread (self-efficacy), and conveyed consistent messages. Results of these two studies revealed more about boater AIS awareness, knowledge, attitudes, motivations, and behaviors than any

other audience surveyed about AIS to date. Importantly, the 2000 study demonstrated that AIS boater outreach can strongly influence awareness and behavior regardless of differences among regions and those behaviors can be sustained. Most effective AIS outreach efforts reduced risk for spread of AIS in Minnesota and Vermont followed by Ohio, California, and Kansas. Minnesota and Vermont invested more in AIS outreach and used more of the best strategies and methods to reach boaters than the other states surveyed. Differences among states were largely due to emphasis placed on AIS management through AIS outreach.

AIS outreach effectively influenced behaviors. Boaters were especially knowledgeable and took greater levels of action to prevent the spread of AIS in Minnesota (90%) and Vermont (82%). Ohio boater awareness was relatively high; however, less than half (45%) took actions. California and Kansas boater awareness was generally lower, yet 40% and 30%, respectively, took action. Finally, when asked about the likelihood of taking actions in the future, the greatest increases among boaters were in Kansas (39%), California (38%), and Ohio (27%)- resulting intent for action rose to over 94% in each state. Management actions need to specifically target outreach toward this proclivity to act to prevent and slow the spread of AIS. Another compelling indication that AIS outreach can sustain behavior is the 20% increase in actions taken by Minnesota boaters from 1994 (70%) to 2000 (90%).

AIS outreach reduced risk for AIS spread. A worst-case scenario is that no boaters take actions to prevent the spread. If AIS could spread on every boat that was moved according to the five-state survey, about 12 million introductions would occur each year. Comparing Minnesota and California, boaters led with an estimated 4.4 to 5.3 million

moves, and boaters in Vermont had the fewest moves at 127,000. Of course, each of these introductions did not cause widespread infestations. Invasion ecologists confirm that not every introduction causes an established population. Therefore, effectively managing the risk of AIS spread does not mean preventing every potential introduction; rather it is about reducing propagule pressure by reducing the frequency and magnitude of introductions to prevent establishment- a subtle, but important distinction.

This study provides circumstantial but compelling evidence that preventing the spread can nearly be achieved by employing effective AIS boater outreach- the frequency of potential introduction of AIS decreased substantially in all states. Put another way, effectively managing the risk of spread by recreational boaters resulted in reduction of new introductions by over 93% in Minnesota, 92% in Vermont, 72% in Ohio, 61% in California, and 57% in Kansas (Table 13). This is an indication that AIS outreach, while relatively limited in some states, was effective in priming motivation to take action, thus reducing propagule pressure. Furthermore, if all boaters who reported that they will likely take action in the future actually do so (Figure 21), propagule pressure in all states could be reduced by 94-99%.

These results support the contention that the spread of AIS is not inevitable, an important determinant for decisions by management in choosing to address AIS through outreach. Understanding that boaters can make a difference is important. Boaters need to know that their individual and group actions make a difference. Positive communication can reinforce that difference for boaters who already take action and prime those who have not. Of the states surveyed, Minnesota and Vermont again stand out as the most

successful comprehensive programs aimed at preventing new AIS, containing existing, infestations, and minimizing AIS impacts by influencing boater behavior.

Actions taken. Most boaters reported taking multiple actions to prevent AIS spread-an indication that prevention guidelines are effectively influencing behaviors. High percentages of boaters drain water (73-86%), conduct visual inspection (46-83%), remove aquatic plants and animals from equipment (49-80%) followed by allowing boat to dry at least 5 days (43-62%). Release of unwanted live bait into the water (36-58% of respondents) remains a high risk behavior for spreading AIS. AIS management needs a better understanding of why anglers release live bait into the water so that more effective and efficient outreach, policies, and programs can reach a greater number of boaters and anglers. Low percentages of boaters reported flushing motor with tap water (8-41%) and rinsing boat with high pressure and/or hot water (10-33%), which was not surprising since they are time consuming and labor intensive actions. Boat washing is an important action for removing AIS, but it is generally not viewed by authorities as a substitute for primary actions (i.e., inspect, remove, drain). Boaters and anglers apparently do not perceive the seriousness of not washing their boat between waterbodies or the consequences of releasing unwanted fish (Hockett, McClafferty, & McMullin, 2005). This helps explain why they are not highly motivated to use boat wash stations or to not release unwanted bait. Outreach to raise awareness of these serious issues is needed to help prevent the spread of AIS.

Awareness of AIS. Boater awareness about AIS varied widely among states. Zebra and quagga mussel awareness was high in Minnesota, Ohio and Vermont. Both invasive mussels were relatively well-known in California and Kansas. Since those species had

not been heavily promoted, awareness was likely due to national and regional mass media coverage. Awareness of Eurasian watermilfoil was highest in Minnesota and Vermont, where 92% and 89%, respectively, were aware of it. It was virtually unheard of in the other states. Other AIS, even those of concern, were insufficiently addressed by AIS outreach. Boater awareness on those species was usually low and only occasionally moderate (e.g., Kansas: 47% of respondents knew of white perch; Minnesota: 21% knew of spiny waterflea; Vermont: 65% knew of hydrilla). Many of those AIS have infested waters for years, yet there is little awareness about most of them. For effective risk management, boaters need to be made aware of AIS plants and animals including emerging issues, such as diseases like viral hemorrhagic septicemia (VHS). The importance of preventing spread was consistent with boaters' level of awareness, influenced by the priority placed on outreach and promotion using best methods in that state.

Most important means for information. Management of AIS can be improved by knowing which media and strategies effectively reach each intended audience. Recognition of best sources for information about AIS or infestations differed among states congruent with what outreach to which boaters had been exposed. Consistently, best sources for information recognized by Minnesota and Vermont boaters were signs at boat launches. Top ranked sources in all states were: newspapers, regulation pamphlets, television, magazines and newsletters (especially Kansas and Ohio), and boat registration materials. Other trusted sources of information by Minnesota and Vermont boaters were radio, public service announcements on television, as well as brochures and fact sheets.

Few boaters in any state surveyed identified the Web or a hotline as a best source; however, due to its growth in popularity, interest in getting information on AIS from the Web by boaters has likely increased since 2000. Billboards show promise as a medium in Minnesota and Vermont (and beyond). For information about infestations, signs, media sources, friends and relatives, and regulation pamphlets were important. Watercraft education-inspectors were important in Minnesota and should be expanded beyond Wisconsin and Iowa- two states that recently recognized the benefits of such efforts. Employing the best means of reaching boaters with information about the locations of infestations is critical so that recreationists can be extra vigilant in taking action after recreating on those waters.

Use of radio provides an opportunity to effectively reach boaters using different types of watercraft based on boaters' listening preferences. For boaters who reported taking action, radio listening preferences varied by boat type and state. Sailboat owners tended to prefer oldies/classic rock. Personal watercraft, duck boat, small powerboat, and pontoon users preferred country and oldies/classic rock. Large powerboat owners preferred listening to oldies/classic rock, talk, and country. Kayakers and canoers listened to public, oldies/classic rock, and country.

For boaters who reported that they were unlikely to take precautions to prevent the spread of AIS (non-compliant boaters), oldies/classic rock was preferred across all states surveyed, except Kansas, where country was strongly preferred. Talk radio was preferred in California and Ohio. Country stations were also preferred in Minnesota and Vermont.

Risk for overland transport of AIS. Many boaters pose no risk for spreading AIS based on their boating behavior, but enough warrant attention. Roughly half (42-63%) of

boaters did not move their boats between waterbodies during the 2000 boating season- they pose no risk for spreading AIS. Of those who move boats, 70-80% left their boat in the water less than a day, and 19-29% left their boat in the water longer. Assuming that the longer a boat is in the water, the greater the potential colonization rate on hull, motor, trim tabs, etc., the latter group poses high risk for spread of AIS, if they do not take effective actions. Many boaters left their watercraft out of the water for 5-14 days (36-57%) before moving it to a different waterbody. Equally as many boaters (30-52%) who took their boat out of the water, moved it without letting it dry for 5 days. In Minnesota, a greater proportion of boaters have high potential for transporting AIS because about 20% reported using watercraft within 4 days 6-8 times during 2000.

This emphasizes that the action of drying alone is insufficient to eliminate risk. It also emphasizes why a suite of guidelines emphasizing “inspect, remove, and drain” should be consistently communicated in AIS outreach. Boaters who left their boat in the water for longer than one day, and those who moved their boat after they had been out of the water for less than five days posed the greatest risks for overland transport, if they did not take actions to prevent the spread. Overall, using 5 days as a guideline is a reasonable request given that a large proportion of the boating population is already in compliance. Requiring boaters to leave their boat out of the water longer than is needed may undermine their willingness to comply.

Risk based on distance boats were moved. Seven out of 10 (73%) boaters move their watercraft 50 miles or less. Minnesota and Vermont boaters moved most frequently over the shortest distances. At ten miles or less, nearly double the number of boats were moved in Minnesota compared to Vermont, followed by California, Ohio, and Kansas.



Few boats moved 51 miles or more. Six percent (110 of 1,952) of respondents moved their boats out of their resident state. Recently, zebra and quagga mussels have moved very long distances (500 miles or more), including to a few Western states. Four boats total were moved from mussel-infested states to Utah (1), Texas (1), and Florida (2). No respondents indicated that they moved boats from Minnesota, Ohio, or Vermont- all states with some zebra or quagga mussel infestations- to Arizona, California, or Nevada. Patterns of boat movement support the conceptual spread of AIS described as “fireworks” versus “hub and spoke.” AIS outreach needs to focus efforts around the source areas for potential overland transport.

Understanding attitudes, beliefs and motivations of boaters. Understanding attitudes and beliefs is the key to linking motivations to actions (Ajzen, 1985). Reasons boaters did not take action was consistent. Most boaters who did not take action reported that it was not because they were unmotivated. Rather, most reported that they “didn’t know what to do,” or believed that they “didn’t boat on infested waters”. Of those not taking action in Minnesota (10%) and Vermont (18%), only 4% of Minnesota and 8% of Vermont boaters “didn’t know what to do”. Of those not taking action, more boaters in Ohio (22%), California (35%) and Kansas (37%) “didn’t know what to do”.

Top motivators influencing all boaters to act to prevent the spread of AIS were: a sense of personal responsibility (62%), a desire to keep [AIS] out of our lakes or streams (59%), desire to prevent damage to my boat or equipment (44%), signs at marinas and boat launches (42%), and talking with friends (42%). Information in fishing and boating regulation pamphlets, magazine or newsletter articles, brochures, and AIS WATCH ID

card cards were particularly likely to be read, absorbed and trusted. As shown in the literature review, behavior is unlikely motivated by any single attitude, belief or prompt.

Together, these motivators likely interact to elicit attitudes that activate personal and social normative beliefs in compliant boaters. Furthermore, results were not surprising since CBSM suggests that compliance can be high in situations where inaction clearly does not benefit the individual or society (McKenzie-Mohr & Smith, 1999). Boaters who take action to prevent the spread of AIS likely receive simultaneous gratification from the fact that their actions, which are convenient and cost nothing, fulfilled their personal responsibility, and have effectively protected their lake or prevented damage to their property.

Laws and regulations, television/radio public service announcements, enforcement checks on roads or at launches, creel surveys, watercraft inspection-education programs, and fines were not as effective as other motivators among boaters, except in Minnesota and Vermont, where these media and disincentives were extensively emphasized. The reason for prompts and disincentives not ranking higher is that boaters were not exposed to them, and therefore could not be motivated by them.

Contrary to claims by some scientists, natural resource managers, and lake association leaders or members, based on this study of boaters sent a strong signal that they are not apathetic or complacent toward AIS. Very few respondents (1-3%) believed that “taking steps wouldn’t help”, that “[AIS were] not a problem”, or that “they didn’t have time”. (None of the 496 Minnesota respondents identified excused themselves from not taking action.) Excuses can lead to apathy and complacency that can extend into

personal norms, which in turn can influence social norms of relatives, friends and acquaintances.

In Minnesota and Vermont, where efforts have promoted positive AIS communication and education prevention messages to boaters, voluntary compliance is very high. This identifies an opportunity to build on previous successes in AIS outreach tailoring strategic methods to reach boaters with select media so that they have the tools and skills necessary to be extra vigilant. Boaters are empowered when they know what to do and know which waters are infested. Targeting values, attitudes, and beliefs can bring them to a tipping point beyond which they will take action, but it must be in accordance with their self-image. Otherwise, boaters will not be influenced to take action, nor sustain long-term desired behaviors.

Evidence based on this study suggests that fallacious claims that are unfounded and misinformation could negatively impact prevailing normative beliefs, motivations to comply, and attitude outcomes of boaters- undermining years of successful outreach. Effective AIS management needs to recognize and address perpetuation of fallacies and misinformation. Keeping apathy and complacency in check can be achieved with positive messaging and reinforcing of personal and social norms by using images of boaters taking actions (e.g., draining water, removing aquatic plants, disposing of unwanted live bait in the trash), especially those holding egoistic, self-enhancing and conservative values.

Most boaters, especially in Minnesota (96%) and Vermont (86%), were more likely to take action when they knew they were in infested waters. California (76%), Ohio (63%), and Kansas (55%) were less influenced to take action. Apparently in these latter

states, AIS outreach about being extra vigilant when on infested waters had not been framed as strongly as an outcome evaluation behavior determinant. Recall that when asked about the likelihood of taking action in the future, the greatest increase regarding behavior intent among boaters in all states increased to over 90%. Emphasis on always taking action needs to be reinforced among boaters who already take action, and prompt those who do not.

Effective behavior targets for non-compliant boaters, those who never took action (7-14% of all respondents), were similar to those who took action. However, preventing boat damage, laws, regulations, and enforcement checks were identified as strong influencers for compliance. Boaters who comply are those who exhibit behaviors consistent with environmental stewardship. Their attitudes and beliefs are consistent with protection and sustainability, whereas, non-compliant boaters exhibit low levels of engagement and interest.

Motivations for boaters to take actions differed among states. While this study did not directly affiliate categories of motivations with boaters, inferences taken from human dimension literature suggest that boaters' motivational framework probably works within a base combination of: achievement (actions are easy), competence (guidelines provide skills), power (guidelines and action combine to provide empowerment), attitude (self-confidence that their actions are effective), and incentive-based (social/environmental altruism). Disincentives related to laws and regulations are important motivators, but results suggest that more boaters are motivated by knowing the threats and knowing what to do, indicating that more are motivated through outreach than enforcement or fines. This does not imply that regulations and enforcement are not important. The point is that

through AIS outreach, boaters are empowered to take action so that they can more easily comply with regulations. This should make enforcement of regulations much easier.

The challenge for AIS outreach is to distinguish the attributes of the three types of boaters: those who comply, those who sometimes comply, and those who rarely or never comply. Compliant boaters are highly engaged- a small expenditure of resources is needed to ensure that they sustain their behavior. The behaviors of compliant boaters can serve as models and as place-based social influences on those who rarely or never comply. Ideally, this would happen at boat accesses or be demonstrated at boat and fishing shows, or other events. Visual depictions in outreach media should also be used to positively influence normative beliefs and outcome evaluations particularly among those who rarely or never comply. Moving away from descriptive norms, the use of injunctive norms can more strongly influence behavior such that non-compliant boaters reflect upon their self-image (e.g., “well, if others are doing it, it seems like it’s expected- I might as well be doing it too. Maybe it is worth the time and effort”).

Using images and phrases such as, “stop aquatic invasives”, can serve as strong injunctive norms that can influence compliance by non-compliant audience segments. To be more effective, AIS boater outreach should tap these motivations, stressing prevention as important, and delivering concise, consistent messages.

AIS impacts on boaters. Few boaters felt that AIS impacted them, except in Vermont (29%). Kansas (3%) was lowest. AIS impacts on recreational boaters can be generalized to three categories: navigation, fishing, and swimming. Several AIS were identified as impacting fisheries. Many boaters identified impacts of certain AIS (e.g., Eurasian watermilfoil, zebra mussel, hydrilla, water chestnut) clogging motors and

cooling systems. Many respondents identified human health problems created by the zebra mussels' sharp shells (e.g., cutting people's feet and hands). Importantly, a couple of respondents noted decreased property value (unspecified) due to the need for AIS increased lakeshore property cleanup and maintenance.

Boater willingness to pay. Most boaters in all states were willing to pay (WTP) more for angler licenses and boater registrations to fund AIS prevention efforts. WTP ranged from a low of \$1.18 in Kansas, to \$1.52 in Ohio, \$1.95 in California, \$2.03 in Minnesota, and \$2.71 in Vermont. Revenue based on their WTP (multiplied by the number of registered boaters and anglers in each state) would produce: \$2,401,707 in Minnesota, \$1,421,950 in California, \$1,029,567 in Ohio, \$240,040 in Kansas, and \$218,000 in Vermont. An increase in boater and angler license fees could underwrite statewide AIS outreach, community-based grant programs, or subsidize watercraft education-inspection programs, particularly in states where they do not exist.

Successful elements of AIS messages. Besides effective delivery, successful AIS outreach requires message consistency and content. Evidence from this study shows specific information about how and which AIS can potentially be spread by boaters. Characteristics of boater behaviors coupled with life histories of AIS that pose threats for spread by boaters creates an opportunity to reflect upon and potentially revise messages currently being promoted in AIS outreach and communication. Effective AIS outreach content needs to stress what to look for, where to look, what to do, and whom to contact to report suspicious sightings.

Delivery: Outreach delivery is a key component to the effectiveness of AIS outreach. Extensive details concerning effectiveness of delivery of AIS outreach were

discussed earlier. Best media and strategies were: signs at boat launches, mass media (newspaper, magazines, television and radio), regulation pamphlets, magazines and newsletters, and boat registration materials. Regional and national media can provide valuable heuristic effects by effectively priming boaters helping to extend AIS communication across lines of political jurisdictions.

Timing and placement are important. Delivery is most effective when boaters are planning trips, and on their way to or at their destination (Marion & Reid, 2007).

Recognition of signs at launches and watercraft inspection-education by boaters in Minnesota and Vermont reflect that importance. Knowing which waters are infested can influence boaters to be extra vigilant to prevent the spread. Signs can be easily placed at water accesses. They are very effective and relatively cheap (\$20 to \$100) depending upon size and materials. As mentioned earlier, signs have been emphasized in Vermont and Minnesota (over 6,000 are posted in Minnesota). Watercraft inspectors (paid or trained volunteers) can help support AIS outreach and by helping to shape personal and social normative beliefs about the importance of taking actions to prevent the spread.

Multi-media, as suggested in CBSM, should be used strategically to gain recreationists' attention. Personal contact works, evidenced by the recognition of watercraft inspection-education by boaters in states that support such programs. Identifying and promoting the most effective media and strategies to reach recreationists is essential, particularly as social media becomes more popular- these can be used to reinforce behavior norms. Social media (e.g., email, RSS feeds, Twitter, Facebook) has the potential to reach recreationists frequently through portable hand-held electrical

devices such as cell phones, ipods, and mp-3 players. More exposures to messages- the stronger the influence on attitudes, norms, and self-efficacy.

Content and Consistency: Content is critical to effectiveness of AIS outreach.

Most successful outreach efforts convey messages that are positive, consistent, and appeal to the values, motivations, and self-image of boaters. Use of “slow the spread” as a phrase commonly promoted in AIS outreach is weakly valanced in terms of shifting normative beliefs and resulting positive outcomes. Use of “prevent the spread” is much stronger in that it tends to support injunctive norms to sustain behavior.

As an aside, the author has witnessed that authorities in some states do not even mention “prevention” during statewide AIS meetings (e.g., Michigan’s Call to Action on AIS, March 5, 2008, East Lansing, MI; personal observation). Even at a recent international conference, only one plenary speaker much to his credit, Dr. Timothy Kenney, Deputy Assistant Secretary for Oceans and Atmosphere, NOAA-Department of Commerce, duly emphasized prevention through AIS outreach as a needed focus for management (14<sup>th</sup> International Conference on Aquatic Invasive Species, May 14-19, 2006, Key Biscayne, FL; personal observation). As emphasized previously, there must be a paradigm shift through which by more federal and state authorities accept the concept of prevention and recognize the unintended consequences of poor messaging to effectuate AIS management. Organizational training and leadership can help bring about desired change.

Messages need to be specific. Tailored guidelines were designed so that various recreationist groups would relate to the information. National Voluntary Guidelines for Recreational Activities (Federal Register, 2000) convey consistent, positive and effective



solutions that boaters can take to prevent the spread of AIS. Each begins with positive verbs conveying simple, easy-to-do actions. Each is intentionally designed to avoid the use of “don’t do this or that”, since messages that convey a negative tone may not appeal to recreationists. Intended also to break down barriers, suggested actions require no cost, materials, supplies, or equipment. Since these actions are effective in preventing the spread of AIS, use of chemicals to disinfect boats and equipment seems unnecessary because drying and hot water can disinfect equipment.

Below are guidelines modified from the national guidelines, which are specific and the most effective based on the results of this study:

- ✓ ~~Remove~~ aquatic plants, fish, animals, and mud from boat, motor, trailer and equipment
- ✓ ~~Drain~~ water from boat, motor, bilge, livewell and bait buckets
- ✓ Dispose of unwanted live bait, fish parts, and worms in the trash
- ✓ Rinse boat and equipment with high pressure, hot (120°F or higher) water on your way home or at home, OR
- ✓ ~~Dry~~ everything for at least five days

~~Guidelines~~ for boaters and anglers (above), recreational baitfish harvesters, waterfowl hunters, sailors, personal watercraft users, scuba divers, and seaplane pilots are available for AIS outreach (Federal Register, 2000). Complementary guidelines for aquarists and water gardeners aimed at preventing the release or escape of aquarium fish, plants, snails, crayfish and diseases into the environment were co-developed by the author with the pet industry and the U.S. Fish and Wildlife Service as part of an award-winning campaign called Habitattitude™([www.habitattitude.net](http://www.habitattitude.net)).

Using these guidelines will help to educate and provide the skills needed to break down such barriers as not knowing what to do in order to establish long-term behavior change. Further development and refinement of guidelines may be warranted with the biological life history of new AIS to improve biological efficacy and compliance by recreationists and consumer hobbyists.

What you say is what you will get. Conflicting messages, misinformation, and promotion of fallacies can result in non-compliance. A study by Lackey and Ham (2003) found that conflicting outreach messages possibly caused non-compliance among visitors at a national park. Minnesota and Vermont used the best methods, most consistently promoted messages, and emphasized “prevention”- producing the highest levels of motivation for voluntary self-inspection by boaters (based on testimonials indicating that AIS boater outreach can be effective).

Evidence from this study demonstrates that recreational boaters were willing to take action if they “knew what to do”. Most often, boaters’ motivations for taking action were to keep AIS “out of our lakes or rivers” or because of “personal responsibility”. Effective AIS outreach should tap these motivations, stressing why preventing the spread is important, and delivering concise, consistent messages at every outreach opportunity.

Public sightings and reporting of new infestations is vital to aid in preventing and containing AIS spread. Content should support public participation by identifying whom to contact, how, and what is needed from them to aid reporting. AIS WATCH ID cards and other materials have proven very effective in motivating boaters, anglers and others to report suspected infestations. Recommended wording is:

“note exact location; place plant specimen in a sealed plastic bag or store animal specimen in a sealed container with rubbing alcohol, and contact a state, federal, or tribal natural resource management authority, Sea Grant or Extension office.”

Volunteer citizen AIS or water quality monitoring networks can be important conduits for information about AIS to shoreland property owners, boaters, and other community members, who are concerned about lakes or rivers.

When the public is engaged in a participatory process, positive AIS outreach messages and feedback are better received and can increase compliance. Most boaters are and nearly all could be engaged. Ultimately, the challenge in AIS outreach is to block AIS spread from recreational pathways, and at the same time, build community support and capacity to deal with AIS issues locally.

Audience demographics. Registered boaters averaged 50-54 years old and ranged from 84-91% male depending upon the state. Surprisingly, many owned multiple boats making audience characterization complex based on boat type. Due to changing demographics nationally- we are becoming a more pluralistic, ethnological, and multi-cultural society- AIS outreach will need to identify and employ messages specific to individual groups taking into account ethnicity, faith, altruism, age, gender, and social influence. Furthermore, different messages to address recreationists who are already influenced to act may be very different from those who do not act.

Conceptual models. Design of any successful education program requires a good understanding of the audience whose behavior is being targeted. It is easy for AIS management to assume that they know how people learn, process information, react to appeals, think, and behave.

Dual coding theory (Paivio, 1986) can help explain how people process audio and visual information at the same time, so that they can more easily recall it at a later time. The theory suggests that people have better memory recall when an image is supplied with text, compared to just text alone. Several combinations of visual and text messages are used during testing to help elucidate learning constructs. This approach would be particularly useful in designing effective AIS outreach materials for education (e.g., brochures) and communication (e.g., newspaper ads, billboards) and, to the extent possible, influencing behavioral intent. As an example, a test group of a non-compliant demographic could be exposed to images illustrating people whom they relate to taking action, then measuring changes in attitudes and beliefs that could trigger behavior intent.

Witte's (1992) extended parallel process model (EPPM) can provide basic information concerning appeals. According to EPPM, individuals weigh appeals based on their perceived susceptibility to the threat and perceived severity of the threat. The greater the perceived susceptibility to a serious threat, the more motivated an individual is to a second appeal. If the appeal is perceived as irrelevant or insignificant, it may be ignored along with any subsequent appeals. Perceived efficacy determines whether an individual, in response, takes action to prevent or control the threat. If an individual doubts that he or she can make a difference or does not believe he or she has the capacity or skill to act upon the recommended response, he or she may deny or avoid any reaction.

Evidence presented in this study shows that boater behavior was largely driven by personal motivation, which implies doing the right thing for the common good. Others were motivated by concerns for the welfare of lakes and streams. These responses are not surprising- behavior change based on communication media that engender social

influence processes, helps maintain a favorable self-concept (Cialdini & Goldstein, 2004). Boaters surveyed report being self-empowered to take action; knowing what to do and understanding that action makes a difference. Such understanding helps avoid anxiety and fear, which can otherwise lead people into inaction.

Some agencies, lake associations, and other organizations claim that AIS outreach should use fear tactics to motivate boaters into taking action to prevent the spread of AIS. This may be short-sighted. Use of fear in communication and outreach needs to be carefully considered. Fear of the unknown elicits an emotional response. Fear can be an effective short-term motivator; however, scare tactics and negative messages can reinforce attitudes of denial, message avoidance, or negative responses. Impacts of such appeals may not offer an effective long-term solution to foster and sustain behavior change among recreationists. No studies were found that evaluated fear appeals to elicit perceived susceptibility to and threats of AIS. Cognitively, boaters targeted with outreach understand the threats of AIS (although susceptibility and severity were not directly messaged).

Motivation, primed through communication and education, can influence self-efficacy and increase self-control over AIS prevention. This is not surprising since empirical evidence based on Ajzen's theory of planned behavior (TPB) indicates that barriers for behavior change can be overcome when beliefs, norms, and self-efficacy are targeted as behavioral determinants. While not empirically tested in this study, boaters demonstrated conformity with the conditions of Ajzen's theory. This indicates that respondents were aware of their own beliefs about consequences, attitudes, and values regarding behavior controls for the welfare of themselves, lakes and streams, and

ascription to personal responsibility. Recognizing these attributes of boater psychology can fill knowledge gaps about how recreationists react to threats of AIS and how they perceive themselves and their outdoor recreation heritage being impacted.

Ajzen's (1985) TPB is effective in determining how people think, what they are thinking, and what they know. At the core of TPB is assessing how enduring values, beliefs, attitudes, and self-efficacy influence motivation. TPB offers an opportunity to learn more about how these attributes develop into actions. It can provide insights into why individuals act, or do not intend to act. Boaters may not act because the behavior is not reflective of their self-image or what they think others perceive about them. They may lack confidence or the ability to perform the actions.

TPB takes into consideration perceived social pressure to engage in that behavior. Results from this study were not empirically tested using this model; however, many boater attributes fit well into predicting behavior outcomes reported by them. Application of TPB shows promise for further use as a conceptual model to assess knowledge, understanding, and influence and to sustain changes in behavior among recreationists.

Community-based social marketing (CBSM) is gaining traction through its successful use in natural resource management and conservation issues. CBSM is a strategy for designing, implementing, and evaluating outreach aimed at promoting sustainable behaviors (McKenzie-Mohr & Smith, 1999). Many AIS outreach efforts of the past have relied on the assumption that people will react to information and change their behavior accordingly. CBSM is a strategic approach that could be applied to AIS outreach aimed at breaking down perceived or real barriers to desired actions by individuals, while offering benefits and promoting sustained desired behavior. CBSM

could be used to guide the design of assessment instruments to measure and provide insights into new and improved messages for greater influence over persuasive behavior determinants (e.g., inspect your boat; do not release). Reinforcing desired behavior through personal and social norms is critical to fostering sustained behavior change.

Prevention efforts must refocus AIS outreach, using the best means of reaching boaters and other recreationists, emphasize what actions need to be taken, and appeal to what motivates them. In doing so, environmental educators will need to create and adapt pedagogy using stronger behavioral objectives.

#### Implications for AIS Management and Outreach to Recreationists

Findings of this study lead to several broad management guidelines followed by a suite of outreach recommendations to improve efforts to prevent the spread of AIS.

Dedicate long-term funding and resources. Understandably, over the past two decades insufficient resources have been allocated by federal and state agencies for preventing the spread of harmful AIS. Dealing with an issue that is out-of-sight and out-of-mind is a paradoxical decision for states faced with already shrinking resources for natural resource management. To broaden efficiency and effectiveness, management at federal, state, tribal and local levels needs to refocus and dedicate resources more on prevention elements, including outreach. State appropriations, boater and angler license fees and gas taxes are used in several states (e.g., Minnesota, Wisconsin, and Maine). Federal funding to the regional panels on ANS (<http://www.anstaskforce.gov/panels.php>) should be made available for direct outreach or through grants in order to address regional AIS outreach priorities.

Support comprehensive programs. Proactive management relies upon elements of prevention through public outreach and risk assessments, monitoring, control, and regulations. Addressing each pathway to prevent and control the spread is essential- otherwise spread and impacts will not be mitigated. The reality is that AIS will spread if nothing is done. For boaters, prevention through outreach, watercraft inspection, reporting of new sightings, and regulation and enforcement is effective. Similar programs, like those used in Minnesota and Vermont, need to be modeled to support the building of an ethos of conservation in order to meet the AIS challenge.

Manage pathways, not species. Widespread acceptance is that species-by-species management is not as efficient as addressing the pathways- evidenced by the continued rapid spread of AIS, like zebra mussel and quagga mussels in some Great Lakes states and in the West. Worldwide, there are thousands of species that would be invasive to the U.S., if introduced. Species-by-species management becomes redundant as approaches to addressing most AIS are similar. Addressing pathways for spread by reducing propagule pressure is critical to effective AIS management. Understanding the life histories of those AIS within each pathway, including recreational activities, is vital if AIS outreach is to convey what recreationists need to do.

Support prevention research. Natural resource management activities largely focus on control by reducing the impacts of established infestations of AIS. Research has played an important role in successfully finding technological solutions to controlling some harmful AIS (e.g., sea lamprey, purple loosestrife). Eradication of AIS is often not possible due to the lack of resources, lack of will, or the lack of potential for success. Prevention efforts are even more uncommon. An inventory of AIS research efforts (Great



Lakes Panel on ANS, 1996) confirms that only 5% of research focused on “prevention of introductions,” which leaves AIS management marginalized with few tools or options.

Indeed, efforts that emphasize control, monitoring and research on impacts are generally thought of as successful. However, these efforts are usually reactionary and not proactive in preventing the introduction and spread of AIS. Since new AIS are being introduced and spreading across the U.S. at an accelerated rate, our reliance on reactive measures is insufficient. More emphasis needs to be placed on preventive measures such as the boater risk assessment presented through this study. Public awareness and action are keys to preventing the spread of AIS.

Promote AIS outreach through environmental education and social science. Responding to the challenge, AIS outreach needs to continue to build upon the rich history of environmental education by promoting stewardship and a conservation ethic. Effective management of AIS starts with behavior. Boat wash stations are clearly not the “silver bullet” in many situations because of limitations. In Minnesota, the DNR, Minnesota Sea Grant along with the U.S. Fish and Wildlife Service, encourages public awareness, watercraft inspections, regulations and enforcement to prevent and contain the spread of AIS. Boat washing is an appropriate action, but it is not viewed as a substitute for the key actions described above. Careful consideration must be given to the use of technology and chemicals such as bleach to treat watercraft. Suggesting these as alternatives could divert people’s attention away from personal responsibility and performing easy, hands-on actions. Rather, it is suggested that outreach promote inspection and removal of aquatic plants and AIS to keep prevention personally relevant to boaters to support a belief in their own control over AIS.

AIS outreach, as shown through this study, has been successful in instilling individual responsibility, social norms, and community responsibility- all concepts at the heart of sustained behavior change. Study results demonstrated that boaters were motivated to take action when they knew what to do. Effective outreach can tap that motivation by stressing the importance of preventing the spread and delivering concise, consistent messages. Barriers to behavior change must be continually assessed and targeted through AIS outreach. Doing so will require the use of innovative AIS communication and education messages based on injunctive norms. Injunctive norms influence negative meaning perspectives, break down barriers to behavior change, reinforce social norms, and cause individuals to reconsider personal responsibility to themselves, family, society, environment, and their economic well-being.

Use clear communication and content. Use the national guidelines suggested above. Messages specific to actions are most effective. Use fear with caution. Avoid misinformation and fallacies. “It only takes one mistake” and “it’s only a matter of time” confuses the message. These tend to undermine success in changing behavioral intent, and fuel apathy among recreationists and agency staff as well.

Use best methods to motivate compliance. Where effectively delivered, AIS outreach attained high compliance in Minnesota and Vermont; results from other states demonstrate that they are well positioned also to achieve high compliance (over 90%), if effective outreach is delivered. Signs at launches, newspapers, magazines, television, radio, and information in regulation pamphlets should be widely promoted. Since commercial media are important sources of information, paid media spots should be placed around fishing season opener and other major recreation holidays.

Greater compliance likely can be achieved through a comprehensive program of outreach, watercraft inspection, policy, and enforcement. Minnesota was the first state to pass statutes specifically addressing the overland transport of AIS by boaters.

Enforcement of state laws such as those in Minnesota and Vermont prohibiting transport of any aquatic vegetation, harmful species, and contaminated boats and water has successfully interrupted the pathways for AIS spread. Recognizing the benefits of this model, Wisconsin, Colorado, and Utah recently adopted programs with similar elements.

Assess outreach outcomes and impacts. Assessment of AIS outreach is critical to document successes, guide future development, and maximize effectiveness. Outreach usually fails because education is not well-thought out; just doing some outreach does not automatically inform audiences or elicit desired behavior change. AIS outreach providers need to better understand their target audiences, and assess progress based on behavior determinants.

Lack of successful assessment evidence has created two barriers to AIS management embracing outreach as a priority. First, many management authorities have been reluctant to consider AIS outreach because of perceptions that it is inefficient, ineffective, lacks benefits, or all of the above. Second, agencies and organizations rarely have the time, interest, or capacity to make comprehensive assessments within or across multiple states. Without applied evaluative research showing that prevention through AIS outreach can be effective, authorities have been generally slow to react in dedicating resources or staff, particularly when minimizing impacts through control and eradication has been a major priority.

This study strongly suggests that states and other jurisdictions that make AIS outreach a priority can work to bring about sustained behavior change among boaters, thereby protecting our waters from harmful AIS. This research represents significant success in terms of environmental education with potential application to states and other jurisdictions. It is expected that results of this study will benefit the states surveyed, as well as agencies, businesses, academia, and non-governmental organizations elsewhere by providing tools (e.g., model survey instrument) and strategies for effectively delivering and evaluating AIS outreach. Such efforts can prevent the spread of AIS and minimize the damage they cause to our society, the environment, and the economy.

*Minnesota at the forefront of AIS: A brief case study.* Many states point to Minnesota as a model for successfully preventing and slowing the spread of AIS. In the early 1990s, Minnesota responded to the threats of AIS by emphasizing boater outreach, watercraft inspection, monitoring, regulations and enforcement. Authorized by the Minnesota Legislature, the Minnesota Department of Natural Resources (DNR) established a program to prevent introductions of new harmful AIS, control the spread of existing AIS, and reduce their impacts on the environment, society, and economy.

For nearly 20 years, prevention efforts emphasized regulations and outreach. Key components of AIS outreach include radio, television, and newspaper advertising, public service announcements, print materials, news releases, media contacts, Website, staffing of booths at sport shows and other events, and watercraft inspections.

While Minnesota DNR's enforcement activities emphasize outreach to change behavior to prevent spread of AIS, the threats of enforcement, fines, and legal consequences of non-compliance are disincentives to help them obey laws. Critical state

law prohibits transport of all aquatic plants, prohibited species on a public road. Launch a watercraft or place a trailer in the water if it has aquatic plants, zebra mussels, or other prohibited species attached. It is also unlawful to transport water from infested waters or take wild animals from infested waters, except by permit. From a pathway assessment perspective, this is a very effective approach for AIS management as part of a comprehensive program.

Minnesota was the first state to institutionalize a watercraft inspection program subsidized by a user fee beginning in 1992. Inspections last from April to mid-October. Depending upon the number of inspectors, about 50,000 watercraft are inspected annually across Minnesota. Watercraft inspectors work at water accesses and events providing information to the public. Laws and rules are enforced by conservation officers; watercraft inspectors do not have enforcement authority and contact conservation officers if any enforcement action may need to be taken.

Today, the successes of these efforts continue to rely on collaborations with many partners, including the University of Minnesota Sea Grant Program, Minnesota Department of Natural Resources, University of Minnesota Extension, U.S. Fish and Wildlife Service, and Minnesota Waters and its lake associations, and recently Wildlife Forever. For nearly two decades, partners have emphasized outreach to recreational boaters and anglers, encouraging them to act in ways that will prevent hitchhikers from spreading. Due to statewide cooperation of citizens, recreationists, the tourism industries, businesses, and agencies, less than 1% of Minnesota's waters are infested with AIS such as zebra mussels and Eurasian watermilfoil. With 15,000 lakes, thousands of miles of

rivers and streams, and acres of wetlands to protect, Minnesotans recognize the importance of acting to prevent the spread of the state's current and potential AIS.

According to the DNR, the spread of "Eurasian watermilfoil and zebra mussels is much less than it would have been in the absence of a comprehensive program, [sic] Where the support for efforts to inform boaters and other users [of the spread of zebra mussels] was less" the spread was greater in Michigan and Wisconsin compared to Minnesota, particularly during the 1990s (Exotic Species Program, 2002, p. 3). There are more water accesses from which zebra mussels could have spread in those states than in Minnesota. However, Minnesota invested and continues to invest more effort into public awareness and prevention regarding AIS.

Evidence shows that the spread of Eurasian watermilfoil in Minnesota has slowed. Watercraft inspectors report that the frequency of aquatic vegetation observed on boats, motors, and trailers has decreased over the years. This suggests that boaters are responding by removing aquatic plants at the water access or at home before they trailer their watercraft to another waterbody. Higher levels of awareness and increased actions taken by boaters provide further correlative relationships that the investment in AIS outreach is providing benefits by successfully preventing or slowing the spread of AIS across the state. Access checks by watercraft inspectors in 1999 revealed that an average of 24% of boats leaving water accesses had aquatic plants attached (Exotic Species Program, 2000). Only 3% carried vegetation as they approached public accesses on infested waters. Results reinforce that boater outreach needs to continue to be integrated with watercraft inspection and enforcement. In 2008, an average of 15% of boats were

found with vegetation (Invasive Species Program, 2009). An average of only 6% of boaters entering water accesses on infested waters were found with plants attached.

The DNR concluded that a majority of boaters using infested waterbodies were inspecting and removing aquatic plants from their boats, motors, and trailers. Road check violation rates for transport of aquatic plants were 20%. Comparing boaters using infested water (6%) to boaters from road checks (20%), the DNR further concluded that boaters are making better efforts to inspect and remove aquatic plants. Where authority exists, water access inspections and road checks are invaluable as outreach and enforcement regimes for interdicting the spread of AIS.

Two invasive fish in the Duluth-Superior Harbor, the Eurasian ruffe, found in 1986, and round goby, found in 1995, are frequently caught by anglers, but neither fish have spread inland. As noted previously, awareness concerning the Eurasian ruffe and round goby was low in the 2000 statewide survey due to dilution factors of other areas not being targeted or aware. However, conversations by the author with anglers at dozens of boat shows and other events over nearly 17 years suggests anecdotally that awareness in the Duluth-Superior area is high. Anglers report frequently catching these invasive fish and doing their part to prevent the spread. As an outcome, neither ruffe nor goby have spread from the harbor to inland lakes or adjacent watersheds.

Conservation leaders agree that AIS outreach is working. An open letter by Douglas H. Grann, President and CEO of Wildlife Forever, one of the largest conservation organizations in the U.S., emphasizes growing consensus:

Many have asked, does [AIS outreach] work? and how do you know? We know we are making a difference by the low infestation rates that are being reported in

Iowa, Minnesota, and Wisconsin. More than ever, anglers and boaters are cleaning and draining their boats, dumping bait in garbage cans, and teaching the next generation to do the same. (2009)

Establishment of a comprehensive program emphasizing outreach, watercraft inspection, monitoring, policy and enforcement has been shown to be effective. Evidence, corroborated by observations of watercraft inspectors and through this study, suggests that enforcement of laws prohibiting transport of all aquatic plants, prohibited species, and contaminated boats and water have been successful in interrupting the pathways for AIS spread.

#### Responding to the Challenges : Recommendations for Future AIS Outreach

Effective AIS management will need to focus more on preventive strategies than reactive strategies in order to be sustainable. As we continue to move into this millennium, environmental education challenges identified in Chapter 4 will need to be addressed.

Three models lend themselves well to help improve AIS outreach. Paivio's (1986) dual coding theory could be used to test a compliant versus a non-compliant demographic. One way to target apathy and complacency is to target the non-compliant demographic with messages and images of people whom they relate to taking action, then measure any influence on attitudes and beliefs that could trigger compliance.

Witte's (1992) extended parallel process model (EPPM) can provide information on appeals based on perceived susceptibility and severity of the threat. If AIS are perceived to be irrelevant, measurements could help improve efforts to frame AIS as a relevant issue to recreationists.



Ajzen's (1985) theory of planned behavior is an empirical model that conceptualizes attributes of beliefs (consequences), attitudes, motivations (intrinsic/extrinsic) to comply, norms, and self-efficacy to predict human behavior.

CBSM offers a framework to create effective AIS communication and education (McKenzie-Mohr & Smith, 1999). It does this by uncovering barriers and benefits, using forms of commitment that tap into motivations, using approaches to develop personal and social norms, and using prompts as reminder tools to influence desired behavior by recreationists. Last, heuristic models (Kahneman, Tversky, & Slovic (1982) offers an opportunity to study how AIS communications could be used to short-circuit behavior to elicit compliance.

Applying such conceptual models in AIS outreach shows promise in validating their use as tools to help design more effective and efficient AIS outreach programs by revealing how people think, how they think about susceptibility and severity, and what people are thinking and what they think they know.

Successes of AIS outreach offer environmental education an opportunity to connect with recreational audiences that rely on water resources- fostering a strong connection between them, individual behavior, conservation ethics, and stewardship. Promoting use of science and technology is essential in promoting environmental stewardship and protection. This author suggests avoiding the use of technology or chemicals by embodying a sense of personal responsibility and action.

Like environmental education, AIS outreach will need to respond to the challenge of changing demographics embracing and remaining sensitive to language, ethnicity, cultural values, religious practices, current attitudes and beliefs, to convey pro-

environmental stewardship and conservation. Constructivist approaches to teaching can help improve the public's understanding of AIS and the relevancy of the issues. To engage more recreationist (including youth), integrating AIS outreach into formal, non-formal, and free-choice learning opportunities is appropriate in places such as at zoos, aquaria, and environmental learning centers through displays and programs.

Effective management of AIS requires understanding the potential spread of AIS by recreationists. Evidence provided through this study demonstrates that AIS outreach can be effective and efficient at raising awareness and changing behavior of recreational boaters. Other recreationists such as waterfowl hunters, scuba divers, seaplane operators, fishing guides, and fishing tournament participants represent audience segments for which little is understood concerning their attitudes and behavioral compliance. These audiences require further emphasis in outreach and evaluation to design effective programs aimed at preventing the spread of AIS.

Specific recommendations to help improve AIS outreach are highlighted below:

1. Prioritize pathways (audiences) posing greatest risks with AIS outreach.
2. Support policies aimed at interrupting those pathways including watercraft inspection and enforcement.
3. Integrate AIS monitoring into existing volunteer water quality monitoring.
4. Continue to evaluate the efficacy of AIS communication and education strategies and methods to reach boaters and other audiences to understand where and how AIS outreach reaches them.

5. Increase or augment use of signs at water accesses and marinas to reach recreational water users, including information about whether that waterbody is infested, what actions are needed, and regulations that may apply.
6. Use mass media (newspapers, magazines, television, radio, e-news), signs at water accesses, and information in regulation pamphlets. Because mass media are primary sources of information for boaters, strong consideration should be given to paid media spots, especially around fishing opener, Memorial Day, Fourth of July, and Labor Day- all times when thousands of boaters and anglers are out on the water. (Many agencies including the Minnesota DNR have done this for several years.) With a focus on paid spots, public service audio and video announcements are still distributed by the DNR to smaller markets where they are broadcast in those communities.
7. Establish new and strengthen existing relationships with reporters to ensure that consistent and accurate research-based information about AIS is covered in television, newspapers, radio, magazines, and e-news- as these are trusted sources of information to boaters and likely other recreationists.
8. Use existing and design new advertising media to communicate AIS awareness to target audiences such as traveler information systems (TISs) to broadcast AM radio aimed at resident and non-residents along major interstate highways.
9. Experiment and evaluate new approaches or methods based on human dimensions research and advances in environmental education or communication technology such as Websites and social networking e-media (e.g., email, RSS feeds, Twitter, Facebook).

10. Use other effective educational print media including brochures, windshield flyers, stickers, and species-specific fact sheets, digital media including CDs, DVDs, and video.
11. Distribute AIS WATCH identification cards, and field guides.
12. Use direct mail AIS educational information to registered boaters, marinas and boat slip renters, lakeshore property owners and their associations, resorts and motels, and fish tournament organizers and entrants.
13. Develop and build capacity for community-based AIS campaigns that target highways serving as potential transportation corridors for AIS among resident and non-resident boaters and anglers.
14. Support watercraft inspection to convey threats and demonstrate to boaters how to inspect and remove plants, animals and mud from watercraft, motors and trailers so that next time they have the knowledge and skills necessary to prevent the spread of AIS before they launch or leave a water access.
15. Use boat wash stations as educational tools in conjunction with an educational program or campaign, especially at outdoor events, fishing tournaments, water festivals and sport shows- not as stand-alone prevention efforts.
16. Ensure that AIS communication and education targets small powerboat owners since they are a major segment of the recreational boating public.
17. Broaden and extend AIS outreach to small and large fishing tournaments by encouraging hosts to join in outreach efforts by distributing information in registration packets or pledge cards.

18. Conduct further research into the social dimensions of AIS prevention behaviors to gain deeper understanding of intrinsic (e.g., personal norms) and extrinsic motivations (e.g., regulations, fines) based on values, beliefs, and attitudes. (Example: does knowing that a waterbody is infested increase vigilance by encouraging boaters to take action?)
19. Collaborate with agencies, academia, tribes, non-governmental organizations, business, industry, and communities to build capacity to deal with AIS at state and community levels.
20. Use voluntary guidelines recommended above based on those by the Recreational Activities Committee of the ANS Task Force.
21. Provide best sources of information that identify where infestations are located.
22. Emphasize compliance with laws and regulations or ordinances.
23. Apply and adapt approaches used in AIS outreach to other target audiences, as well as other conservation education efforts, and emphasize evaluation.
24. Apply the model survey instrument to establish baseline information or progress toward of AIS outreach in order to meet statewide goals to prevent, contain, and mitigate the impacts of AIS.
25. Collaborate to build relationships, pool resources, focus on priority issues, avoid duplication of effort, and save time and effort.

#### Limitations of the Study

A limitation of the study was the attempt to identify risk for spread of AIS based on boat type. Unexpectedly, many boaters own multiple watercraft. Due to the low numbers of single watercraft owners, results did not produce meaningful comparisons

between boat types concerning risk for spread. Gathering information about the watercraft that they used most might be an approach that could generate more robust insights into the risks of watercraft use based on boat type.

Another limitation of this study is that it did not directly empirically validate conceptual models regarding cognition, appeals, predicting behavior, and revealing barriers for fostering and sustaining behavior change. Empirical literature confirms the success of the use of these models by social scientists in being able to test and predict a wide variety of behavior attributes that would provide most robust relationships between audience responses and behavior determinants.

#### Conclusions

Effective management of AIS starts with behavior. This comprehensive study was the first to assess and compare the efficacy of AIS boater outreach programs aimed at behavior intervention in different regions of the U.S. While results showed that boaters pose risks for spreading AIS based on their behaviors, most Minnesota and Vermont boaters took action to prevent the spread. Differences in level of knowledge among states' boaters was dependent upon whether that state made AIS outreach a priority, used the most effective means to reach them, and framed actions as those that would prevent the spread, compared to slow the spread.

Over 94% of boaters were likely willing to take action in the future to prevent the spread of AIS. Boaters reported taking action based on such attitudes as “personal responsibility”, a desire to “keep AIS out of our lakes and streams”, and “prevent damage to my boat and equipment”. Effective AIS outreach taps into motivations, keeps messages simple, concise, and consistent, and stresses why preventing the spread is

important. Communicating consistent messages concerning AIS spread is critical- miscommunication and promoting fallacies confuses the message, fuels public apathy and complacency, and undermines successes in behavior intervention.

Comprehensive programs emphasizing outreach, watercraft inspection, monitoring, policy, and enforcement has been shown to be effective. Evidence suggests that enforcement of laws prohibiting transport of all aquatic plants, harmful species, and contaminated boats and water have been successful in interrupting the pathways for AIS spread. Since attitudes of boaters about lakes and streams seem largely driven by ethics, messages need to continue to strengthen the personal responsibility, emphasize consequences of inaction or improper action, and teach the skills necessary to be “clean boaters.” Successful AIS outreach needs to emphasize embodiment of values, motivations, and self-image to continue to develop environmental stewardship among boaters, anglers and other recreationists. Environmental educators will need to create and adapt pedagogy using stronger behavioral objectives.

These findings will help states, provinces and task forces justify spending for AIS outreach and evaluation. Several states, provinces and task forces are using the model survey instrument developed through this study. This assessment will benefit states surveyed directly and benefit agencies and organizations in other states by providing a tool and best management practices for more effective delivery of AIS outreach.

Understanding the risk of AIS spread by recreational activities is critical to guide future development and maximize management effectiveness. Benefits realized as positive change are increases in awareness and behavior that can protect lakes and rivers. Empirical evidence from this study showed that awareness, knowledge, attitudes, and

behaviors of recreational boaters were positively influenced. While AIS management recognizes that recreational boaters are part of the problem, boaters responded and showed willingness to be part of the solution as good stewards. They also showed evidence that they place value on protecting lakes and rivers, thus they are not necessarily part of the nature-deficit disorder. Recognizing the importance of these results and the shortage of information concerning AIS-related behaviors, social science research filled knowledge gaps from learning and cognition to behavior interventions. Findings place AIS outreach at a new nexus for developing more effective and efficient AIS outreach, management, and policy.



## REFERENCES

- Abroms, L., & Maibach, E. (2008) The effectiveness of mass communication to change public behavior. *Annual Review of Public Health*, 29 (16), 1-16.
- Ajzen, I. (1985). From intentions to actions: A theory of planned behavior. In J. Kuhl, & J. Beckman, J. (Eds.), *Action-control from cognition to behavior*. Heidelberg: Springer.
- Ajzen, I. (1992). Persuasive communication theory in social psychology: A historical perspective. In *Influencing human behavior: Theory and applications in recreation and tourism*. M. J. Manfreda (ed.). Champaign, IL: Sagamore.
- Ajzen, I., & Fishbein, M. (1980). *Understanding attitudes and predicting social behavior*. Englewood Cliffs, NJ: Prentice Hall.
- Altschuld, J. W., & Witkin, B. R. (2000). *From needs assessment to action*. Thousand Oaks: Sage.
- Anderson, K. A., Kelly, T. J., Sushak, R. M., Hagley, C. A., Jensen, D. A., & Kreag, G. M. (1999). *Public perceptions of the impacts, use and future of Minnesota Lakes: Results of the 1998 Minnesota lakes survey*. A joint publication of the University of Minnesota Sea Grant Program and Minnesota Department of Natural Resources, Office of Management and Budget Services. 31 pp.
- Andreason, A. R. (2003). The life trajectory of social marketing. *Marketing Theory*, 3 (3), 293-303.
- Aquatic Nuisance Species Task Force (ANSTF). (2008). *Aquatic nuisance species impacts*. Retrieved March 21, 2008, from <http://www.anstaskforce.gov/impacts.php>
- Arcury, T. A., Scollay, S. J., & Johnson, T. P. (1987). Sex differences in environmental concern and knowledge: The case of acid rain. *Sex Roles* 16, 463-472.
- Aronson, E., & O'Leary, M. (1982-83). The relative effectiveness of models and prompts on energy conservation: A field experiment in a shower room. *Journal of Environmental Systems*, 12, 219-224.
- Atherton, J. S. (2005). *Learning and teaching: Behaviourism*. Retrieved May 26, 2008, from <http://www.learningandteaching.info/learning/behaviour.htm>
- Atherton, J. S. (2009). *Learning and teaching; angles on learning, particularly after the schooling years*. Accessed February 5, 2010, from [www.learningandteaching.info/learning/](http://www.learningandteaching.info/learning/)

- Baker, P., Baker, S., and Mann, R. (1993). Potential range of the zebra mussel, *Dreissena polymorpha*, in and near Virginia. Virginia Sea Grant Program, Virginia Institute of Marine Science, VSG-93-04.
- Balcom, N., & Rohmer, E. (1994). Zebra mussel awareness and boat use patterns among boaters using three 'high risk' Connecticut lakes. (CT-SG-94-03, 17 pp.). [Bulletin]. University of Connecticut, Cooperative Extension System, Sea Grant Marine Advisory Program, Groton.
- Ballantyne, R. R., & Packard, J. M. (1996). Teaching and learning in environmental education: Developing environmental conceptions. *Journal of Environmental Education*, 27 (2), 25-32.
- Bandura, A. (1982). Self-efficacy mechanism in human agency. *American Psychologist*, 37, 122-147.
- Bandura, A., & Walters, R. H. (1963). *Social learning and personality development*. New York: Holt, Rinehart, & Winston.
- Barrett, D. (2002). The rise of cause-related marketing. Harvard Business School Publishing, 9-302-105. 10 pp.
- Barrow, L. H., & Morrissey, J. T. (1988-89). Energy literacy of ninth-grade students: A comparison between Maine and New Brunswick. *Journal of Environmental Education*, 20, 22-25.
- Bar-Tal, D. (1976). *Prosocial behavior: Theory and research*. New York: Wiley.
- Bar-Tal, D. (1982). Sequential development of helping behavior: A cognitive-learning approach. *Developmental Review*, 2, 101-124.
- Batson, C. D. (1987). Prosocial motivation: Is it ever truly altruistic? *Advances in Experimental Social Psychology*, 20, 65-122.
- Bern, S. L. (1981). Gender schema theory: A cognitive account of sex typing. *Psychological Review*, 88 (4), 354-364.
- Bloom, B. S., & Krathwohl, D. R. (1956). *Taxonomy of educational objectives: The classification of educational goals, by a committee of college and university examiners. Handbook 1: Cognitive domain*. New York: Longmans.
- Blum, A. (1987). Student's knowledge and benefits concerning environmental issues in four countries. *Journal of Environmental Education*, 18, 7-13.
- Booth, E. M. (1996). *Starting with behavior: A participatory process for selecting target behaviors in environmental programs*. Washington, DC: GreenCOM, Academy for Educational Development.

- Braun, A. (1983). *Umwelterziehung zwischen anspruch und wirklichkeit* [Environmental Education between Claim and Reality]. Frankfurt: Haag & Herchen.
- Britton, D. K. (2007). Western quagga mussels. A fact sheet by the U.S. Fish and Wildlife Service, University of Texas Arlington, TX.
- Brookfield, S. D. (1987). *Developing critical thinkers*. San Francisco: Jossey-Bass.
- Brookfield, S. D. (1991). The development of critical reflection in adulthood. *New Education*, 13, 39-48.
- Bossenbroek, J. M., Johnson, L. E., Peters, B., & Lodge, D. M. (2007). Forecasting the expansion of zebra mussels in the United States. *Conservation Biology*, 21 (3), 800-810.
- Bossenbroek, J. M., McNulty, J., & Keller, R. P. (2005). Can ecologists heat up the discussion on invasive species risk? *Risk Analysis*, 25, 1595-1597.
- Browner, C. M. (1995, Spring). Why environmental education? *EPA Journal*, 21 (2), 6-9.
- Buchan, L. A. J. & Padilla, D. K. (2000). Predicting the likelihood of Eurasian watermilfoil presence in lakes, a macrophyte monitoring tool. *Ecological Applications*, 10, 1442-1455.
- Carlton, J. T. (1992). Dispersal of living organisms into aquatic ecosystems as mediated by aquaculture and fisheries activities. In A. Rosenfield & R. Mann (Eds.), *Dispersal of living organisms into aquatic ecosystems* (pp. 13-46). University of Maryland, College Park, Maryland.
- Carlton, J. T., & Geller, J. B. (1993). Ecological roulette- the global transport of nonindigenous marine organisms. *Science*, 261, 78-82.
- Carson, R. (1962). *Silent spring*. Boston: Houghton Mifflin.
- Chawla, L. (1998). Significant life experiences revisited: A review of research on sources of environmental sensitivity. *Environmental Education Research*, 4 (4), 369-382.
- Christensen, N. L., Bartuska, A. M., Brown, J. H., Carpenter, S., D'Antonio, C., Francis, R., Franklin, J. F., MacMahon, J. A., Noss, R. F., Parsons, D. J., Peterson, C. H., Turner, M. G., & Woodmansee, R. G. (1996). The report of the Ecological Society of America committee on the scientific basis for ecosystem management. *Ecological Applications*, 6, 665-691.
- Cialdini, R. B. (2001). *Influence: Science and practice* (4<sup>th</sup> ed.). Boston, MA: Allyn and Bacon.

- Cialdini, R. B., Demaine, L. J., Sagarin, B. J., Barrett, D. W., Rhodes, K., & Winter, P. L. (2006). Managing social norms for persuasive impact. *Social Influence*, 1 (1), 3-15.
- Cialdini, R. B., & Goldstein, N. J. (2004). Social influence: Compliance and conformity. *Annual Review of Psychology*, 55, 591-621.
- Cialdini, R. B., & Trost, M. R. (1998). Social influence: Social norms, conformity, and compliance. In G. Lindzey & E. Aronson (Eds.), *The Handbook of Social Psychology* Volume 2 (pp. 151-192). New York: Random House.
- Ciruna, K. A., Meyerson, L. A., & Gutierrez, A. (2004). The ecological and socio-economic impacts of invasive alien species in inland water ecosystems. Report to the Conservation on Biological Diversity on Behalf of the Global Invasive Species Programme, Washington, D.C. (34 pp.)
- Claudi, R., & Leach, J. (Eds.). (1999). *Nonindigenous freshwater organisms: Vectors, biology and impacts*. CRC Press, Lewis Publishers.
- Colaizzi, A., Williams, K. J., & Vincent, J. E. (1984). When will people help? The effects of gender, urgency, and location on altruism. *Psychological Reports*, 55, 139-142.
- Corcoran, P. B. (1999). Formative influences in the lives of environmental educators in the United States. *Environmental Education Research*, 5 (2), 207-220.
- Cranton, P. (1994). *Understanding and promoting transformative learning: A guide for educators of adults*. San Francisco: Jossey-Bass, Wiley.
- Cross, S. E., & Madson, L. (1997). Models of the self: self-construals and gender. *Psychological Bulletin*, 122, 5-37.
- Czarapata, E. J. (2005). *Invasive plants of the Upper Midwest: An illustrated guide to their identification and control*. University of Wisconsin Press.
- Dawes, R. M. (1980). Social dilemmas. *International Journal of Psychology*, 35 (2), 111-116.
- Day, B. A., & Monroe, M. C. (Eds.). (2000). *Environmental & education communication for a sustainable world: Handbook for international practitioners*. Washington, DC: GreenCOM, Academy for Educational Development.
- Decker, D. J., Brown, T. L., & Mattfeld, G. F. (1987). Integrating social science into wildlife management. In L. Miller, R. P. Gale, & P. J. Brown (Eds.), *Social science in natural resource management systems* (pp. 83-92). Boulder, CO: Westview Press.

- Decker, D. J., Brown, T. L. & Siemer, W. F. (2001). Evolution of people-wildlife relations. In D. J. Decker, T. L., Brown & W.F. Siemer (Eds.), *Human dimensions of wildlife management in North America* (pp. 2-22). Bethesda, MD: The Wildlife Society.
- Dietz, T., Ostrom, E., & Stern, P. C. (2003). The struggle to govern the commons. *Science*, 302, 1907-1912.
- Dietz, T., Stern, P. C., & Guagnano, G. A. (1998). Social structures and social psychological bases of environmental concern. *Environment and Behavior*, 30, 450-471.
- Dillman, D.A. (1978). *Mail and telephone surveys*. New York: Wiley.
- Dillman, D.A. (2000). *Mail and internet surveys: The tailored design method* (2<sup>nd</sup> Ed.). New York: Wiley.
- Dolinski, D., Nawrat, M., & Rudak, I. (2001). Dialogue involvement as a social influence technique. *Personality and Social Psychology Bulletin*, 27, 1395-1406.
- Doll, B. 1993. Mid-Atlantic zebra mussel fact sheet. University of North Carolina Sea Grant, North Carolina State University.
- Drake, J. M., & Bossenbroek, J. M. (2004). The potential distribution of zebra mussel in the United States. *BioScience*, 54, 931-941.
- Drake, J. M., Baggenstos, P., & Lodge, D. M. (2005). Propagule pressure and persistence in experimental populations. *Biology Letters*, 1, 480-483.
- Drake, J. M., & Jerde, C. L. (2009). Stochastic models of propagule pressure and establishment. In R. P. Keller, D. M. Lodge, M. A. Lewis, & J. F. Shogren (Eds.), *Bioeconomics of invasive species: integrating ecology, economics, policy and management* (pp. 83-102). New York: Oxford Press.
- Dunlap, R. E., & Mertig, A. G. (1992). The evolution of the U.S. environmental movement from 1970 to 1990: An overview. In R. E. Dunlap & A. G. Mertig (Eds.), *American environmentalism: The U.S. environmental movement, 1970-1990* (pp. 1-10). New York: Taylor & Francis.
- Dunlap, R. E., & Van Liere, K. (1978). The new environmental paradigm: A proposed measuring instrument and preliminary results. *Journal of Environmental Education*, 9, 10-19.
- Dweck, C. (1999). *Self-theories: Their role in motivation, personality and development*. Philadelphia: Psychology Press.
- Eagley, A. H. (1987). Reporting sex differences. *American Psychologist*, 47 (2), 756-757.

- Eagley, A. H., & Crowley, M. (1986). Gender and helping behavior: A meta-analytic view of the social psychological literature. *Psychological Bulletin*, 100, 283-308.
- Ehrlich, P. R. (2002). Human natures, nature conservation, and environmental ethics. *Bioscience*, 52, 31-43.
- Engleson, D. C., & Yockers, D. H. (1994). A guide to curriculum planning in environmental education. Madison: Wisconsin Department of Public Instruction.
- Exotic Species Programs. (1993). Ecologically harmful exotic aquatic and wild animal species in Minnesota: Annual report for 1993. p. 18. St. Paul: Minnesota Department of Natural Resources.
- Exotic Species Programs. (1995). Ecologically harmful exotic aquatic and wild animal species in Minnesota: Annual report for 1995. p. 22-23. St. Paul: Minnesota Department of Natural Resources.
- Exotic Species Program. (1996). Harmful exotic species of aquatic plants and wild animals in Minnesota: Annual report for 1996. p. 23. St. Paul: Minnesota Department of Natural Resources.
- Exotic Species Program. (2000). Harmful exotic species of aquatic plants and wild animals in Minnesota: Annual report for 2000. p. 47. St. Paul: Minnesota Department of Natural Resources.
- Exotic Species Program. (2002). Harmful exotic species of aquatic plants and wild animals in Minnesota: Annual report for 2001. p. 32-33. St. Paul: Minnesota Department of Natural Resources.
- Exotic Species Program. (2003). Harmful exotic species of aquatic plants and wild animals: Annual report for 2002 summary, p. 3. St. Paul: Minnesota Department of Natural Resources.
- Federal Register. (2000). Voluntary guidelines on recreational activities to control the spread of zebra mussels and other aquatic nuisance species, 65 (250), 82447-82451. Department of Transportation, Coast Guard. USCG-2000-7206.
- Finger, M. (1994). From knowledge to action? Exploring relationships between environmental experiences, learning, and behavior. *Journal of Social Issues*, 50 (3), 141-160.
- Fishbein, M., & Ajzen, I. (1975). Belief, attitude, intention and behavior: An introduction to the theory and research. United States: Addison-Wesley.

- Fishbein, M., & Ajzen, I. (1981). Acceptance, yielding, and impact: Cognitive processes in persuasion. In R. E. Petty, T. M. Ostrom, & T. C. Brock (Eds.), *Cognitive processes in persuasion* (pp. 339-359). Hillsdale, NJ: Erlbaum.
- Fishbein, M., & Yzer, M. C. (2003). Using theory to design effective health behavior interventions. *Communication Theory*, 13 (2), 164-183.
- Fisher, J. D., Bell, P. A., & Baum, A. (1984). *Environmental psychology* (2<sup>nd</sup> ed.). New York: Holt, Rinehart, & Winston.
- Gagne, R. M. (1972). Domains of learning. *Interchange*, 3 (1), 1-8.
- Geller, J. M., & Lasley, P. (1985). The new environmental paradigm scale: A reexamination. *Journal of Environmental Education*, 17, 9-12.
- Geller, E. S, Winett, R. A., & Everett, P. B. (1982). *Preserving the environment*. New York: Pergamon.
- Gentile, M., Naughton, A. M., & Kayson, W. A. (1986). Factors affecting altruism: Sex, urgency, and time of day. *Psychological Reports*, 59, 79-82.
- Gigliotti, L. M. (1990). Environmental education: What went wrong? What can be done? *Journal of Environmental Education*, 21 (1), 27-34.
- Gladwell, M. (2005). *Blink: The power of thinking without thinking*. New York: Little, Brown & Co.
- Good, T. L., & Brophy, J. E. (1990). *Educational psychology: A realistic approach* (4 Ed.). White Plains, NY: Longman.
- Gould, C. (2007). AP chronicles changes to boating in Minnesota. Accessed April 15, 2010 from, <http://newsgroups.derkeiler.com/Archive/Rec/rec.boats/2007-09/msg02631.html>
- Gould, C. R. (2008). An open letter to Idaho boat dealers from Celia R. Gould, Director, Idaho Department of Agriculture. November 21, 2008.
- Government Accountability Office (formerly General Accounting Office). (2002). *Invasive species: Clearer focus and greater commitment needed to effectively manage the problem*. Report GAO-03-1.
- Grann, D. (2008). An open letter to AIS outreach partners from Douglas H. Grann, President and CEO, Wildlife Forever. February 2, 2009.

- Great Lakes Aquatic Nuisance Species Information System (GLANSIS). (2009). Retrieved December 30, 2009, from <http://www.glerl.noaa.gov/res/Programs/ncrais/glansis.html>
- Great Lakes Commission (GLC). (2007). Great Lakes aquatic invasions - aquatic invasive species prevention and control: Outreach, research, management and policy. Ann Arbor, MI.
- Great Lakes Panel on ANS (GLP). (1996). Panel releases ANS research guidance and inventory. News from the Great Lakes Panel on ANS, ANS Update Newsletter, 2 (4), 2 pp.
- Great Lakes Panel on ANS (GLP). (1997, July). Guidelines for boaters to avoid spreading aquatic nuisance species. Great Lakes Commission, Ann Arbor, MI.
- Great Lakes Panel on ANS (GLP). (1999). National voluntary ANS guidelines: A strategy to interrupt recreational pathways of spread. News from the Great Lakes Panel on ANS, ANS Update Newsletter, 5 (3), 2 pp.
- Great Lakes Panel on ANS (GLP). (2004 draft). Information/Education Strategy & Implementation Plan. Great Lakes Commission, Ann Arbor, MI.
- Great Lakes Regional Collaboration (GLRC). (2005). Strategy to restore and protect the Great Lakes. Retrieved October, 31, 2009, from [http://www.glrc.us/documents/strategy/GLRC\\_Strategy.pdf](http://www.glrc.us/documents/strategy/GLRC_Strategy.pdf)
- Grist Environmental News and Commentary. (2008). How to diversify environmentalism? The movement's greatest challenge is its own lack of diversity. Guest essay by M. Bonta. Retrieved January 4, 2008, from <http://gristmill.grist.Org/story/2008/1/2/82747/54759>
- Gunderson, J.L. (1994a). Exotic species and freshwater boating survey: Results and technical report. 28 pp. Duluth: University of Minnesota Sea Grant College Program.
- Gunderson, J.L. (1994b). Three-state exotic species boater survey: What do boaters know and do they care? 3 pp. Duluth: University of Minnesota Sea Grant College Program. Retrieved September 29, 2003, from <http://www.seagrant.umn.edu/exotics/boat.html>
- Habermas, J. (1971). Knowledge and human interests. Boston: Beacon Press.
- Hardin, G. (1968). The tragedy of the commons. *Science*, 162, 1243-1248.
- Havel, J. E., & Hebert, P. D. N. (1993). *Daphnia lumholtzi* from North America: Another exotic zooplankter. *Limnology and Oceanography*, 38, 1837-1841.



- Havel, J.E., & Stelzleni-Schwent, J. (2000). Zooplankton community structure: The role of dispersal. *Verhandlungen des Internationalen Verein Limnologie*, 27, 3264-3268.
- Hebert, P. D. N., Muncaster, B. W., & Mackie, G. L. (1989). Ecological and genetic studies on *Dreissena polymorpha* (Pallas) - A new mollusk in the Great Lakes. *Canadian Journal of Fisheries and Aquatic Sciences*, 46, 1587-1591
- Henning, B., Barrett, M., & Martin, A. A. (1997). Zebra mussel awareness survey. 23 pp. [Bulletin] Louisiana Sea Grant College Program, Louisiana State University, Baton Rouge.
- Hines, J., Hungerford, H., & Tomera, A. (1986-87). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education*, 18 (2), 1-8.
- Hockett, K. S., McClafferty, J. A., & McMullin, S. L. (2005). The making of a resource steward: Defining the relationship between aquatic recreation and aquatic stewardship. A report for the Recreational Boating and Fishing Foundation, Alexandria, VA.
- Holling, C. S. (1995). What barriers? What bridges? In L. H. Gunderson, C. S. Holling, & S. S. Light (Eds.), *Barriers and bridges to the renewal of ecosystems and institutions* (pp. 3-34). New York: Columbia University.
- Hornik, R., & Woolf, K. D. (1999). Using cross-sectional surveys to plan message strategies. *Social Marketing Quarterly*, 5, 34-41.
- Howarth, E. (1976). Personality characteristics of volunteers. *Psychological Reports*, 32, 855-858.
- Howe, R., & Disinger, J. F. (1991). Environmental education research news. *The Environmentalist*, 11 (1), 5-8.
- Hudson, L. (1967). *Contrary imaginations: A psychological study of the English schoolboy*. Harmondsworth, UK: Penguin.
- Hungerford, H. R., & Volk, T. L. (1990). Changing environmental behavior through environmental education. *Journal of Environmental Education*, 21 (3), 8-21.
- Invasive Species Program. (2009). *Invasive species of aquatic plants and wild animals in Minnesota: Annual report of 2008*. St. Paul: Minnesota Department of Natural Resources.
- Iozzi, L. A. (1989). What research says to the educator. Part one: Environmental education and the affective domain. *Journal of Environmental Education*, 20 (3), 3-9.

- Jencks, C. (1990). Varieties of altruism. In J. J. Mansbridge (Ed.), *Beyond self interest*, 53-67. Chicago: University of Chicago Press.
- Jensen, D. A. (2006). Boat wash stations: just a leaky sieve? Presentation at Zebra Mussels and Other Alien Invaders, Galway, Ireland. Retrieved August 31, 2008, from <http://www.galway.ie/en/Services/Environment/AlienSpecies/BrochuresMapsDownloads/TheFile,4309,en.pdf>
- Jensen, D.A. (2009). Are billboards an effective communication medium to Stop Aquatic Hitchhikers! University of Minnesota Sea Grant Program, Duluth, Minnesota.
- Johnson, B. L. (1999). Introduction to the special feature: Adaptive management-scientifically sound, socially challenged? *Conservation Biology*, 3(1), 10.
- Johnson, L. E., & Carlton, J. T. (1993). Counter-productive public information: The “Noah Fallacy” and mussel myths. *Dreissena polymorpha Information Review*, 3 (3), 2-4.
- Johnson, L. E., & Padilla, D. K. (1996). Geographic spread of exotic species: Ecological lessons and opportunities from the invasion of the zebra mussel *Dreissena polymorpha*. *Conservation Biology*, 78, 23-33.
- Johnson, L. E., Ricciardi, A., & Carlton, J. T. (2001). Overland dispersal of aquatic invasive species: A risk assessment of transient recreational boating. *Ecological Applications*, 77, 1789-1799.
- Johnstone, I. M., Coffey, B. T., & Howard-Williams, C. (1985). The role of recreational boat traffic in interlake dispersal of macrophytes: A New Zealand case study. *Journal of Environmental Management*, 20, 263-279.
- Kahneman, D., Tversky, A., & Slovic, P. (1982). *Judgment under uncertainty: Heuristics and biases*. New York: Cambridge University Press.
- Keller, R. P., & Lodge, D. M. (2007). Species invasions from commerce in live aquatic organisms: Problems and possible solutions. *BioScience*, 57, 428-436.
- Kellert, S. R. (1996). *The value of life: Biological diversity and human society*. Washington, DC: Island Press.
- Kelly, D. (1988). *The art of reasoning*. New York: W. W. Norton.
- Kirk, M., Wilke, R., & Rusky, A. (1997). A survey of the status of state level environmental education in the United States. *Journal of Environmental Education*, 29, 9-16.
- Klessig, L. (1994). Load limits for lakes. *Lake and Reservoir Management*, 10, 1, 69-73.

- Klinger, E., & Cox, W. M. (2004). Motivation and the theory of current concerns. In W. M. Cox & E. Klinger (Eds.), *Handbook of motivational counseling* (pp. 3-27). New York: Wiley.
- Klinger, G. (1980). The effect of an instructional sequence on the environmental action skills of a sample of Southern Illinois eighth graders. Unpublished master's research. Southern Illinois University at Carbondale.
- Knowles, M.S. (1990). *The adult learner: A neglected species* (4<sup>th</sup> Ed.). Houston: Gulf.
- Kolar, C. S., & Lodge, D. M. (2002). Ecological predictions and risk assessment for alien fishes in North America. *Science*, 298 (5596), 1233-1236.
- Kotler, P., & Zaltman, G. (1971). Social marketing, an approach to planned social change. *Journal of Marketing*, 35, 3-12.
- Kovarik, W. (2001). Environmental history timeline. Retrieved September 17, 2005, from <http://www.radford.edu/~wkovarik/envhist/>
- Kraft, C. E., Sullivan, P. J., Karatayev, A. Y., Burlakova, L. E., Nekola, J. C., Johnson, L. E., & Padilla, D. K. (2002). Landscape patterns of an aquatic invader: Assessing dispersal extent from spatial distributions. *Ecological Applications*, 12 (3), 749-759.
- Krebs, D. (1982). Psychological approaches to altruism: An evaluation. *Ethics*, 92 (3), 447-458.
- Krueger, C. C., & Decker, D. J. (1999). The process of fisheries management. In C. C. Kohler & W. A. Hubert (Eds.), *Inland fisheries management in North America* (2<sup>nd</sup> Ed.) (pp. 31-59). Bethesda: American Fisheries Society.
- Lackey, B., & Ham, S. H. (2003). Assessment of communication focused on human-black bear conflict at Yosemite National Park. *Journal of Interpretation Research*, 8 (1), 25-40.
- Lalonde, R., & Jackson, E. L. (2002). The new environmental paradigm scale: Has it outlived its usefulness? *Journal of Environmental Education*, 33, 28-36.
- Laurillard, D. M. (1993). *Rethinking university teaching: A framework for the effective use of educational technology*. London: Routledge.
- Lee, K. N. (1999). Appraising adaptive management. *Conservation Ecology*, 3 (2), 3. Retrieved August 4, 2008, from [www.consecol.org/vol3/iss2/art3](http://www.consecol.org/vol3/iss2/art3)
- Leung, B., Bossenbroek, J. M., & Lodge, D. M. (2006). Boats, pathways, and aquatic biological invasions: Estimating dispersal potential with gravity models. *Biological Invasions*, 8, 241-254.

- Leung, B., Drake, J. M., & Lodge, D. M. (2004). Predicting invasions: Propagule pressure and the gravity of Allee effects. *Ecology*, 85, 1651-1660.
- Leung, B., Lodge, D. M., Finnoff, D., Shogren, J. F., Lewis, M. A., & Lamberti, G. (2002). An ounce of prevention or a pound of cure: Bioeconomic risk analysis of invasive species. *Proceedings of the Royal Society of London Series B Biological Sciences*, 269, 2407-2413.
- Leung, B., & Mandrak, N. E. (2007). The risk of establishment of aquatic invasive species: Joining invisibility and propagule pressure. *Proceedings of the Royal Society of London Series B Biological Sciences*, 274, 2603-2609.
- Lodge, D. M., Lewis, M. A., Shogren, J. F., & Keller, R. P. (2009). Introduction to biological invasions: biological, economic and social perspectives. In R. P. Keller, D. M. Lodge, M. A. Lewis, & J. F. Shogren (Eds.), *Bioeconomics of invasive species: integrating ecology, economics, policy and management* (p. 10.). New York: Oxford Press.
- Lodge, D. M., & Shrader-Frechette, K. (2003). Nonindigenous species: Ecological explanation, environmental ethics, and public policy. *Conservation Biology*, 17 (1), 31-37.
- Lodge, D. M., Williams, S., MacIsaac, H. J., Hayes, K. R., Leung, B., Reichard, S., Mack, R. N., Moyle, P. B., Smith, M., Andow, D. A., Carlton, J. T., & McMichael, A. (2006). Biological invasions: Recommendations for U.S. policy and management. *Ecological Applications*, 16, 2035-2054.
- Louv, R. (2006). *Last child in the woods: Saving our children from nature-deficit disorder*. Chapel Hill: Algonquin Books.
- MacIsaac, H., Borbely, J., Muirhead, J., & Graniero, P. (2004). Backcasting and forecasting biological invasions of inland lakes. *Ecological Applications*, 14, 773-783.
- Mack, R. N., Simberloff, D., Lonsdale, W. M., Evans, H., Clout, M., & Bazzaz, F. (2000). Biotic invasions: Causes, epidemiology, global consequences and control. *Issues in Ecology* (5), Ecological Society of America.
- Maibach, E., Abrams, L., & Marosits, M. (2007). Communication and marketing as tools to cultivate the public's health: A proposed 'people and places' framework. *BMC Public Health*, 7 (1), 88.
- Marangelo, P., Carlton, J., & Johnson, L. (1994). The spread of zebra mussels to inland waters: Advances and lessons from Michigan. [Abstract]. Fourth International Zebra Mussel Conference (March 7-10, 1994). Madison: University of Wisconsin Sea Grant Institute.

- Marion, J. L., & Reid, S. E. (2007). Minimizing visitor impacts to protect areas: The efficacy of low impact education programmes. *Journal of Sustainable Tourism*, 15 (1), 5-27.
- May, B., & Marsden, J. (1992). Genetic identification and implications of another invasive species of dreissenid mussel in the Great Lakes. *Canadian Journal of Fisheries and Aquatic Science*, 49, 1501-1506.
- McAusland, C., & Costello, C. (2004). Avoiding invasives: trade-related policies for controlling unintentional exotic species introductions. *Journal of Environmental Economics and Management* 48: 954-977.
- McKenzie-Mohr, D., & Smith, W. (1999). *Fostering sustainable behavior: An introduction to community-based social marketing*. Gabriola Island, B.C., Canada: New Society.
- McNeely, J. A. (2004). Nature vs. nurture: Managing relationships between forests, agroforestry and wild biodiversity. *Agroforestry Systems*, 61, 155-165.
- Mezirow, J. (1991). *Transformative dimension of adult learning*. San Francisco: Jossey-Bass.
- Milgram, S. (1963). Behavioral study of obedience. *Journal of Abnormal and Social Psychology*, 64 (4), 371-378.
- Milgram, S. (1964). Behavior study: Group pressure and action against a person. *Journal of Abnormal and Social Psychology*, 69, (2), 137-143.
- Mills, E. L., Leach, J. H., Carlton, J. T., & Secor, C.L. (1993). Exotic species in the Great Lakes: A history of biotic crises and anthropogenic introductions. *Journal of Great Lakes Research*, 19 (1), 1-54.
- Minnesota Department of Natural Resources. (1995, March). Minnesotans are exotics aware. *Focus 10,000: Minnesota's Lakeside Magazine*, 6, p.1.
- Mischel, W. (1968). *Personality and assessment*. New York: Wiley.
- Moore, J. H. (1971). Defining and interpreting ecology. *Journal of Environmental Education*, 25 (4), 30-34.
- Muirhead, J. R. & MacIsaac, H. J. (2005). Development of inland lakes as hubs in an invasion network. *Journal of Applied Ecology*, 42, 80-90.
- Myers, J. H., & Bazely, D. R. (2003). *Ecology and control of introduced plants*. Cambridge University Press.

- National Environmental Education and Training Foundation (NEETF) & Roper Starch Worldwide. (1998). The national report card on environmental knowledge, attitudes, and behaviors. Washington, DC.
- National Invasive Species Act (NISA). (1996). P.L. 104-332.
- National Invasive Species Council. (2001). Management plan: Meeting the invasive species challenge. Retrieved September 29, 2003, from <http://www.invasivespecies.gov/council/nmp.shtml>
- National Invasive Species Council. (2005). Five-year review of Executive Order 13112 on invasive species. Retrieved October 31, 2009, from <http://www.invasivespeciesinfo.gov/council/nmp.shtml>
- National Marine Manufacturers Association (NMMA). (2000). Boating 2000 facts and figures at a glance. Retrieved May 1, 2005, from <http://www.nmma.org/facts/archive/boatingstats/2000stats/registrations.html>
- National Oceanic and Atmospheric Administration (NOAA). (2009). Education strategic plan 2009-2029. Retrieved March 10, 2009, from [http://www.education.noaa.gov/plan/09\\_NOAA\\_Educ\\_Strategic\\_Plan\\_Color.pdf](http://www.education.noaa.gov/plan/09_NOAA_Educ_Strategic_Plan_Color.pdf)
- Nico, L.G., & Fuller, P.L. (1999). Spatial and temporal patterns of nonindigenous fish introductions in the United States. *Fisheries*, 24 (1), 16-27.
- North American Association of Environmental Education (NAAEE). (2000). Excellence in environmental education - Guidelines for learning (Pre K-12). Retrieved August 5, 2008, from <http://www.naaee.org/npeee/learnerguidelines/intro.pdf>
- Padilla, D. K., Chotkowski, M. A., & Buchan, L. A. J. (1996). Predicting the spread of zebra mussels (*Dreissena polymorpha*) to inland waters using boater movement patterns. *Global Ecology and Biogeography Letters*, 5 (6), 353-359.
- Paivio, A. (1986). *Mental representations: A dual coding approach*. Oxford, England: Oxford University Press.
- Palmer, J. A. (1993). Development of concern for the environment and formative experiences of educators. *Journal of Environmental Education*, 24 (3), 26-30.
- Palmer, J. A., Suggate, J., Bajd, B., Hart, P., Ho, R. K. P., Ofwono-Orecho, J. K. W., Peries, M., Robottom, I., Tsaliki, B., & Van Staden, C. (1998a). An overview of significant influences and formative experiences on the development of adult's environmental awareness in nine countries. *Environmental Education Research*, 4 (4), 445-464.

- Palmer, J. A., Suggate, J., Bajd, B., & Tsaliki, E. (1998b). Significant influences on the development of adult's environmental awareness in the UK, Slovenia, and Greece. *Environmental Education Research*, 44 (4), 429-444.
- Pergrams, O. R., & Zaradic, P. A. (2008). Evidence for fundamental and pervasive shift away from nature-based recreation. *Proceeding of the National Academy of Sciences*, 105 (7), 2295-2300. Retrieved September 27, 2008, from <http://www.pnas.org/cgi/reprint/0709893105v1>
- Perrings, C., Williamson, M., & Dalmazzone, S. (2000). *The economics of biological invasions*. Cheltenham: Edward Elgar.
- Pimentel, D., Lach, L., Zuniga, R., & Morrison, D. (2000, January). Environmental and economic costs of nonindigenous species in the United States. *Bioscience*, 50, 53-65.
- Pimentel, D., Zuniga, R., & Morrison, D. (2005). Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics*, 52, 273-288.
- Ramsey, J. (1979). *Effects of environmental action and environmental case study instruction on the overt environmental behavior of eighth grade students*. Unpublished master's thesis, Southern Illinois University at Carbondale.
- Rand, A. (1967). *The virtue of selfishness*. New York: Signet.
- Reichard, S. (2005). The tragedy of the commons revisited: invasive species. *Frontiers in Ecology and the Environment*, 3, 9-110.
- Robertson, C. L., & Krugly-Smolka, E. (1997). Gaps between advocated practices and teaching realities in Environmental Education. *Environmental Education Research*, 3, 311-325.
- Ricciardi, A., & Rasmussen, J. B. (1998). Predicting the identity and impact of future biological invaders: A priority for aquatic resource management. *Canadian Journal of Fisheries and Aquatic Sciences*, 55, 1759-1765.
- Roebbers, C. M., & Schneider, W. (2004). The impact of misleading questions on eyewitness memory in children and adults. *Applied Cognitive Psychology*, 14 (6), 509-526.
- Roebbers, C. M., Schwarz, S., & Neuman, R. (2005). Social influence and children's event recall and suggestibility. *European Journal of Developmental Psychology*, 2 (1), 47-69.

- Ruiz, G. M., & Carlton, J. T. (2003). Invasion vectors: A conceptual framework for management. In G. M. Ruiz & J. T. Carlton (Eds.). *Invasive species: Vector and management strategies* (pp. 459-504). Washington, DC: Island Press.
- Rushton, J. P. (1982). Altruism and society: A social learning perspective. *Ethics*, 92 (3), 425-446.
- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and extrinsic motivation: Classic definitions and new directions. *Contemporary Educational Psychology*, 25, 54-67.
- Saettler, P. (1990). *The evolution of American educational technology*. Englewood, CO: Libraries Unlimited.
- Schahn, J., & Holzer, E. (1990). Studies of individual environmental concern: The role of knowledge, gender, and background variables. *Environment and Behavior*, 22 (6), 767-786.
- Schneider, D., Ellis, C., & Cummings, K. (1998). The transportation model assessment of the risk to native mussel communities from zebra mussel spread. *Conservation Biology*, 12, 788-800.
- Schroeder, D. A., Penner, L. A., Dovidio, J. F., & Pilavin, J. A. (1995). *The psychology of helping and altruism: Problems and puzzles*. New York: Academic Press.
- Schultz, P. W., & Zelezny, L. C. (1998). Values and proenvironmental behavior: A five-country study. *Journal of Cross-Cultural Psychology*, 29 (4), 540-558.
- Schultz, P. W., & Zelezny, L. C. (2003). Reframing environmental messages to be congruent with American values. *Human Ecology Review*, 10 (2), 126-136.
- Schwartz, S. H. (1994). Are there universal aspects in the structure and contents of human values? *Journal of Social Issues* 50, 19-45.
- Schwarz, S. & Roebbers, C. M. (2006). Age differences in the effects of social influence on children's eyewitness performance and their metacognitive monitoring. *Journal of Experimental Child Psychology*, 94, (3), 229-248.
- Scott, D., & Willits, F. K. (1994). Environmental attitudes and behavior: A Pennsylvania study. *Environment and Behavior*, 26, 239-260.
- Shannon, C. E., & Weaver, W. (1963). *The mathematical theory of communication*. Urbana and Chicago: University of Illinois Press.
- Siemer, W. F., & Knuth, B. A. (2001). Effects of fishing education programs on antecedents of responsible environmental behavior. *Journal of Environmental Education*, 32 (4), 23-29.



- Simberloff, D. (2003). How much information on population biology is needed to manage introduced species? *Conservation Biology*, 17, 83-92.
- Sivek, D. J., & Hungerford, H. R. (1989/1990). Predictors of responsible environmental behavior in members of three Wisconsin conservation organizations. *Journal of Environmental Education*, 21 (2), 35-40.
- Stapp, W. B., Bennett, D., Bryan, W., Jr., Fulton, J., MacGregor, J., Nowak, P., Swan, J., Wall, R., & Havlick, S. (1969). The concept of environmental education. *Journal of Environmental Education*, 1 (1), 30-31.
- Stem, P.C., & Deitz, T. (1994). The value basis of environmental concern. *Journal of Social Issues*, 50, 65-84.
- Stem, P. C., Dietz, T., & Guagnano, G. A. (1995). The new ecological paradigm in social-psychological context. *Environment and Behavior*, 27, 723-743.
- Stem, P.C., & Oskamp, S. (1987). Managing scarce environmental resources. In D. Stokols & I. Altman (Eds.), *Handbook of environmental psychology*, 2, 1043-1088. New York: Wiley.
- Suvedi, M. (1988). Introduction to Program Evaluation. Program Evaluation Measurement Resource. Michigan State University, Department of Agriculture and Extension Education. Retrieved May 2, 2003, from <http://www.ag.ohio-state.edu/~brick/dcc1pg.htm>
- Suvedi, M., Kruger, D., Shreshtha, A., & Bettinghouse, D. (2000). Michigan citizens' knowledge and perceptions about groundwater. *Journal of Environmental Education*, 31 (2), 16-21.
- Takaki, R. (1993). *A different mirror: A history of multicultural America*. New York: Little, Brown & Co.
- Taniguchi, H. (2006). Men's and women's volunteering: Gender differences in the effects of employment and family characteristics. *Nonprofit and Voluntary Sector Quality*, 35 (1), 83-101.
- Tanner, T. (1980). Significant life experiences: A new research area in environmental education. *Journal of Environmental Education*, 11, 20-24.
- Tversky, A., & Kahneman, D. (1973). Availability: A heuristic for judging frequency and probability. *Cognitive Psychology*, 5, 207-232.
- Tyrrell, M., Butler, B., Chawla, P., Singh, R., Feinberg, G., & Langer, J. (2009). Understanding and reaching family forest owners. Web presentation April 16, 2009.

- UNCED. (1992). Agenda 21: Programme of action for sustainable development. Rio Declaration on Environment and Development. New York: United Nations.
- UNESCO. (1977). The Tbilisi declaration. International Conference on Environmental Education: October 14-26,1977. Reprinted in H.R. Hungerford, W. J. Bluhm, T.L. Volk, & J. M. Ramsey (Eds.), Essential readings in environmental education (2<sup>nd</sup> Ed.) (pp. 13-16). Champaign, IL: Stipes Publishing.
- UNESCO. (1997). Educating for a sustainable future: A transdisciplinary vision for concerted action. Report from the International Conference on Environment and Society: Education and Public Awareness for Sustainability, Thessaloniki, December 8-12,1997.
- UNESCO-UNEP. (1976). "The Belgrade Charter." Connect: UNESCO-UNEP Environmental Education Newsletter, 1 (1), pp. 1-2.
- United Nations. (2003). Report on the world summit on sustainable development (Johannesburg, South Africa, 26 August - 4 September 2002). New York: United Nations.
- Unger, L. S. (1991). Altruism as a motivation to volunteer. *Journal of Economic Psychology*, 12, 71-100.
- U.S. Congress, Office of Technology Assessment. (1993, September). Harmful non-indigenous species in the United States. Washington DC: U.S. Government Printing Office, OTA-F-565.
- U.S. Department of the Interior, Fish and Wildlife Service and U.S. Department of Commerce, U.S. Census Bureau. (2001). 2001 National survey of fishing hunting and wildlife-associated recreation (p. 108).
- Van Liere, K. D., & Dunlap, R. E. (1980). The social bases of environmental concern: A review of hypotheses, explanations, and practical evidence. *Public Opinion Quarterly*, 44, 181-197.
- Vilaplana, J. V., & Hushak, L. J. (1994). Recreation and the zebra mussel in Lake Erie, Ohio. Technical Summary. Ohio Sea Grant College Program. Columbus, OH.
- Volk, T., Meyers, R. B., Short, P., Wongsopawiro, D., & Meyers, R. B. (2006) Exploring links between an environmental education program and environmental quality. Presented at The 3rd Annual Research Symposium: Continuing the Dialogue: Moving into the Future. North American Environmental Education, St. Paul, Minnesota, October 9-10, 2006.

- Western Regional Panel on Aquatic Nuisance Species. (2009). Quagga-zebra mussel action plan for western U.S. waters. A report submitted to the Aquatic Nuisance Species Task Force, October 2009. 41 pp.
- Widgren, O. (1998). The new environmental paradigm and personal norms. *Environment and Behavior*, 30, 75-100.
- Wilcove, D. S., Rothstein, D., Dubow, J., Phillips, A., & Losos, E. (1998). Quantifying threats to imperiled species in the United States. *BioScience*, 48, 607-615.
- Williamson, D. (1994). Zebra mussel survey of boaters and inspection of boats summer, 1994, border crossings and other key sites, Manitoba watershed. A report to Manitoba Environment. Winnipeg, Manitoba, Canada. 10 pp.
- Williamson, M., & Fitter, A. (1996). The varying success of invaders. *Ecology*, 77 (6), 1661-1666.
- Windle, P. N., & Chavarria, G. (2005). The tragedy of the commons revisited: Invasive species. *Frontiers in Ecology and the Environment*, 3, 115-116.
- Witte, K. (1992). Putting the fear back into fear appeals: The extended parallel process model. *Communication Monographs*, 59 (4), 329-349.
- Witte, K., & Allen, M. (2000). A meta-analysis of fear appeals: Implications for effective public health campaigns. *Health Education and Behavior*, 27 (5), 591-615.
- Worster, D. (1994). *Nature's Economy: A history of ecological ideas* (2<sup>nd</sup> Ed.). New York: Cambridge University Press.
- Yamagishi, T. (1994). Social dilemmas. In K. S. Cook, G. A. Fine, & J. House (Eds.), *Social perspectives on social psychology* (pp. 311-334). Boston: Allyn & Bacon.
- Zook, B., & Phillips, S. (2009a). Recommended protocols and standards for watercraft interception programs for dreissenid mussels in the western United States. A report prepared by the Pacific States Marine Fisheries Commission for the Western Regional Panel of the Aquatic Nuisance Species Task Force. June 30, 2009. 45 pp.
- Zook, B., & Phillips, S. (2009b, draft). A survey of watercraft interception programs for dreissenid mussels in the Western United States. A report produced for the Western Regional Panel of the National Aquatic Nuisance Species Task Force and the Western State Boating Law Administrators Association. July 30, 2009. 73 pp.

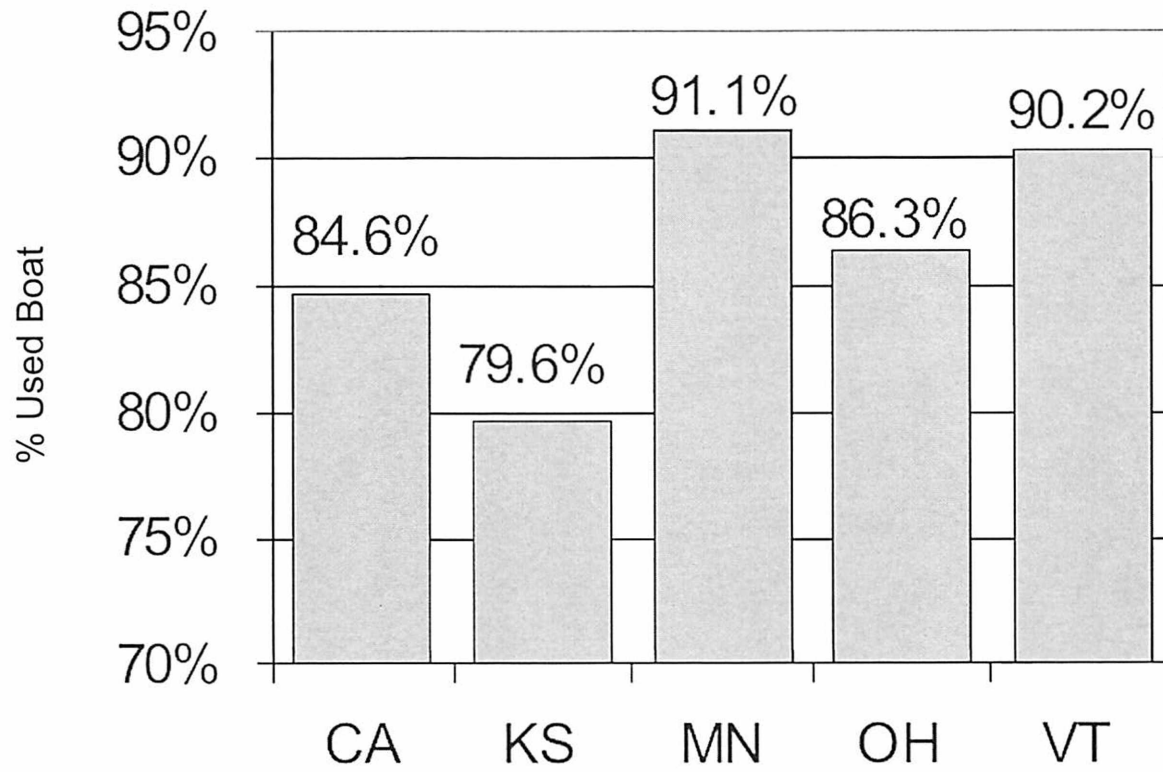


Figure 1. Percent of respondents who used a boat during the 2000 boating season in the five states surveyed.

FIGURES

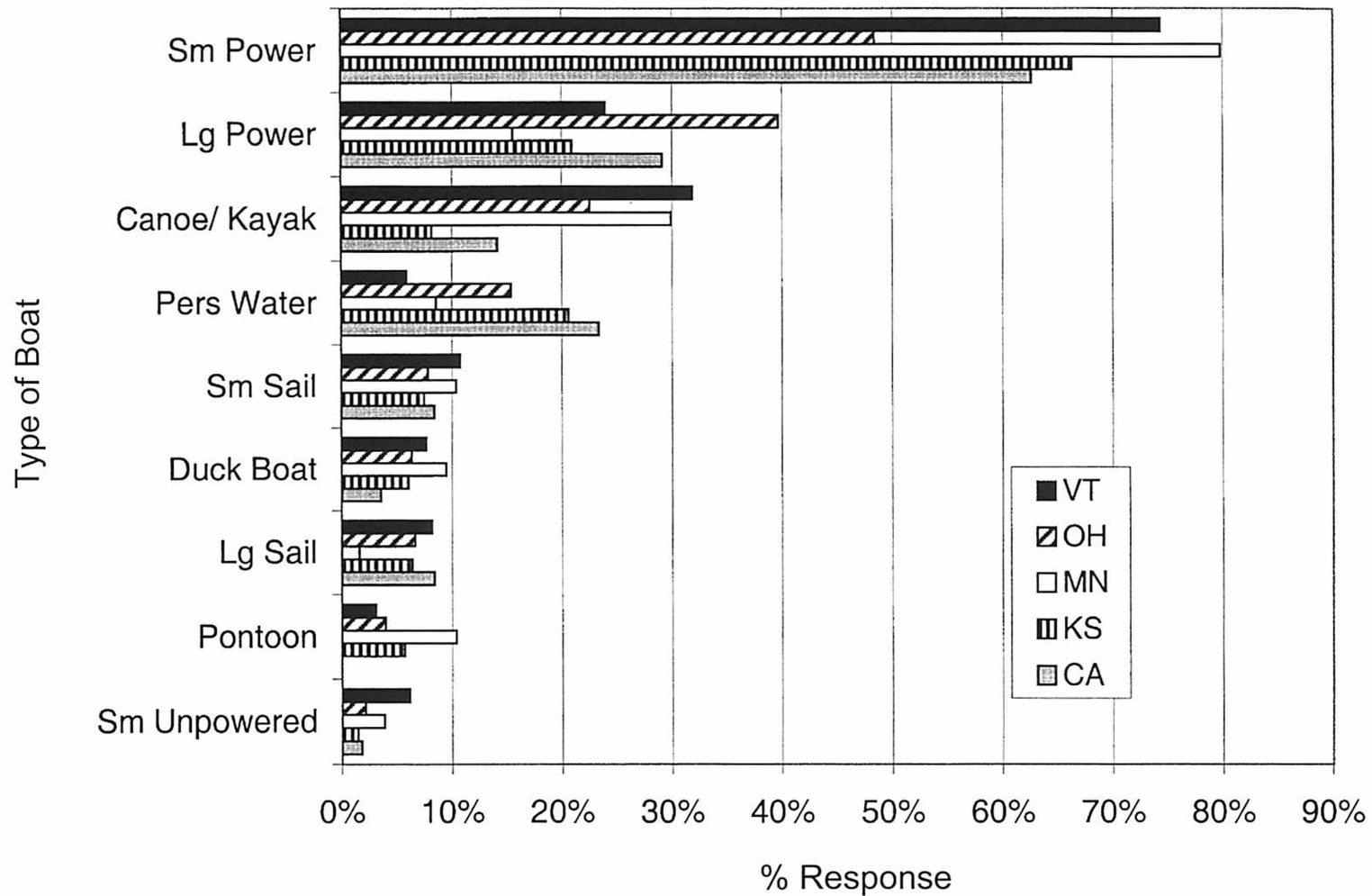


Figure 1.1 Boat types used by respondents during the 2000 boating season for the five states surveyed. Totals for each state may be greater than 100% due to respondents using more than one boat type.

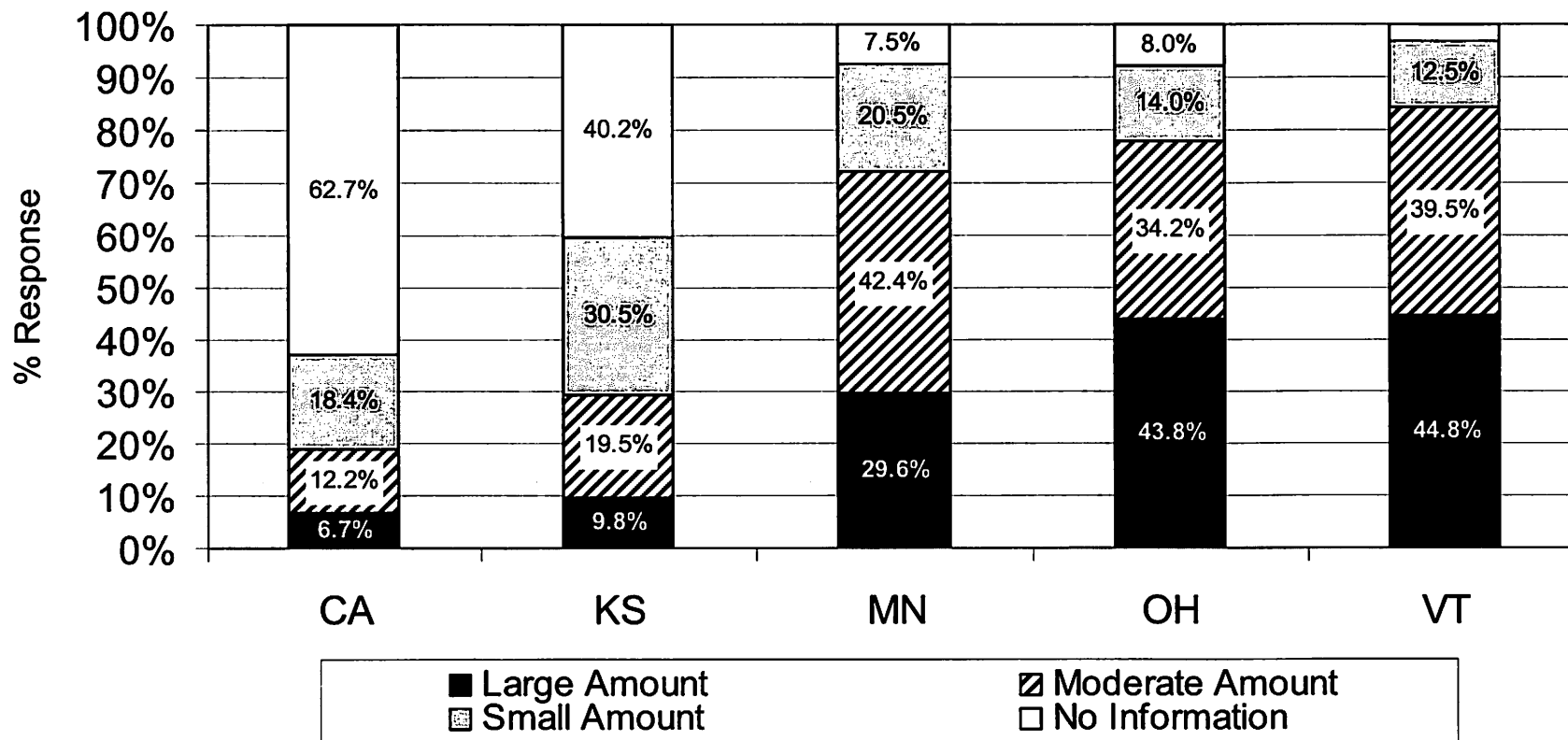


Figure 2. Amount of information boaters heard about zebra or quagga mussels by state. Percents indicate respondents in that category. Categories without numbers were less than 5%.

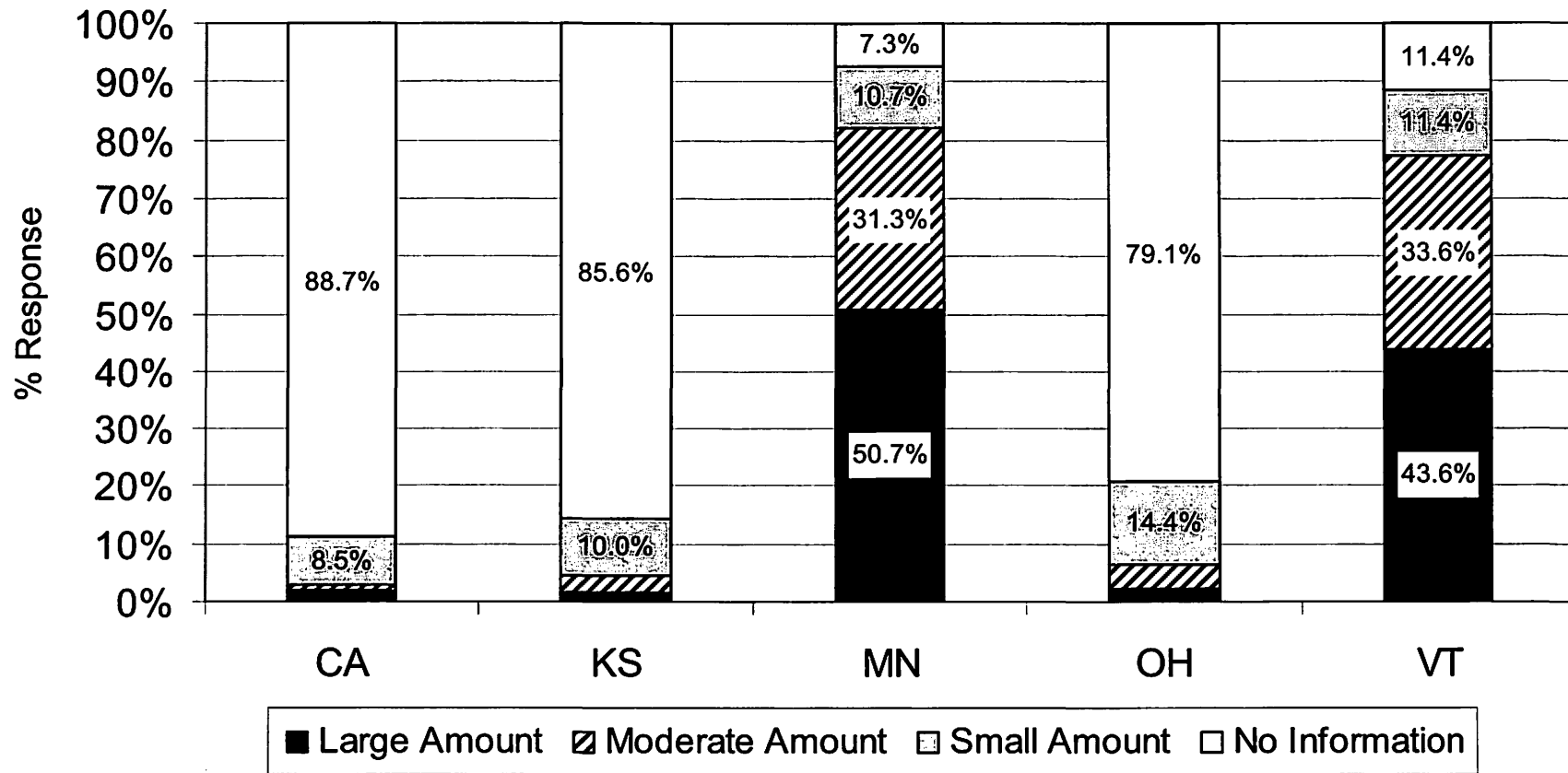


Figure 3. Amount of information boaters heard about Eurasian watermilfoil by state.

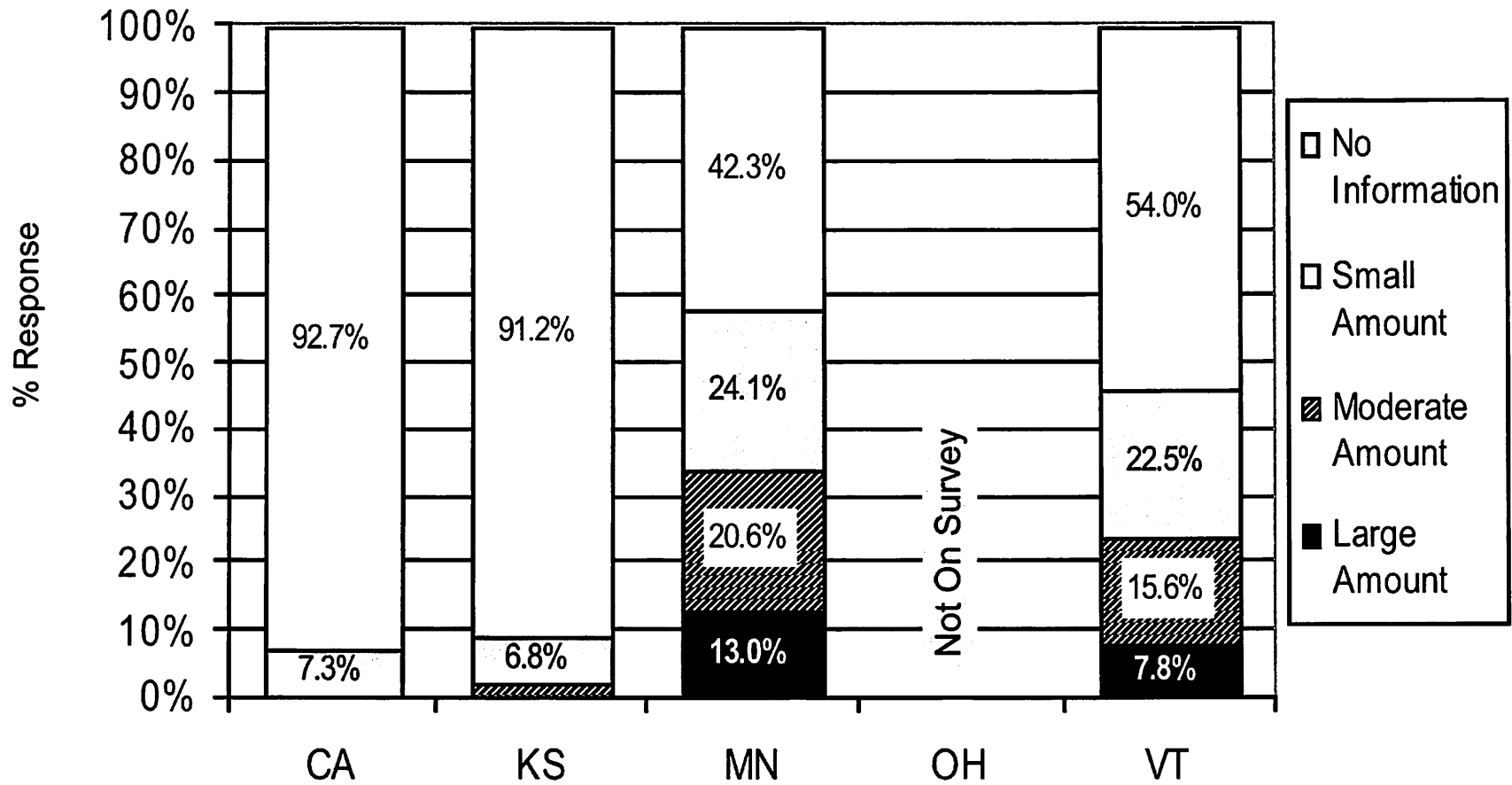


Figure 4. Amount of information boaters heard about purple loosestrife by state. Ohio survey did not include purple loosestrife.



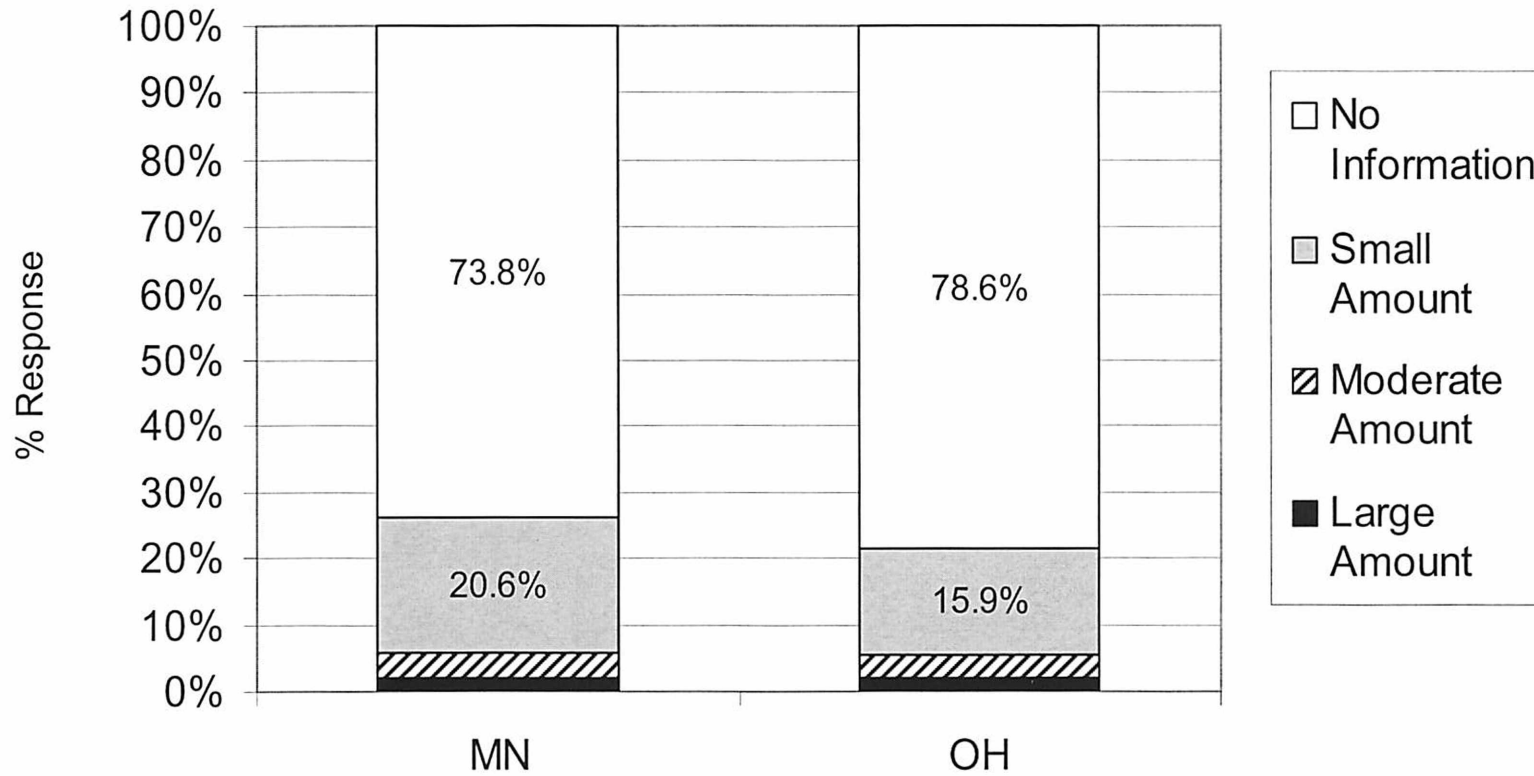


Figure 5. Amount of information boaters heard about spiny waterfleas by state. Two states included spiny waterfleas in their surveys.

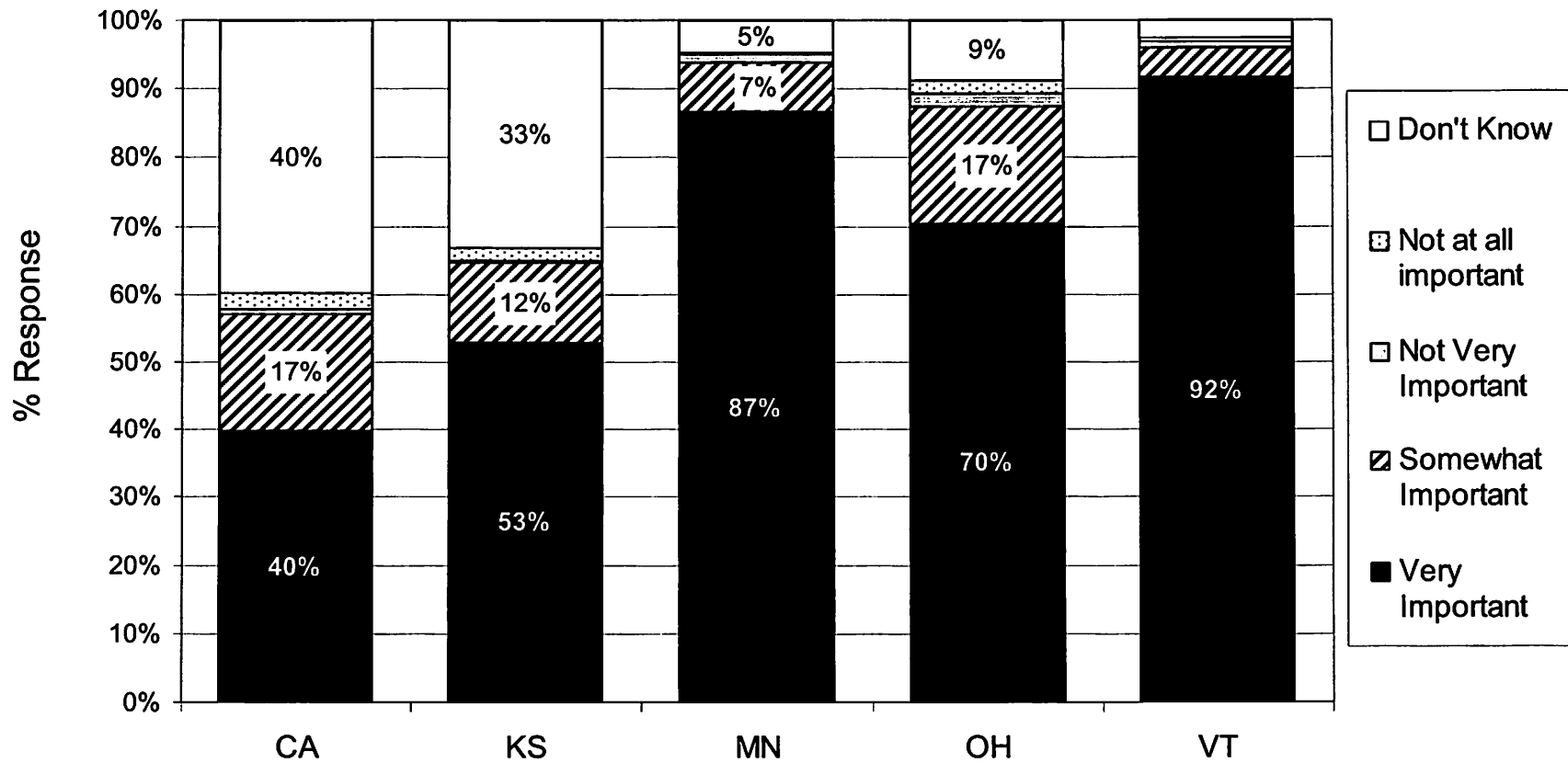


Figure 6. Importance of taking precautions to prevent the spread of zebra or quagga mussels from one body of water to another by state.

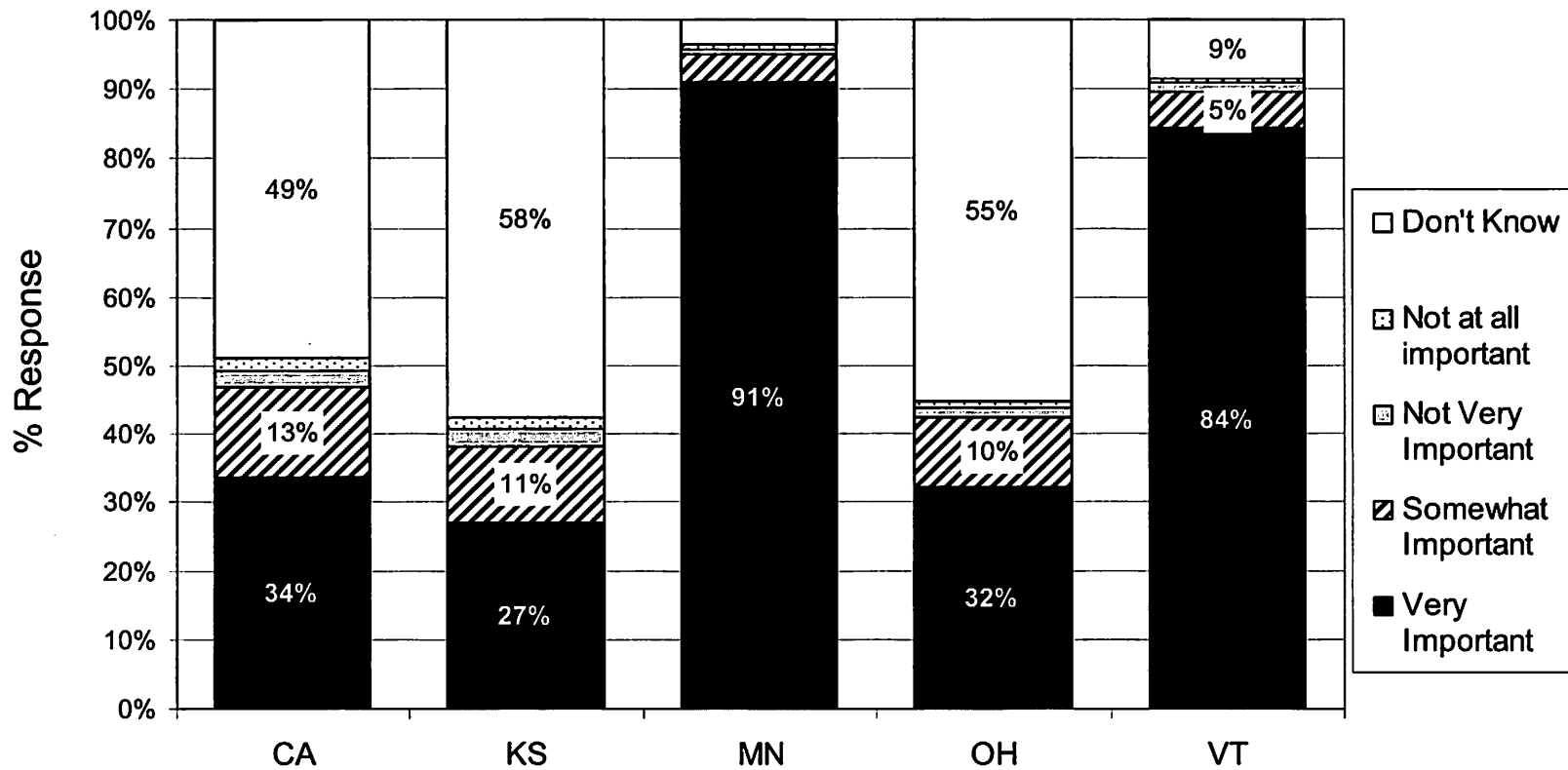


Figure 7. Importance of taking precautions to prevent the spread of Eurasian watermilfoil from one body of water to another by state.

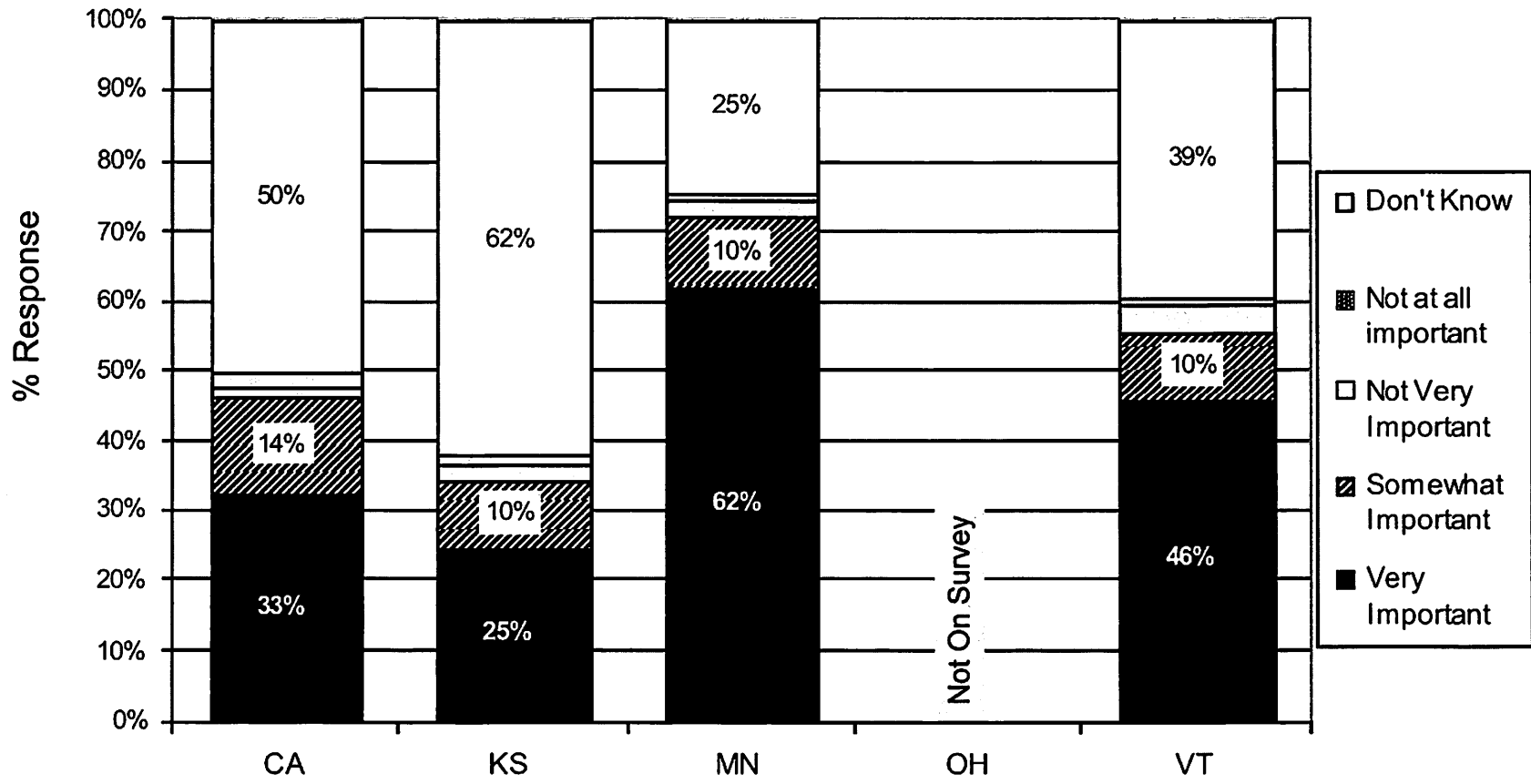


Figure 8. Importance of taking precautions to prevent the spread of purple loosestrife from one body of water to another by state. Ohio survey did not include purple loosestrife.

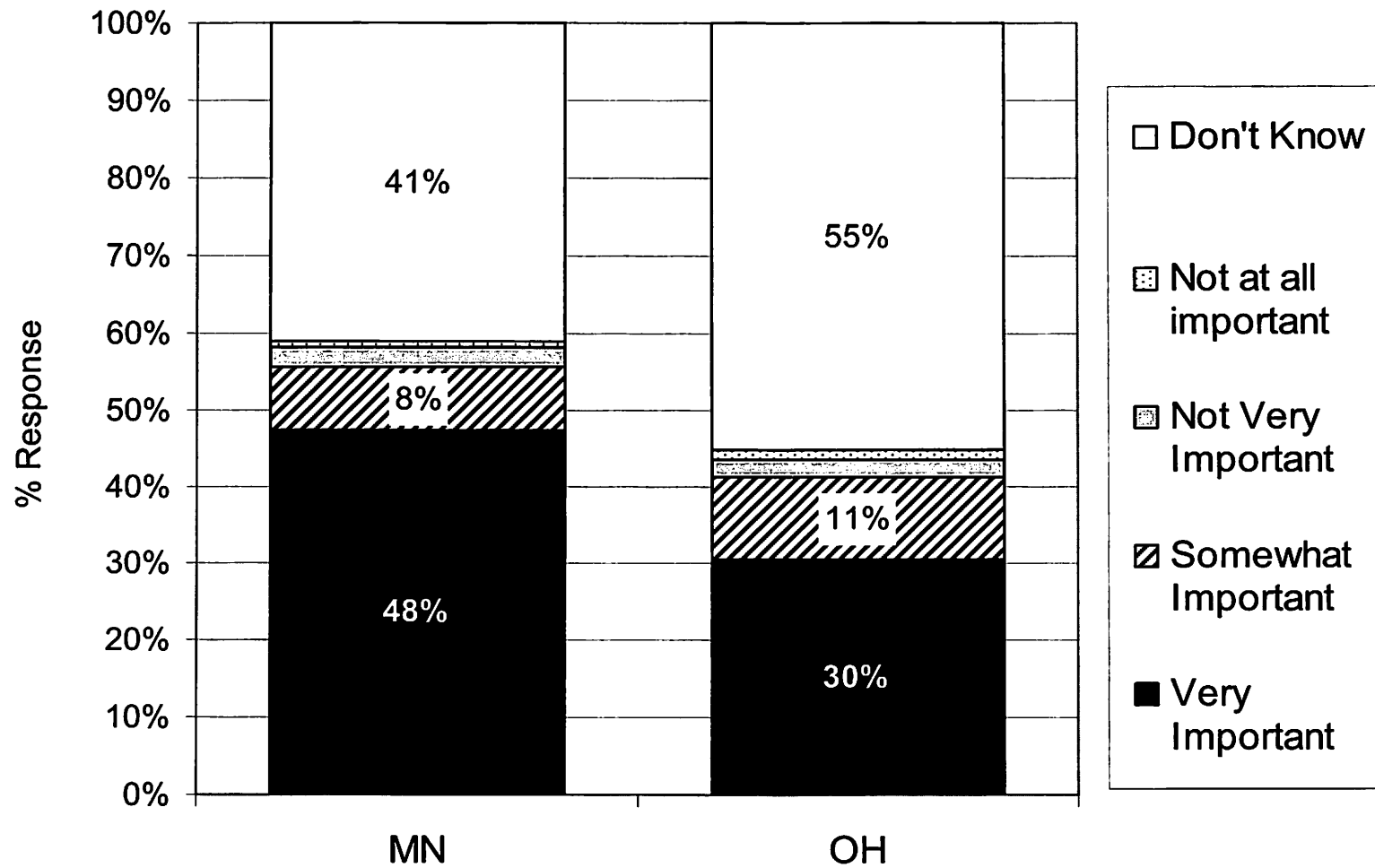


Figure 9. Importance of taking precautions to prevent the spread of spiny waterfleas from one body of water to another by state. Two states included spiny waterfleas in their surveys.

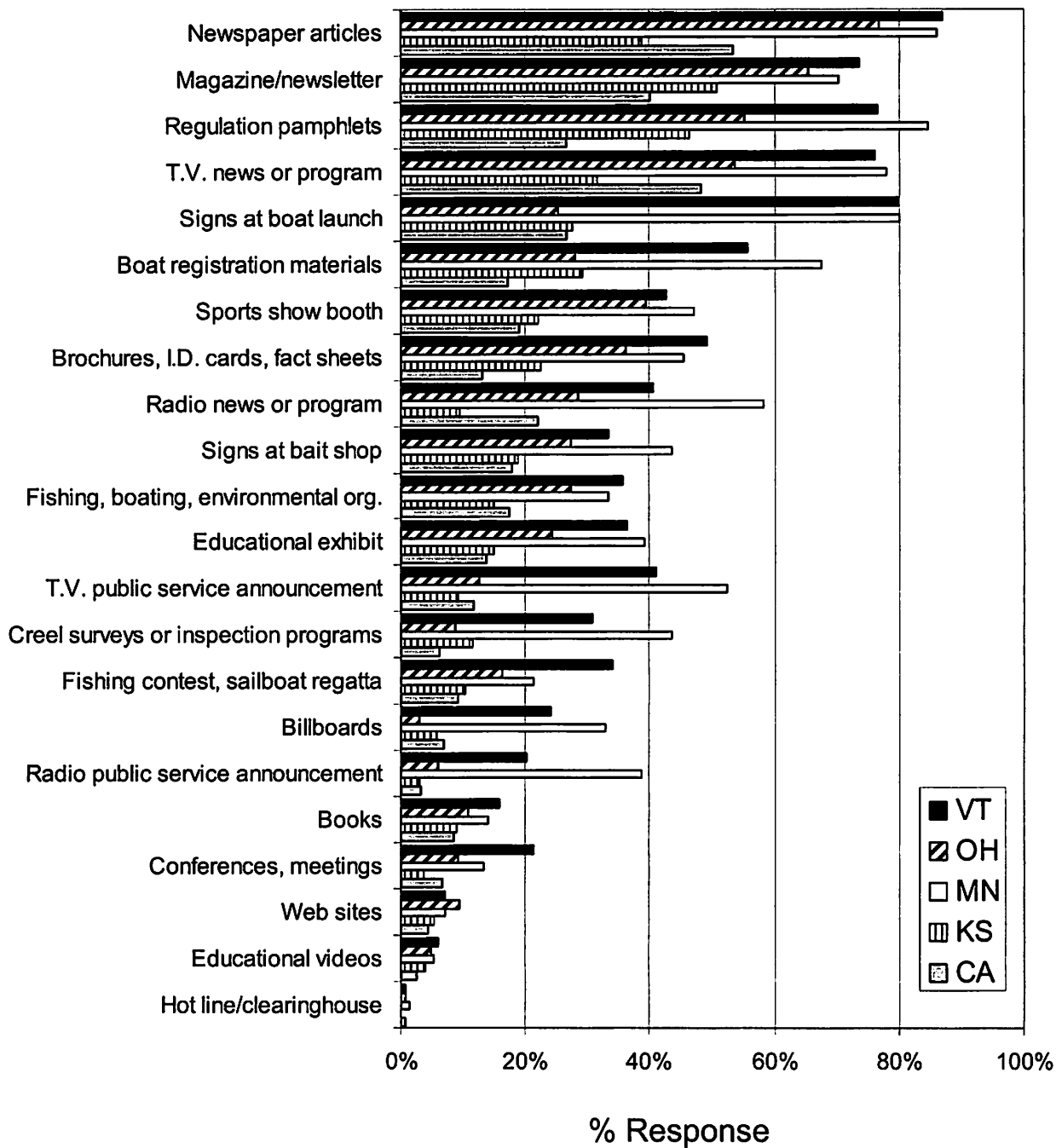


Figure 10. Sources for information about AIS for boaters in each state.

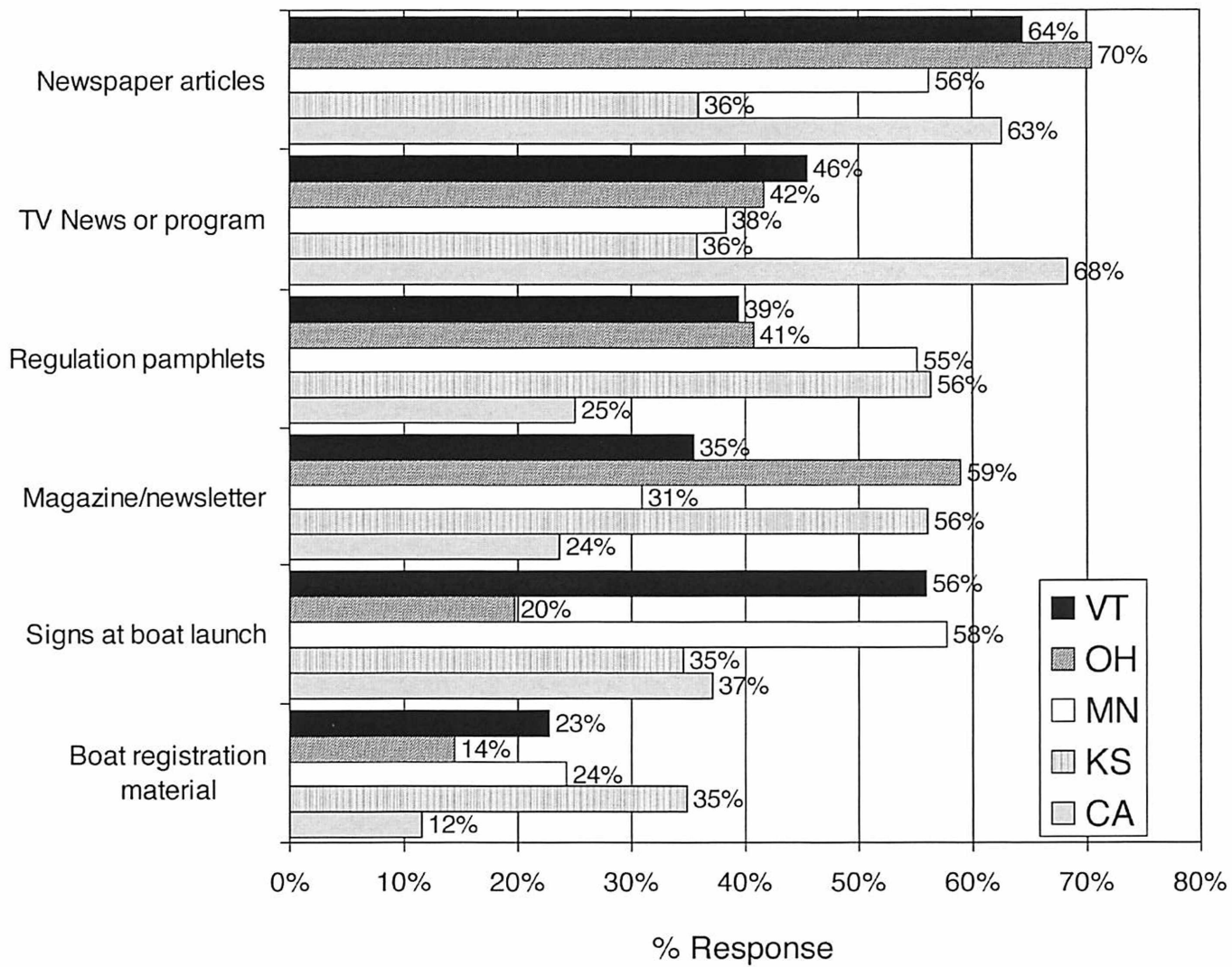


Figure 11. Best sources of information about AIS for boaters in each state.

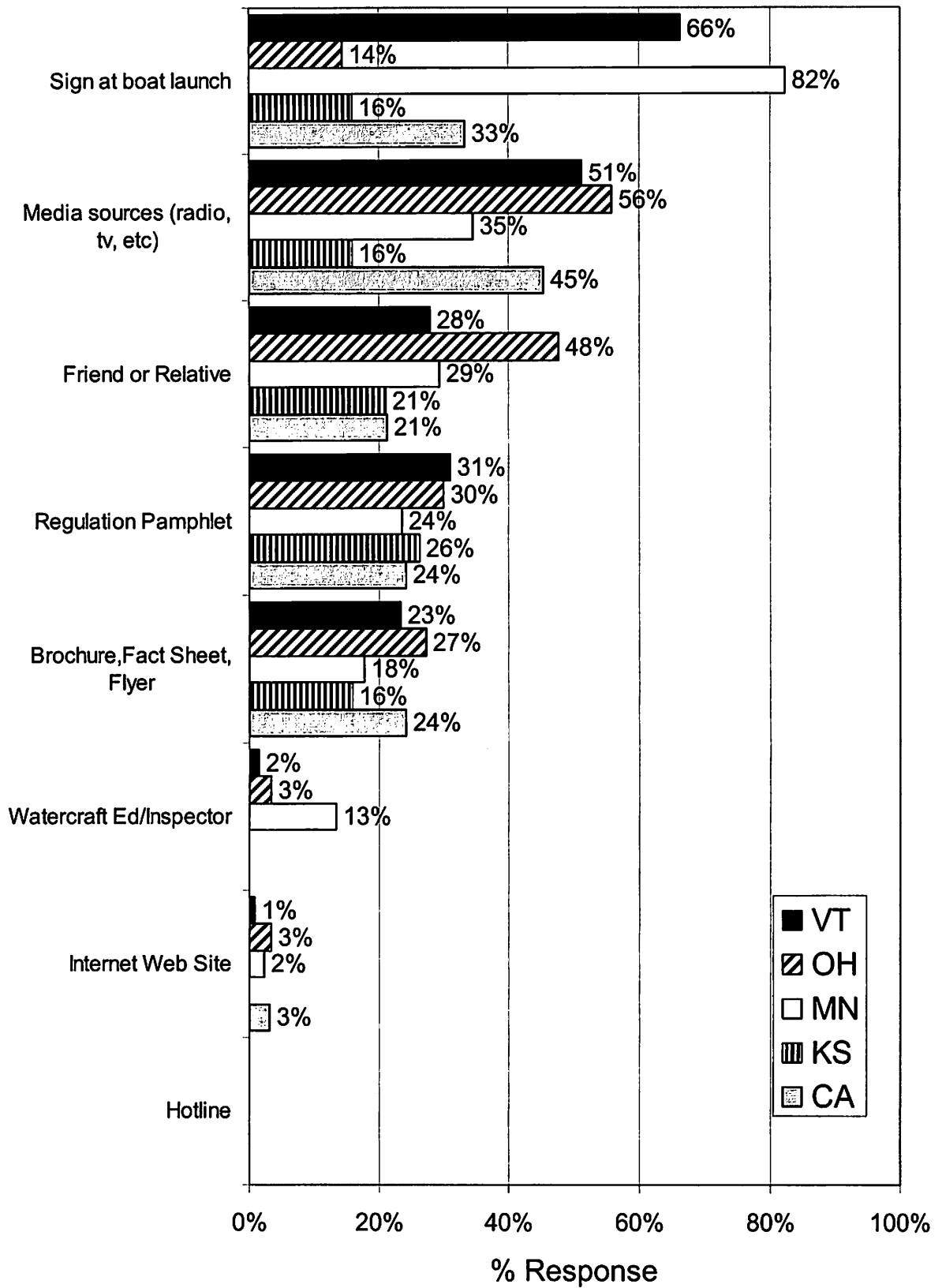


Figure 12. Sources of information used by boaters to identify infested waters.



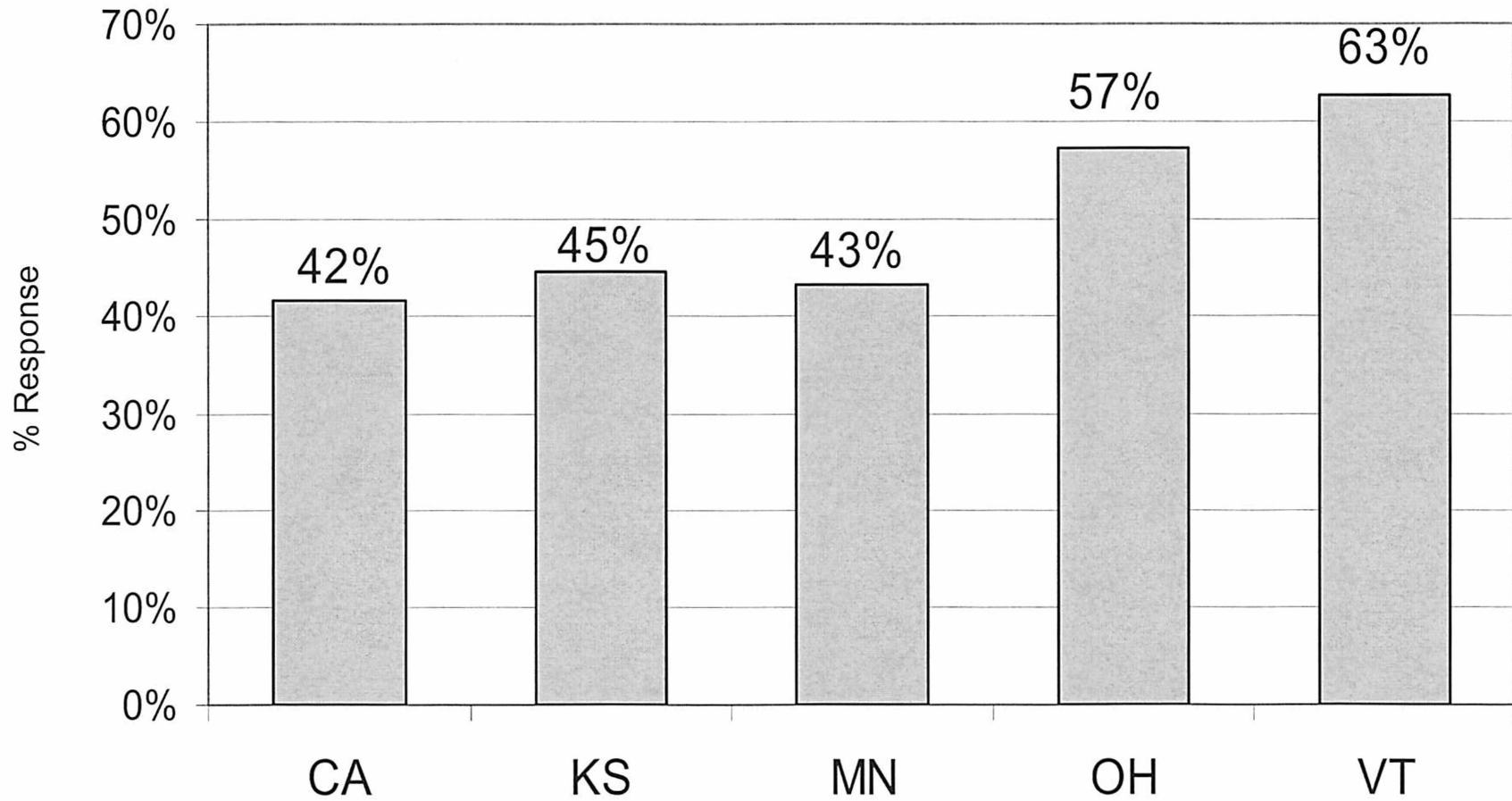


Figure 13. Percentage of boaters who *never* moved their boat to a different waterbody during the 2000 boating season in five states.

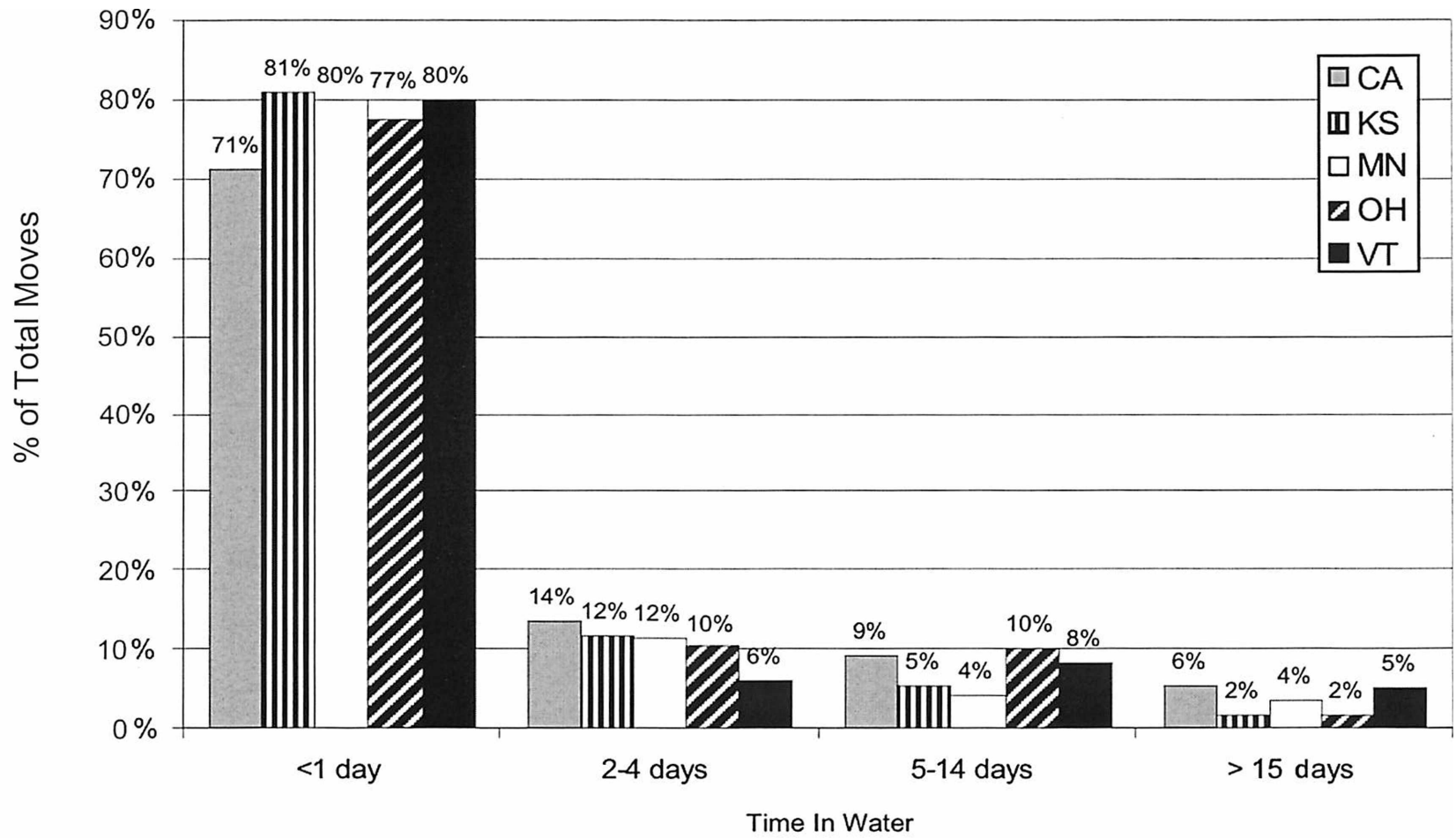


Figure 14. Amount of time boaters left their boat *in* a waterbody before moving it to different a waterbody relative to the total number of moves for each time period.

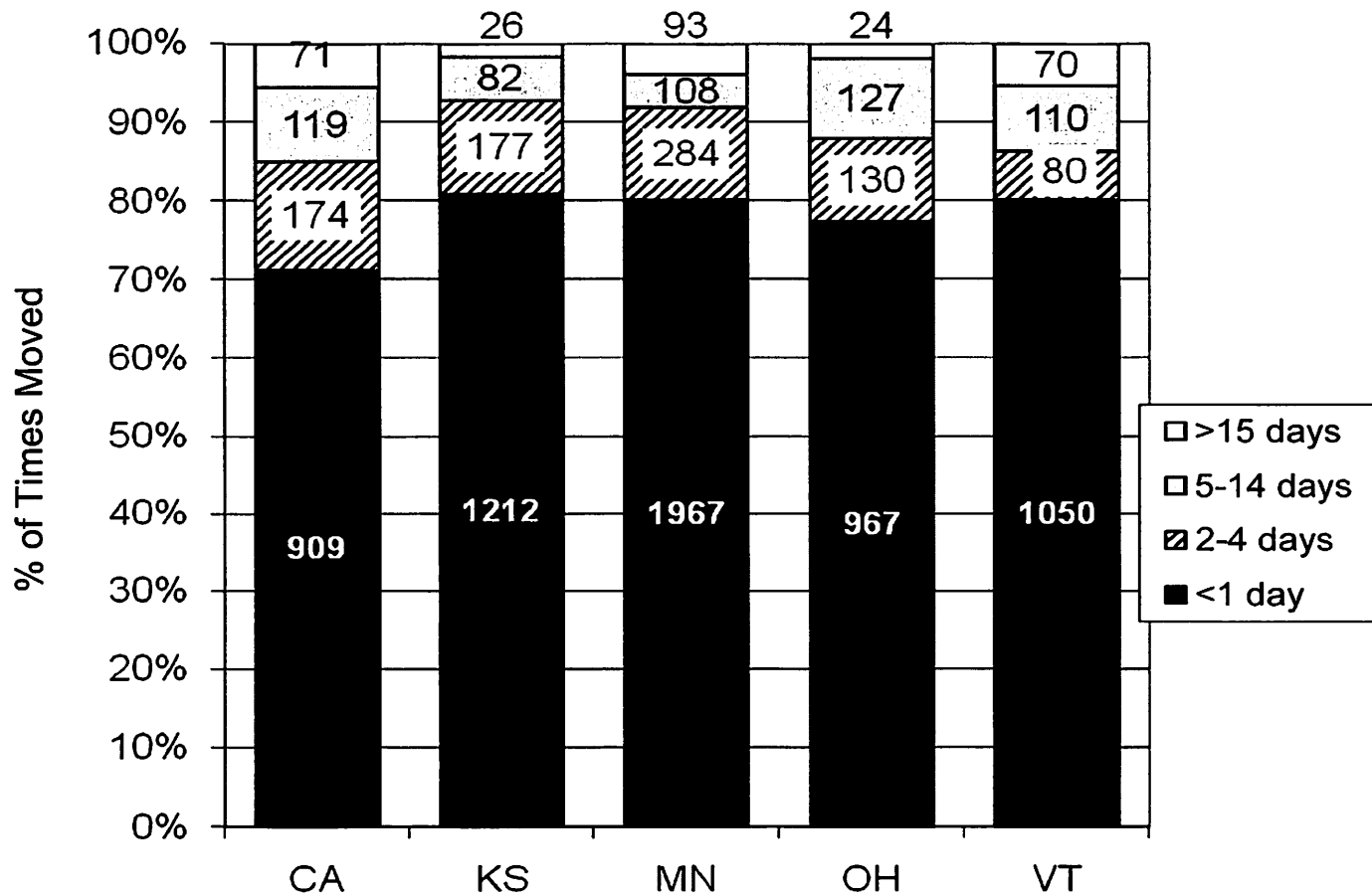


Figure 14.1. Amount of time boaters left their boat *in* a waterbody before moving it to a different waterbody based on the total number of moves listed for each time period. Numbers on bars indicate the total number of moves for that period.

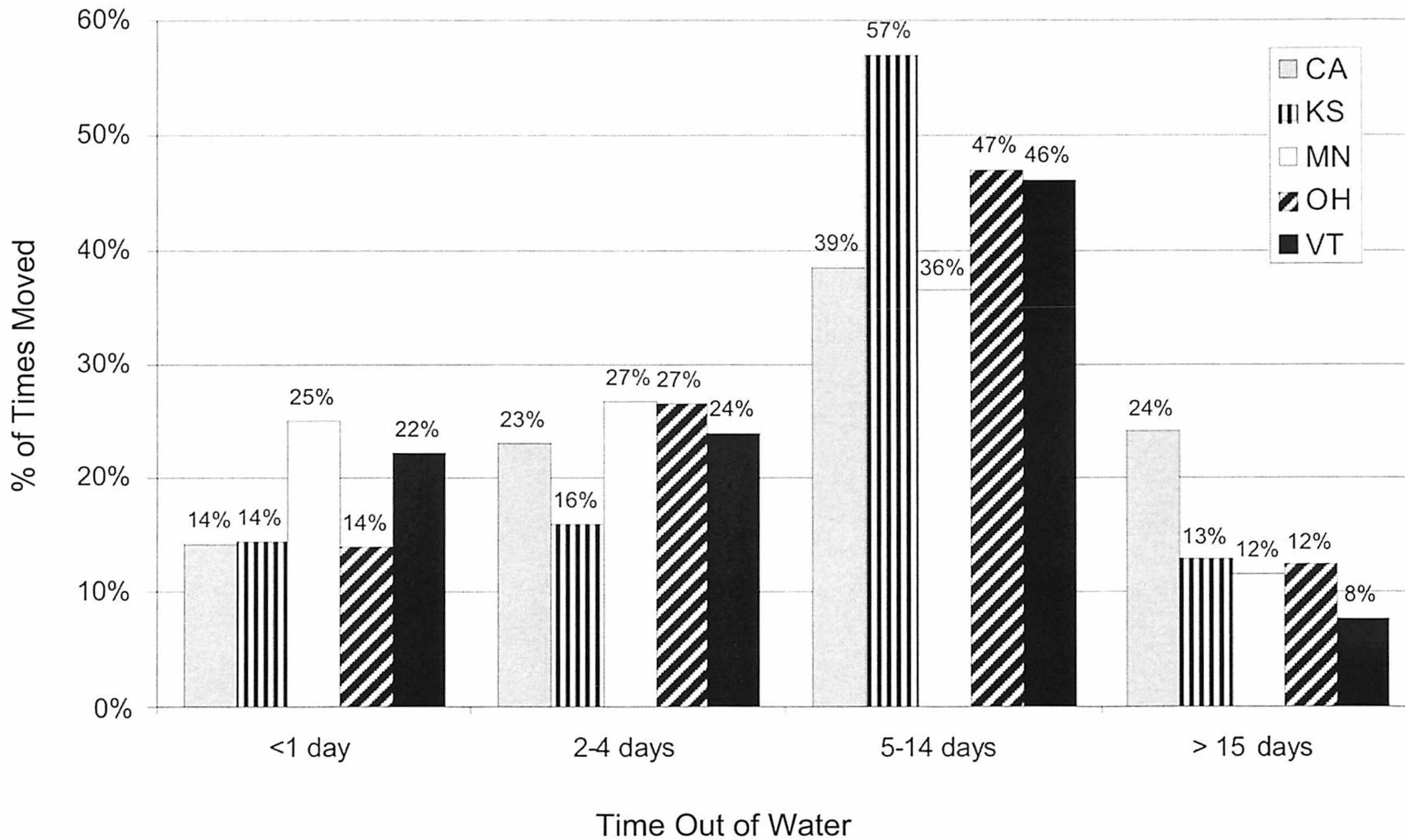


Figure 15. Amount of time boaters left their boat *out* of the water before moving it to a different waterbody relative to the number of moves listed for each time period.

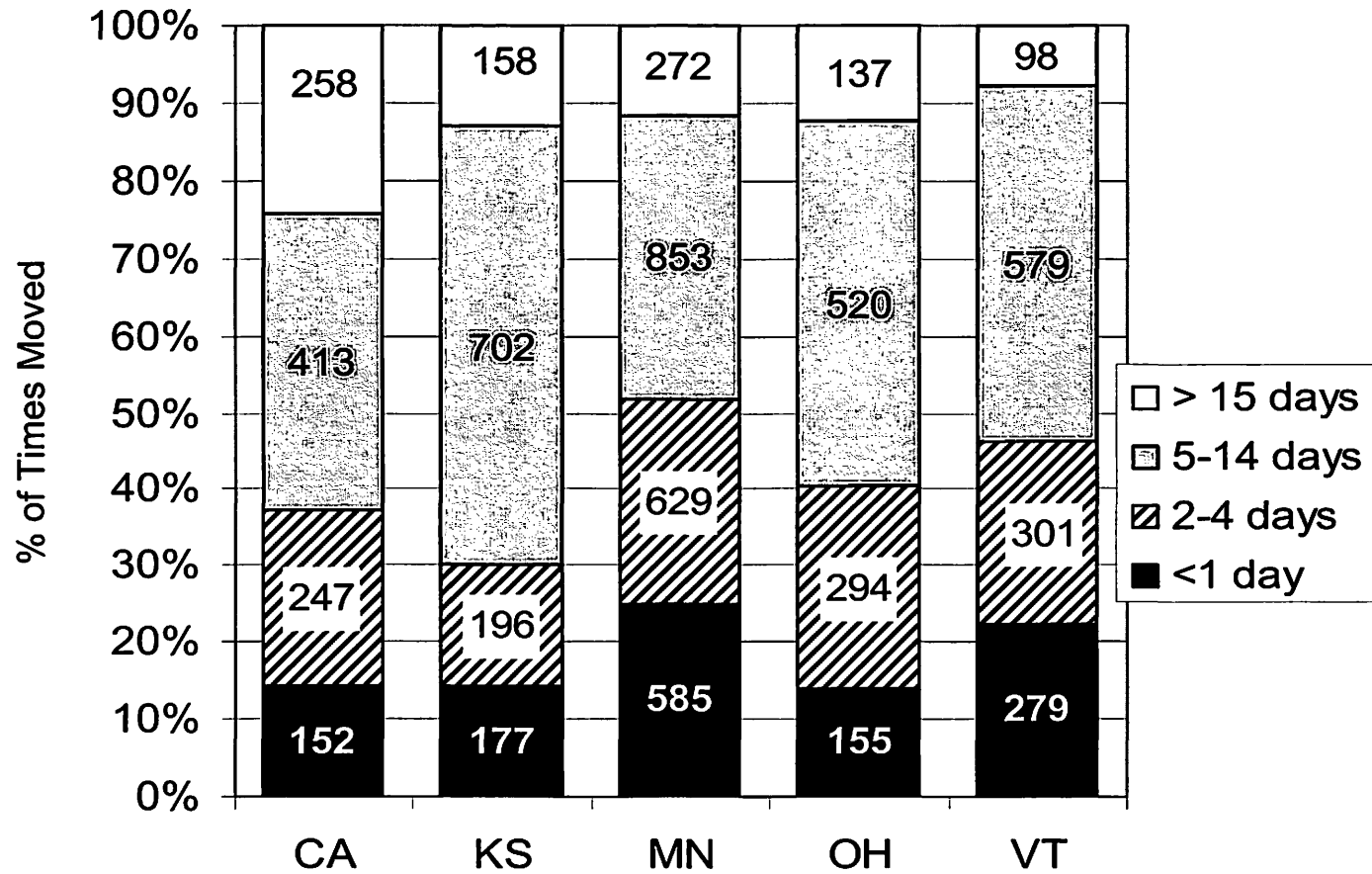


Figure 15.1. Amount of time boaters left their boat *out* of the water before moving it to a different waterbody based on the total number of moves for each time period. Numbers on the bars indicate the total number of moves for that period.

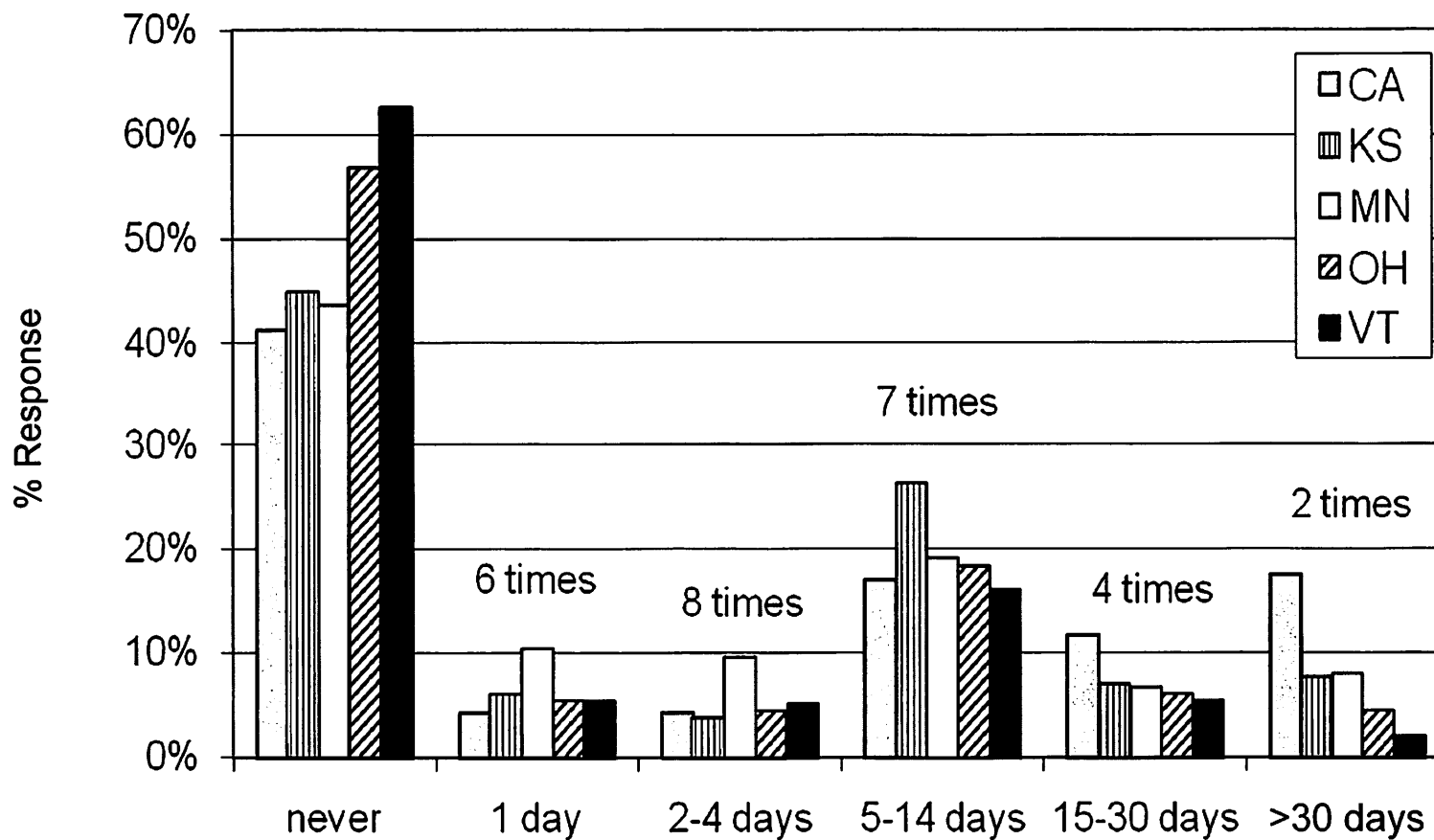


Figure 15.2. Percentage of boaters who used their boat an average number of times on different waterbodies in each time period.

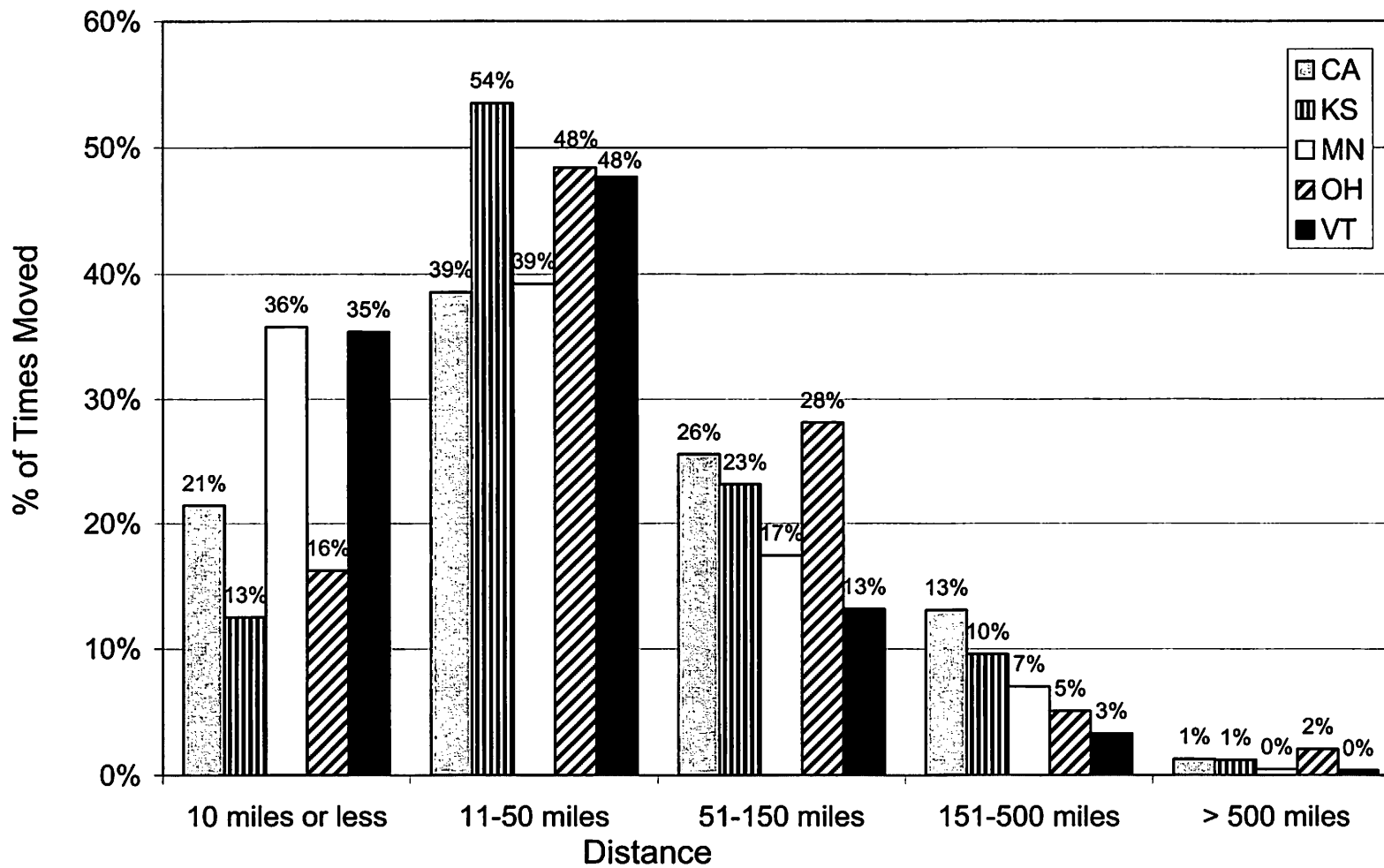


Figure 16. Distance boats were moved between waterbodies based on the number of moves identified for each distance category by state.

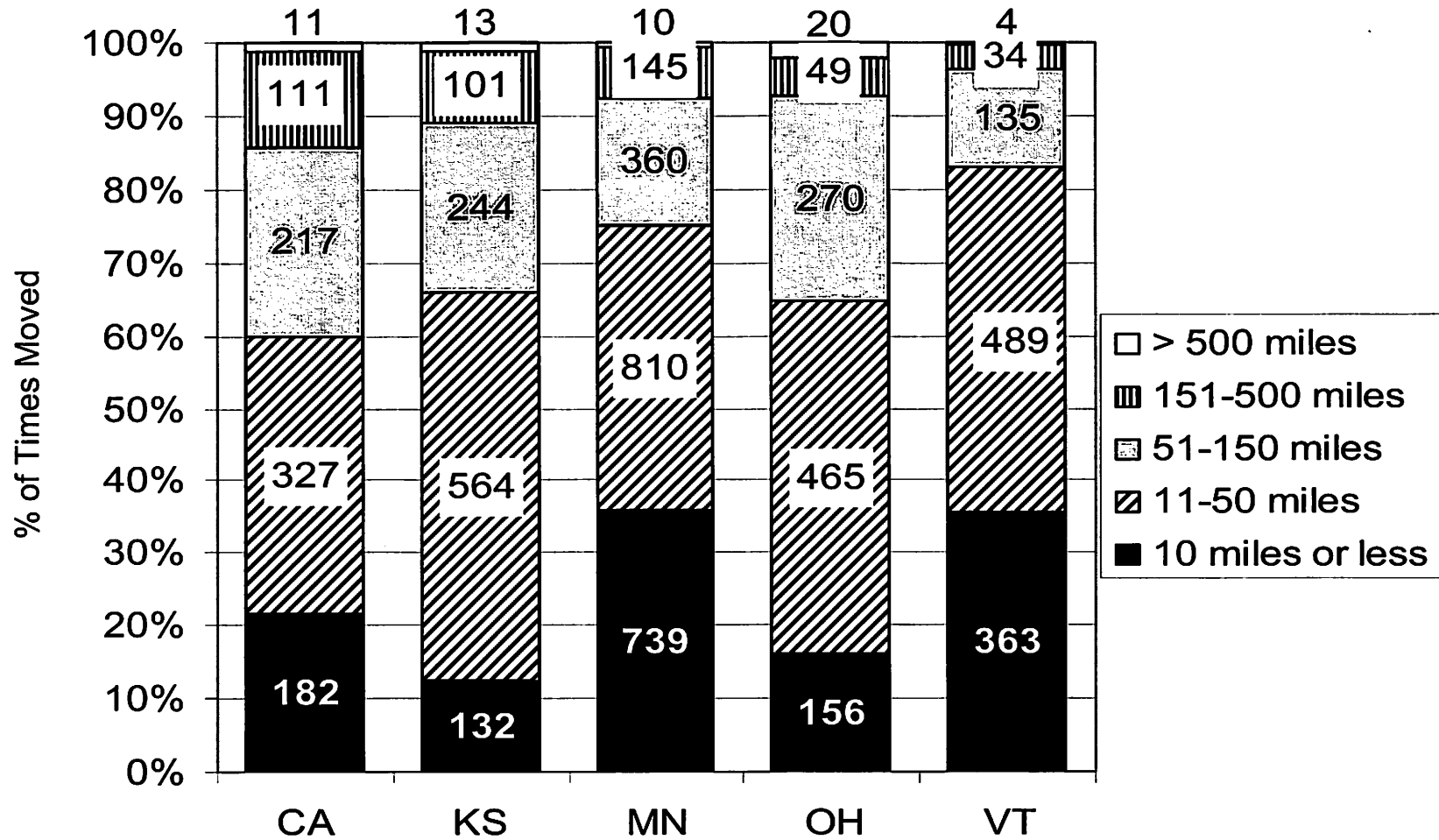


Figure 16.1. Distance boats were moved between waterbodies based on the total number of moves listed for each distance category. Numbers on the bars indicate the total number of moves for that category.





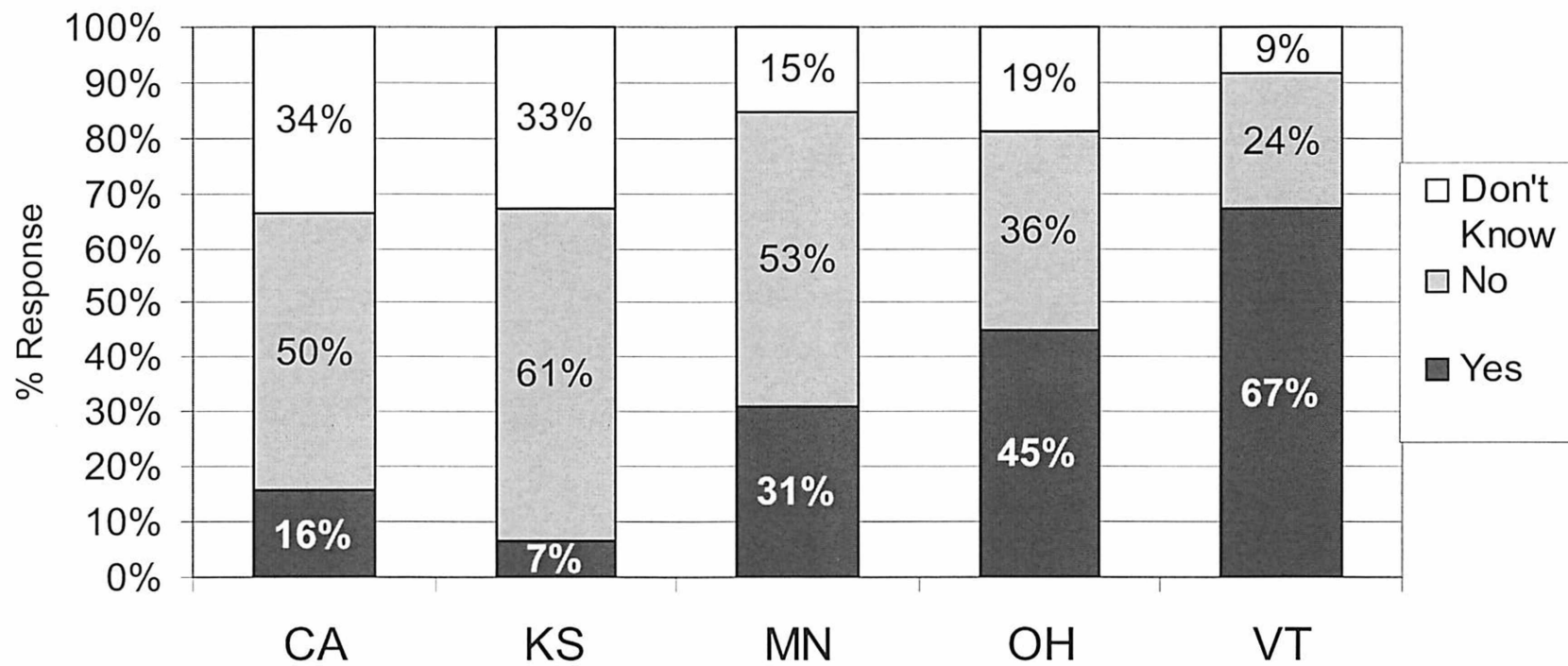


Figure 18. Percent of boaters that knowingly boated on AIS infested water during the 2000 boating season in the five states surveyed.

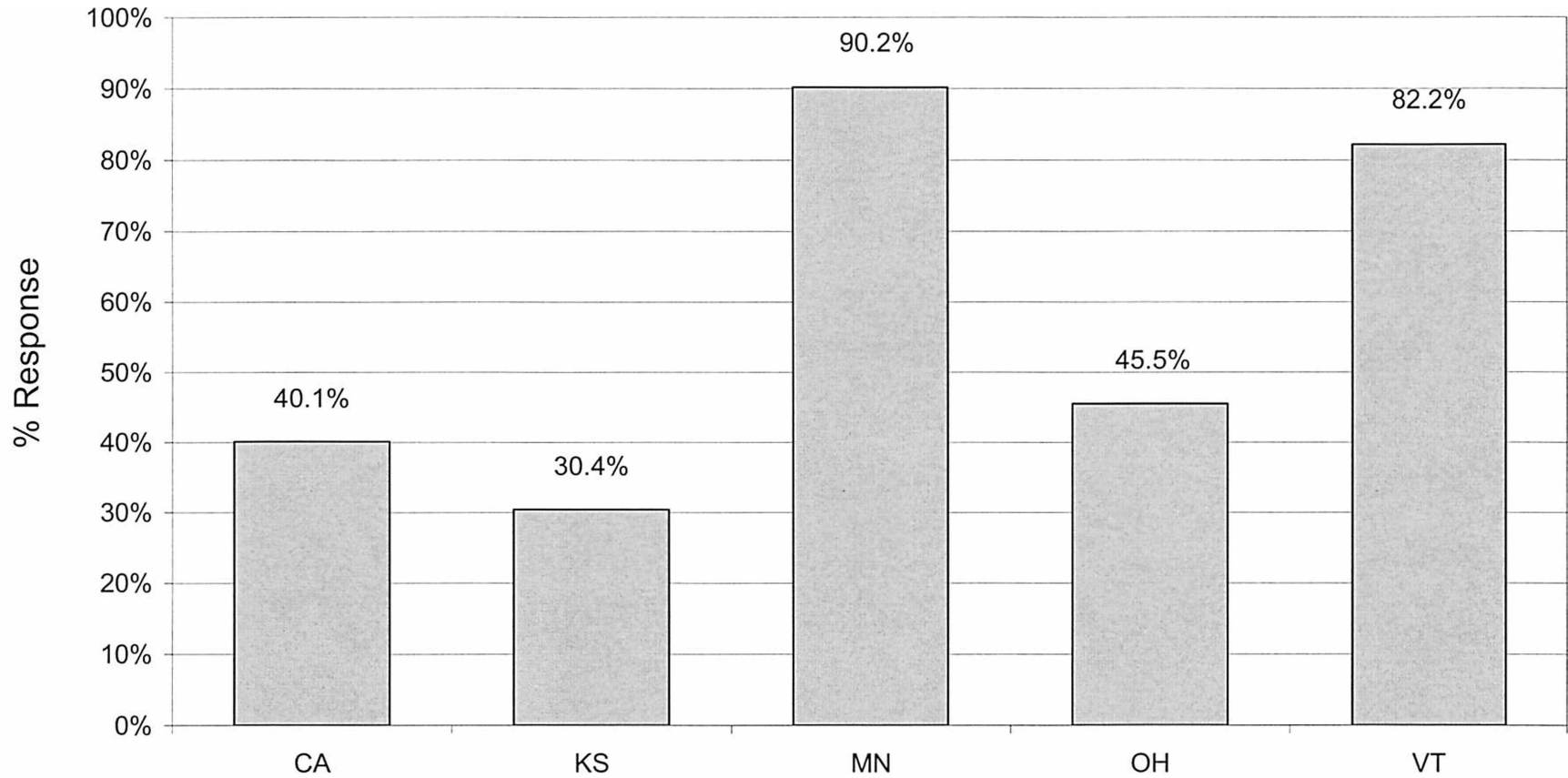


Figure 19. Percent of boaters who reported taking special steps to prevent the spread the transport of water or AIS from one body of water to another.

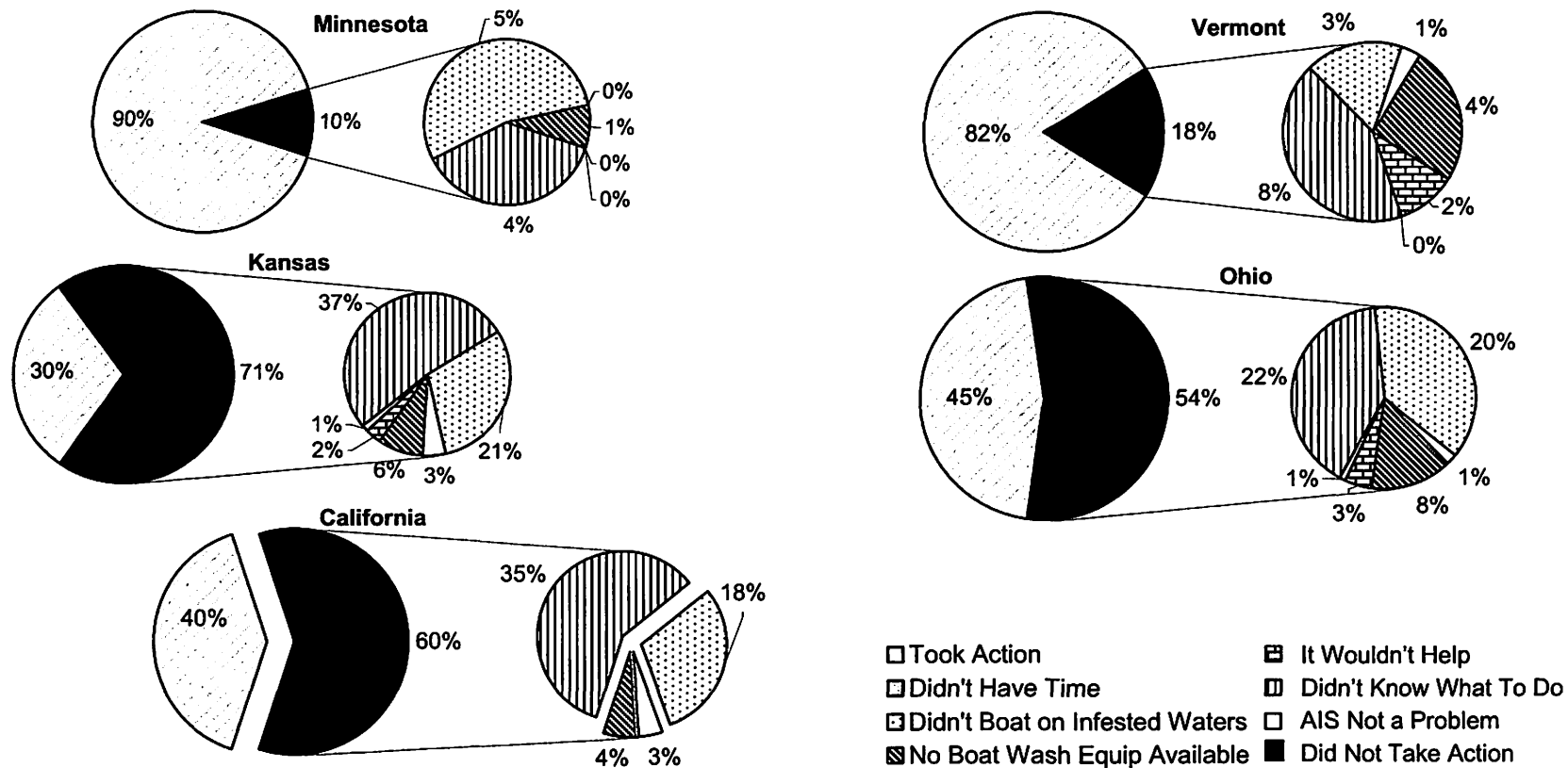


Figure 20. Percent of boaters from each state who reported *taking precautions* to prevent the spread of AIS relative to the percent of those who *did not take precautions* including the reasons why boaters did not take action.

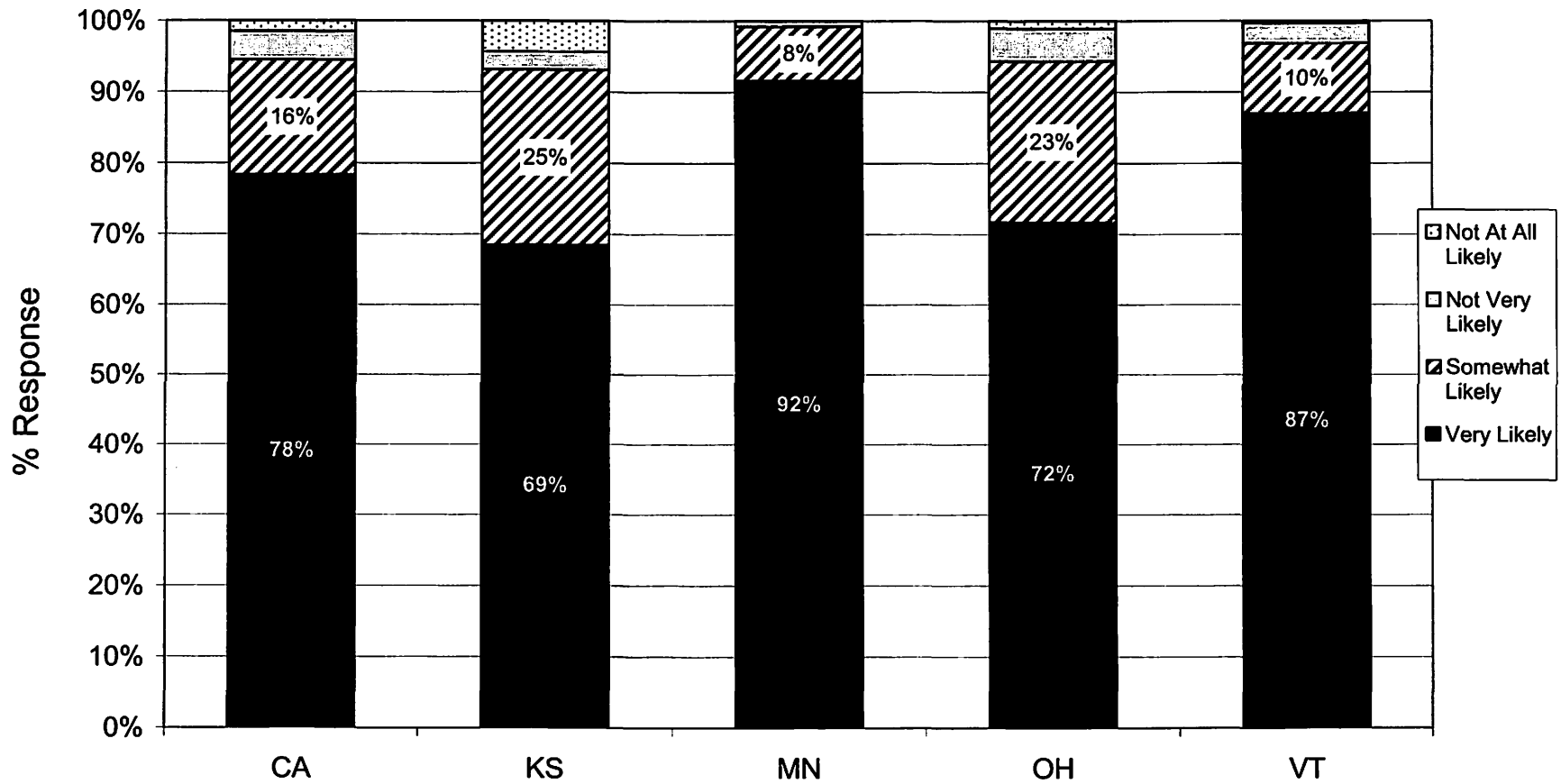


Figure 21. Percent of boaters who reported that they likely *will take* precautions in the future to prevent the spread of AIS between bodies of water.

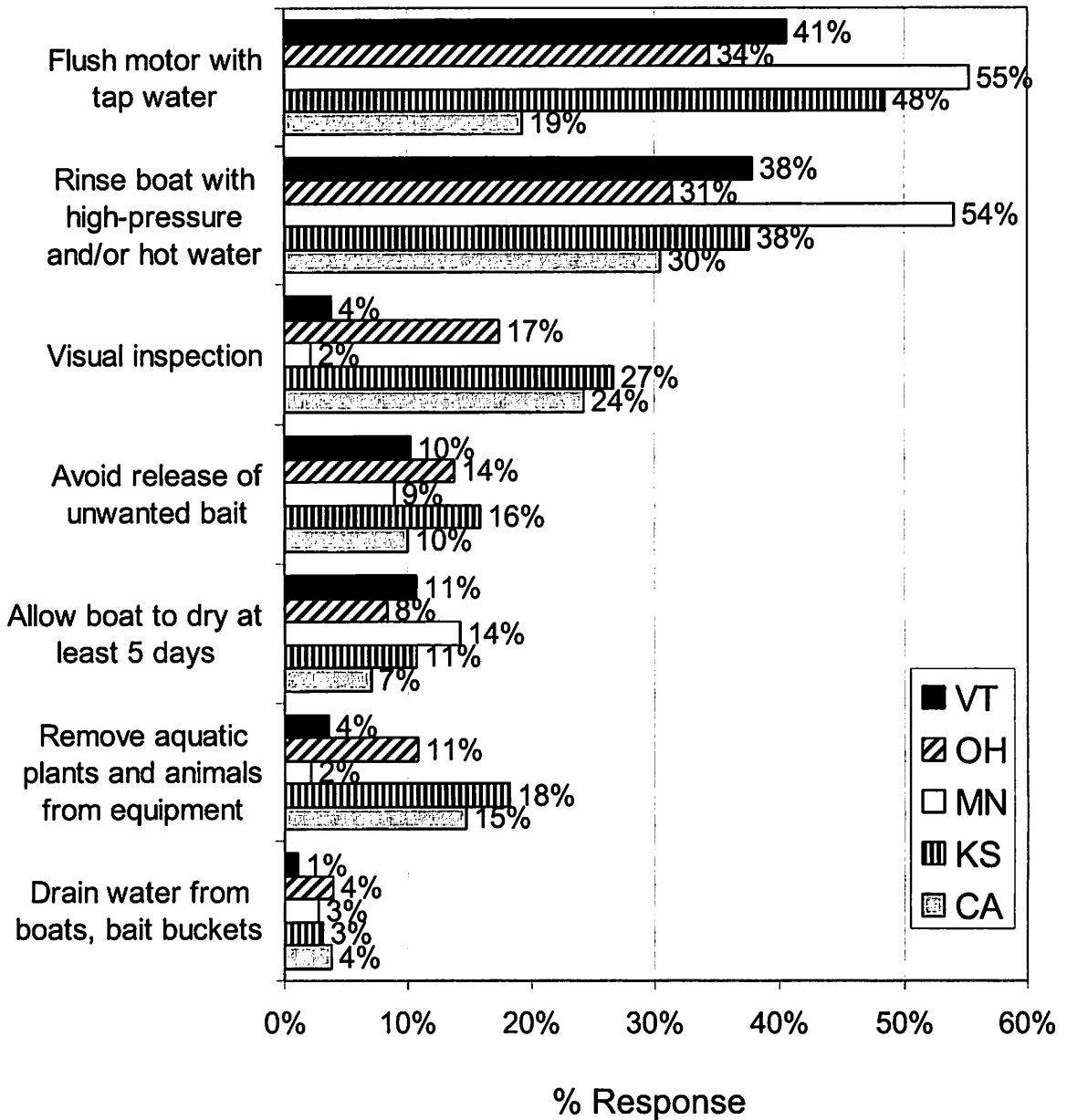


Figure 22. Percent of boaters from each state who reported they *never* take precautions to prevent the spread of AIS.

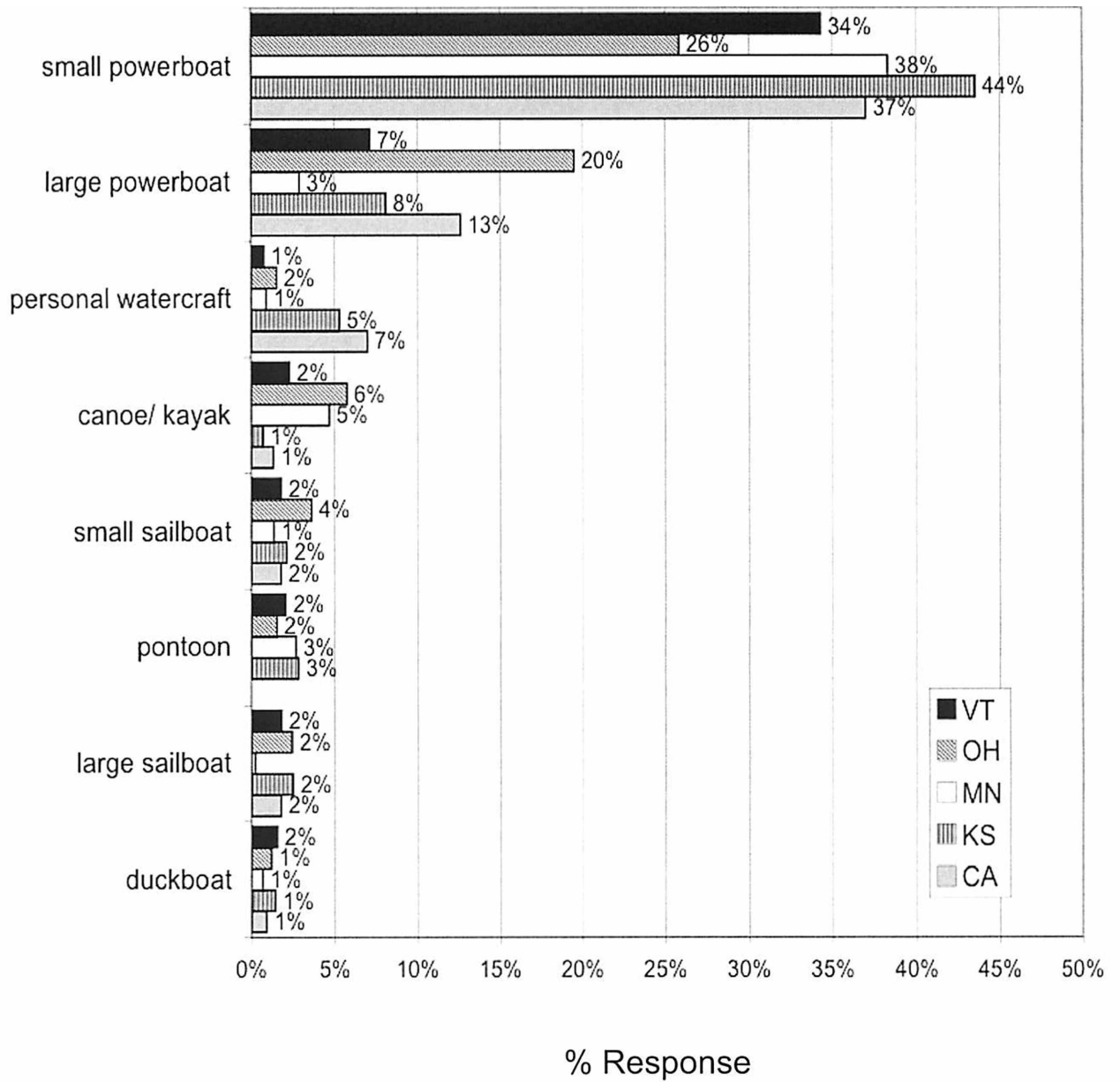


Figure 23. Percent of all boat owners who owned a single boat by category by state.

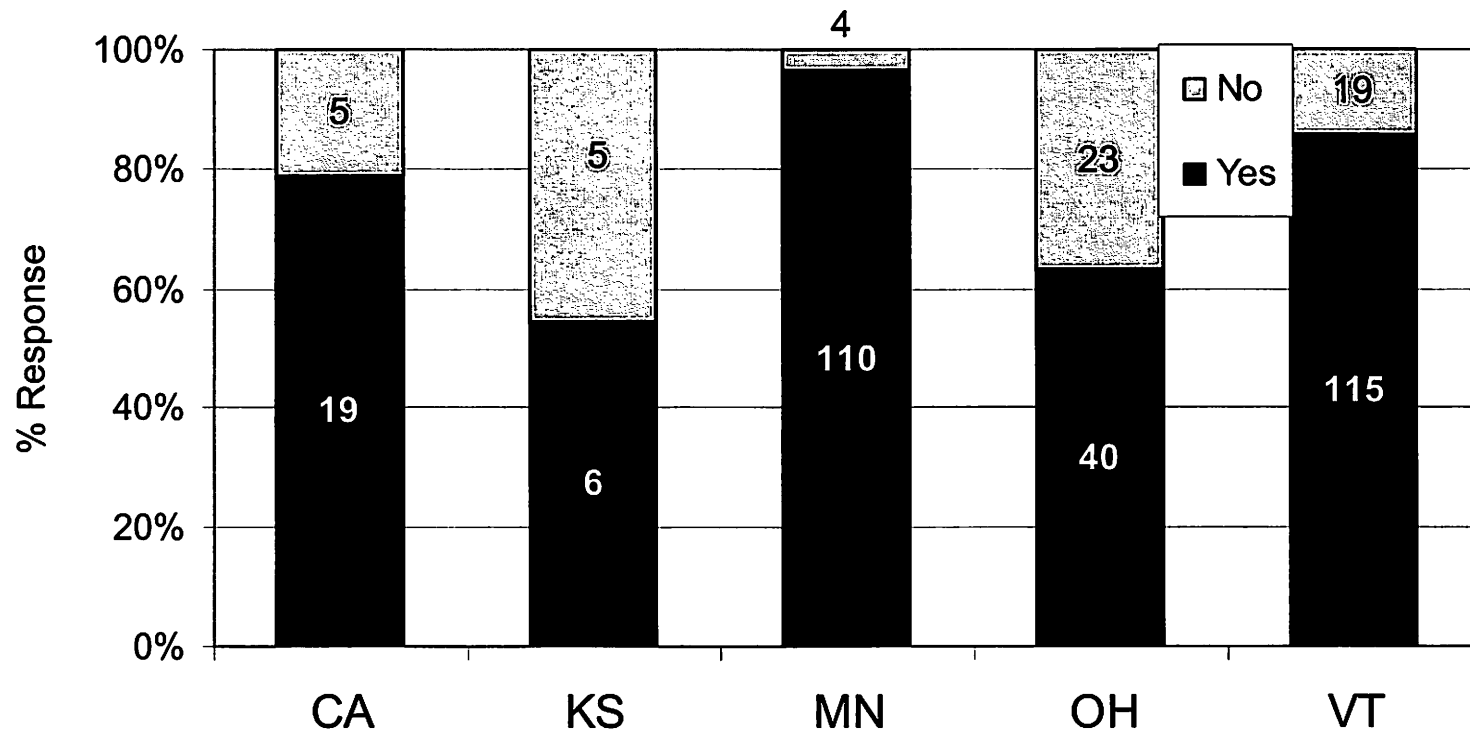


Figure 24. Actual number of responses for action taken when boats were used on waters known by the boater to be infested.



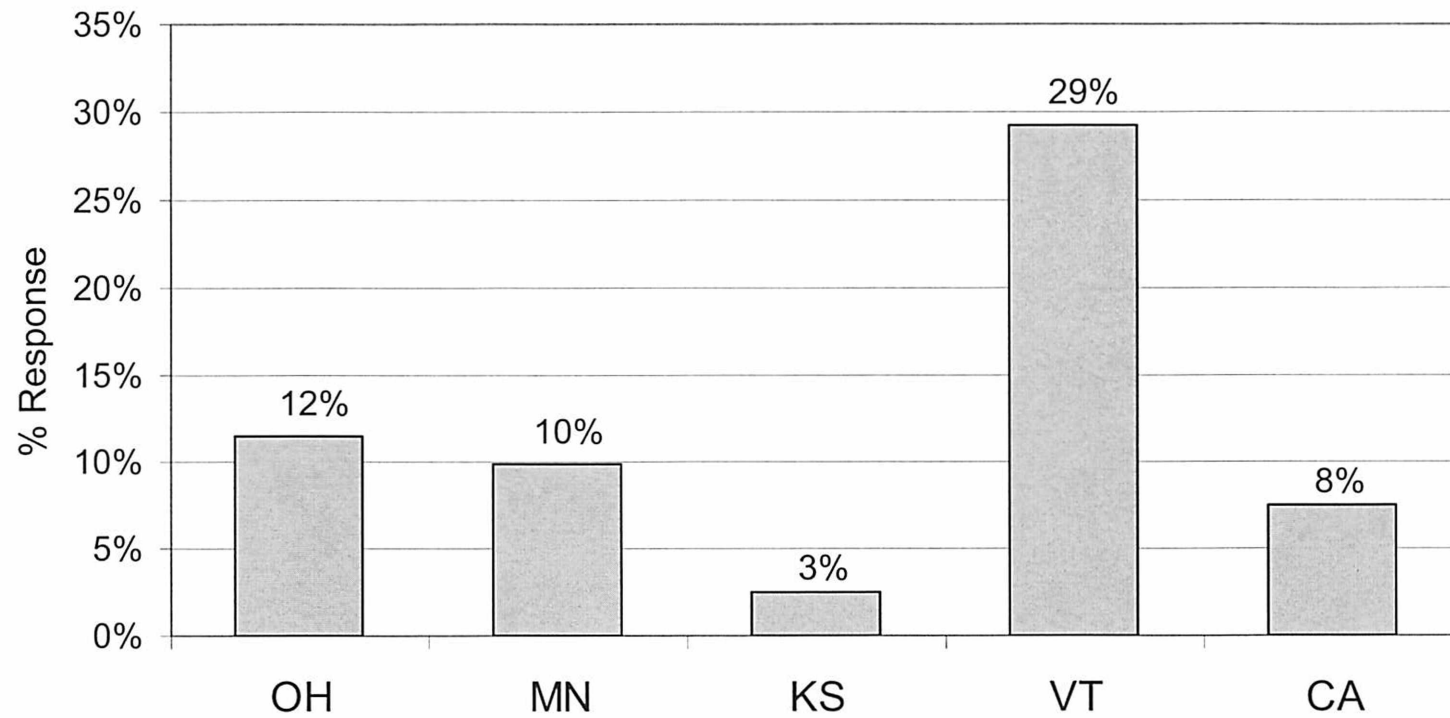


Figure 25. Percent of respondents (boaters and non-boat owners) who replied that AIS had affected their recreational experience during the 2000 boating season.

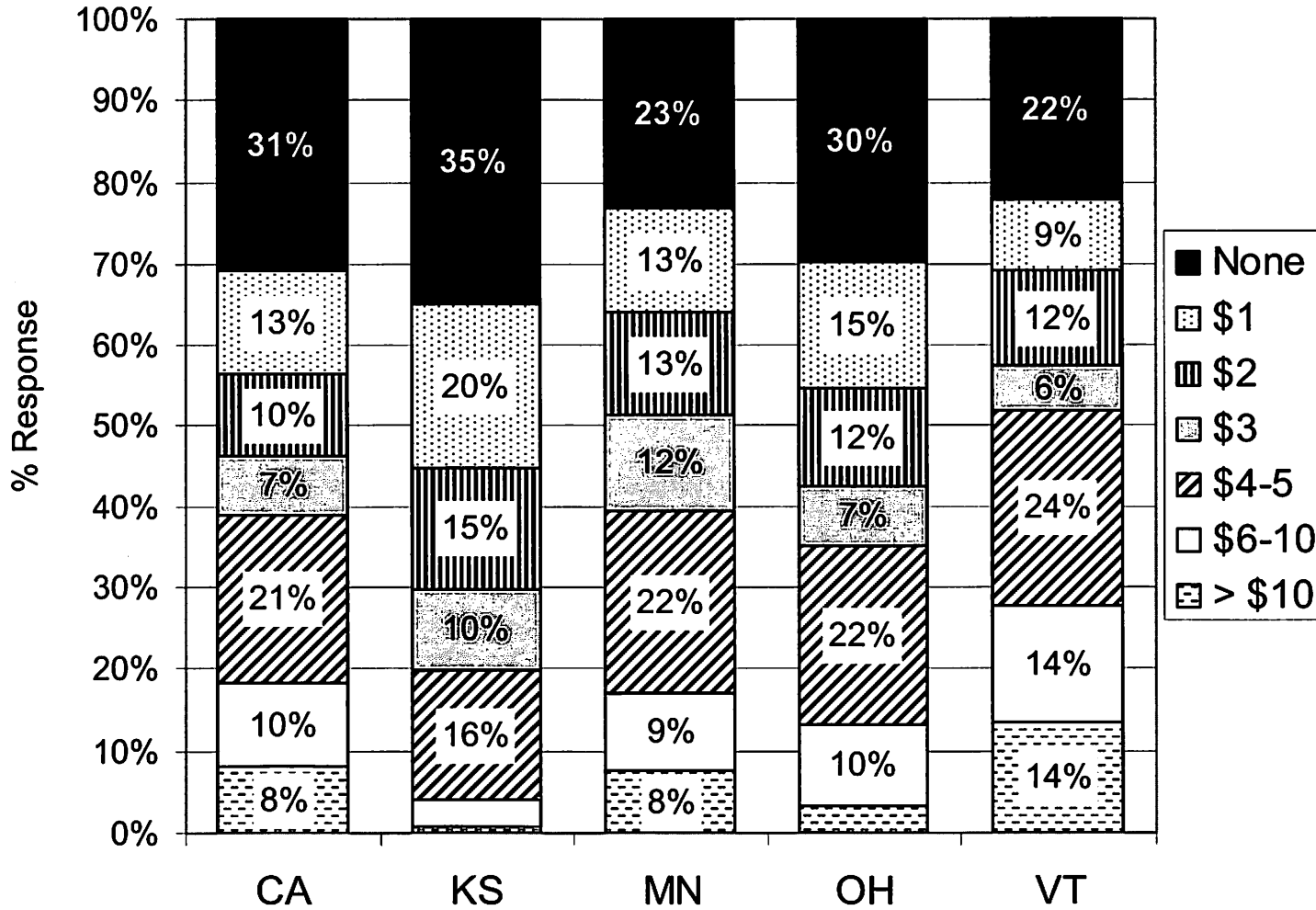


Figure 26. Amount of money boaters were willing to pay for increased boat or fishing licenses if the additional funding was used for AIS prevention and to reduce their impacts.

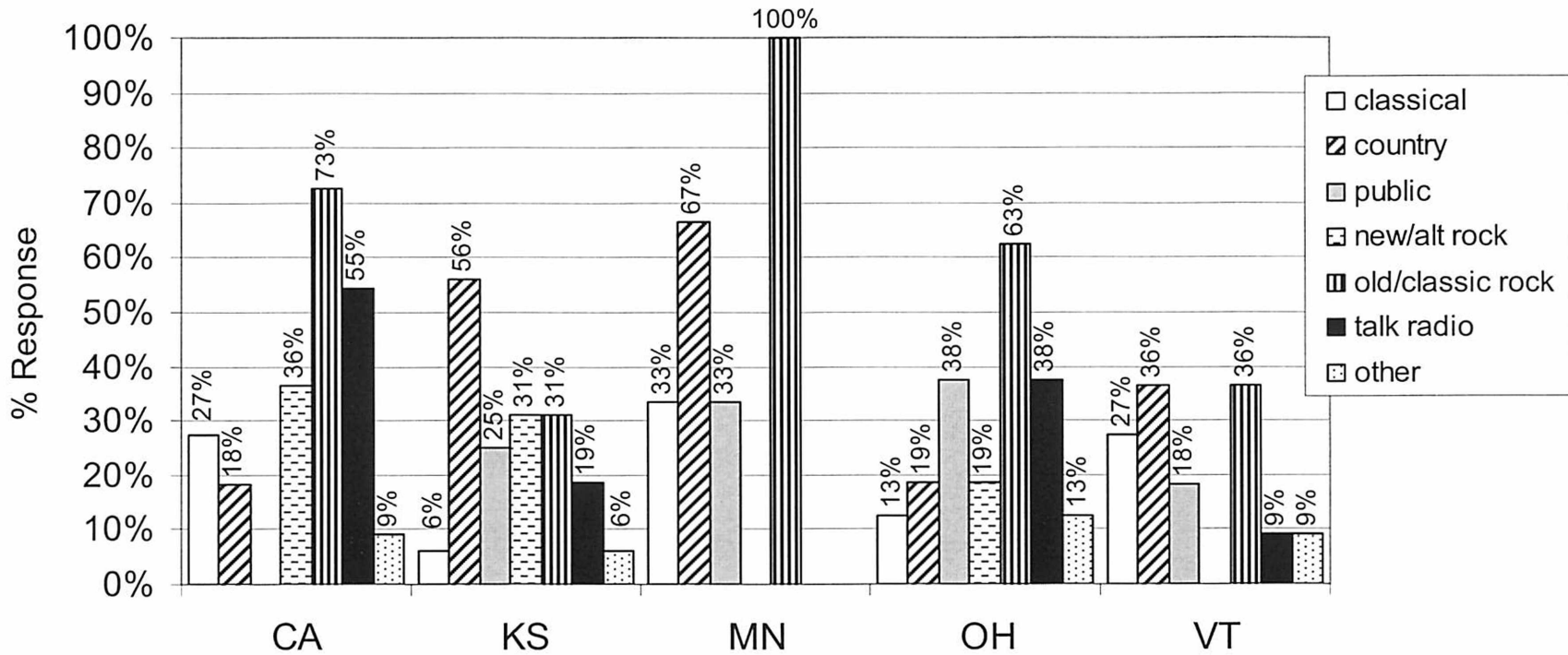


Figure 27. Radio stations listened to by boaters who indicated they would be either not very likely or not at all likely to take precautions to prevent the spread of AIS in the future if they boat on infested waters. Total within each state may be greater than 100% due to respondents listening to more than one type of radio station.

TABLES

Table 1. Five-state AIS and boater survey technical planning committee members.

State	Member	Affiliation
California	Jodi Cassell	California Sea Grant College Program
	Kim Webb	U.S. Fish and Wildlife Service, Region 1
Kansas	Linda Drees	U.S. Fish and Wildlife Service, Region 6 (formerly)
Minnesota	Jeffrey Gunderson	University of Minnesota Sea Grant Program
	Douglas Jensen	University of Minnesota Sea Grant Program
	Jay Rendall	Minnesota Department of Natural Resources
	Michelle Bratager	Minnesota Department of Natural Resources (formerly)
Ohio	Karen Ricker	Ohio Sea Grant Program (formerly)
Vermont	Mike Hauser	Vermont Dept, of Environmental Conservation (formerly)
Others	James Athearn	U.S. Army Corps of Engineers, NW Region (retired)
	Ladd Johnson	University of Laval, Quebec Department of Biology
	Rossanna Armson	University of Minnesota Center for Survey Research

Table 2. Five-state AIS and boater survey identification numbering and paper color by state.

Version	Identification Numbers	Paper Color
California	1000s	Blue
Kansas	2000s	Goldenrod
Minnesota	3000s	Yellow
Ohio	4000s	Salmon
Vermont	5000s	Green

Table 3. Five-state AIS boating survey and postcard mailing dates.

State	1 <sup>st</sup> Mailing	2 <sup>nd</sup> Mailing	3 <sup>rd</sup> Mailing	Final Postcard
California	February 2	February 9	February 23	March 9
Kansas	November 3	November 10	November 27	December 14
Minnesota	October 30	November 6	November 20	December 14
Ohio	October 30	November 6	November 20	December 14
Vermont	October 30	November 6	November 20	December 14

Table 4. Final sample status of the five-state AIS and boating survey.

Status	CA	KS	MN	OH	VT	Total
Surveys returned	272	358	496	389	437	1,952
Refusals	8	18	13	9	8	56
Surveys not returned	432	352	240	319	314	1,657
Eliminated:						
Nondeliverable	80	60	35	67	11	253
No longer have boat	6	1	6	6	3	22
No longer use boat	1	8	7	5	5	26
Other (deceased, < 18 yrs. old, business)	1	3	3	5	22	34
Total sent	800	800	800	800	800	800
Response rates*	38%	49%	66%	54%	58%	53% Mean

\* Response rates =  $\frac{\text{Completed surveys}}{\text{Total sent} - \text{eliminated}}$

Table 5. AIS listed in first two questions for each state surveyed.

California	Kansas	Minnesota	Ohio	Vermont
Zebra/quagga mussels	Zebra/quagga mussels	Zebra mussels	Zebra/quagga mussels	Zebra/quagga mussels
Eurasian watermilfoil	Eurasian watermilfoil	Eurasian watermilfoil	Eurasian watermilfoil	Eurasian watermilfoil
Purple loosestrife	Purple loosestrife	Purple loosestrife	White perch	Purple loosestrife
Hydrilla	Common carp	Spiny waterfleas	Spiny waterfleas	Water chestnut
Chinese mitten crab	Asian carp (bighead, silver, & black carp)	Round goby	Round goby	Alewife
Northern pike	White perch	Eurasian ruffe	Goldfish	Sea lamprey
Giant salvinia	Other	Other	Other	Hydrilla
Egeria densa*				Other

\* Brazilian waterweed

Table 6. Age demographics of boaters in five states surveyed.

Response	California	Kansas	Minnesota	Ohio	Vermont
Total	272	358	496	389	437
Mean Age	50	51	53	51	54
Youngest	17	16	19	21	22
Oldest	88	88	84	92	94
% Male	84	91	88	89	90
% Living in State	98	97	94	98	85

Table 7. Top five sources for information about AIS by boaters in five states surveyed.

<b>% Response</b>	<b>CA</b>	<b>KS</b>	<b>MN</b>	<b>OH</b>	<b>VT</b>	<b>MEAN</b>
Newspaper articles	55	51	88	79	89	73
Magazines/newsletters	43	53	73	69	77	65
Television news	51	33	82	57	79	63
Regulation pamphlets	29	48	87	58	79	65
Info at marinas/boat launches	29	29	83	27	82	54

Table 8. Estimated number of times boats were moved between waterbodies in each state during the 2000 boating season based on the number of registered boats. Estimated mean number of moves per boater was calculated by dividing the estimated total number of moves between waterbodies by the number of registered boats in each state.

<b>State</b>	<b># of Registered Boats</b>		<b>% Boaters Who Moved Boats</b>		<b>Mean # of Moves per Boater Who Moved</b>		<b>Estimated Total # of Moves Between Waterbodies</b>	<b>Estimated Mean # of Moves per Boater</b>
CA	955,700	x	58.1	x	9.6	=	5,330,512	5.6
KS	102,424	x	55.4	x	9.7	=	550,406	5.4
MN	793,107	x	56.8	x	9.7	=	4,369,702	5.5
OH	407,347	x	42.8	x	8.8	=	1,534,232	3.8
VT	37,932	x	37.3	x	9.0	=	127,338	3.4

Table 9. Percent boats by state that were moved along connected waterways or along a coast from waters known by boaters that were infested with AIS into uninfested waters. Frequency of AIS species are listed; some infested waters were not identified.

State	% Who Knew	Chinese Mitten-crab	Eurasian Water-milfoil	Hydrilla	Round Goby	Water Chestnut	White Perch	Zebra Mussel	Other
CA	3% (n=6)	4		2					
KS	0% (n=1)								
MN	4% (n= 16)		9					4	
OH	6% (n=18)		1		2		2	9	2
VT	5% (n=17)		7			1		5	

Table 10. Estimated number of times boats were moved between waterbodies in each state after a minimal time out of water.

State	<1 day	2-4 days	< 5 days
California	635,540	708,174	1,343,714
Kansas	64,527	72,014	136,541
Minnesota	1,040,556	1,127,798	2,168,354
Ohio	192,675	367,264	559,939
Vermont	27,391	29,595	56,986



Table 11. Percent change in reported actions by boaters compared to likelihood to act in the future to prevent the spread of AIS.

Comparison of Intention to Act	CA	KS	MN	OH	VT
Percent who reported that they took actions to prevent AIS spread	40.1	30.4	90.2	45.5	82.2
Percent who reported that they will "very likely" take action in the future	78.0	69.0	92.0	72.0	87.0
Percent change	37.9	38.6	2.0	26.5	4.8

Table 12. Percent of boaters who reported taking various actions at water accesses to prevent the spread of AIS.

Steps Taken	% CA	% KS	% MN	% OH	% VT
<u>Visual inspection</u>					
Almost Always	51	46	83	60	76
Sometimes	16	20	9	17	13
Never	24	27	2	17	4
Does Not Apply	9	7	5	6	7
<u>Drain water from boats, bait buckets</u>					
Almost Always	76	86	73	75	79
Sometimes	6	3	9	6	5
Never	4	3	3	4	1
Does Not Apply	14	8	15	16	15
<u>Avoid release of unwanted bait into water</u>					
Almost Always	36	40	58	38	39
Sometimes	10	17	18	17	10
Never	10	16	9	14	10
Does Not Apply	44	27	15	31	41
<u>Remove aquatic plants/animals from equipment</u>					
Almost Always	52	49	80	61	75
Sometimes	9	12	8	10	11
Never	15	18	2	11	4
Does Not Apply	25	21	10	18	11
<u>Flush motor with tap water</u>					
Almost Always	41	13	8	22	17
Sometimes	21	17	13	16	15
Never	19	48	55	34	41
Does Not Apply	19	22	24	28	26
<u>Rinse boat with high-pressure and/or hot water</u>					
Almost Always	32	20	10	33	26
Sometimes	25	35	26	27	25
Never	30	38	54	31	38
Does Not Apply	12	8	10	9	11
<u>Allow boat to dry at least 5 days</u>					
Almost Always	60	56	43	62	59
Sometimes	22	29	31	21	21
Never	7	11	14	8	11
Does Not Apply	11	4	12	9	10

Table 13. Reduction in propagule pressure calculated based on the estimated number of moves by boaters who did not take precautions to prevent the spread of AIS.

State	Estimated Total # of Moves Between Waterbodies (from Table 8)		% of Boaters Who Took Precautions Between Waterbodies (Table 14)		Estimated # of Moves by Boaters Who Took Precautions Between Waterbodies	Estimated # of Moves by Boaters Who Did Not Take Precautions
California	5,330,512	x	61.1	=	3,568,966	2,073,569
Kansas	550,406	x	57.2	=	314,832	235,574
Minnesota	4,369,702	x	93.4	=	4,081,302	288,400
Ohio	1,534,232	x	72.3	=	1,109,250	424,982
Vermont	127,338	x	91.7	=	116,769	10,569

Table 14. Percent of boaters who reported that select factors had already lead them to take action to prevent the spread of AIS. Factors are ranked highest to lowest based on the average of all states.

Responsible Factors Reported by Boaters	% CA	% KS	% MN	% OH	% VT	% Mean
Sense of Personal Responsibility	44	38	88	55	85	62
Desire to Keep AIS Out of Our Lakes & Rivers	38	38	85	53	83	59
Desire to Prevent Boat Damage	27	29	55	46	63	44
Signs at Marinas or Boat Launches	28	19	72	26	64	42
Talking with Friends, etc	25	19	60	44	62	42
Fishing/Boating Regulation Pamphlets	23	27	66	34	56	41
Media Sources	25	18	56	28	50	35
Magazine or Newsletter Articles	22	19	45	32	42	32
Brochures, Species ID Cards, etc.	18	19	42	24	39	29
Laws and Regulations	14	16	58	16	38	28
TV and Radio Public Sen/ice Announcements	18	11	50	18	43	28
Enforcement Checks on Roads or Launches	11	8	40	6	23	17
Creel Surveys/Inspection Education Programs	8	9	33	7	23	16
Fines That Must be Paid by Violators	12	9	30	9	17	15
Billboards	13	6	28	3	20	14
Presentations to Sporting Associations	7	7	13	10	18	11
Conferences or Workshops	7	7	13	9	17	10
Internet Web Sites	12	6	9	12	10	10
100th Meridian Initiative	8	5	10	5	9	7
Traveler Information Along Roads	4	3	7	2	7	5
Who Did Not Take Action	39	43	7	28	8	25

Table 15. Percent of boaters who reported the following factors would be very effective at leading them to take action to prevent the spread of AIS. Factors are ranked highest to lowest based on the average of all states.

Responsible Factors Reported by Boaters	CA	KS	MN	OH	VT	Mean
Desire to Keep AIS Out of Our Lakes/Rivers	67	57	87	72	82	73
Sense of Personal Responsibility	62	53	83	65	77	68
Signs at Marinas or Boat Launches	58	53	76	56	70	63
Desire to Prevent Boat Damage	57	57	57	69	53	59
Fishing and Boating Regulation Pamphlets	53	54	68	54	57	57
Laws and Regulations	46	45	61	50	52	51
Fines That Must Be Paid by Violators	48	43	57	54	51	51
Enforcement Checks on Roads or Launches	42	43	59	43	52	48
Media Sources	53	34	50	48	51	47
Brochures, Species ID Cards, etc	43	44	49	45	44	45
TV & Radio Public Service Announcements	50	31	49	42	48	44
Magazine or Newsletter Articles	36	32	40	45	40	39
Talking with Friends, etc	36	26	43	40	41	37
Creel Surveys/Inspection Education Prgms.	25	27	41	29	36	31
Presentations to Sporting Associations	23	20	26	25	25	24
Billboards	26	15	32	17	26	23
Conferences or Workshops	21	20	21	23	26	22
Internet Web Sites	23	17	14	24	16	19
100th Meridian Initiative	13	14	15	18	15	15
Traveler Information Along Roads	10	9	11	8	9	9

Table 16. Number and percent of boaters who were unlikely (not very likely and not at all likely) to take precautions against spreading AIS who also responded that listed factors would be very effective at getting them to take action to prevent the spread of AIS in the future. Factors are ranked from highest to lowest based on the average of all states.

Responsible Factors Reported by Boaters	CA Boaters Unlikely to Take Action		KS Boaters Unlikely to Take Action		MN Boaters Unlikely to Take Action		OH Boaters Unlikely to Take Action		VT Boaters Unlikely to Take Action		Mean %
	#	%	#	%	#	%	#	%	#	%	
Desire to Keep AIS Out of 'My' Lake	2	18	4	25	10	63	2	67	6	55	45
Prevent Boat Damage	5	45	3	19	10	63	1	33	3	27	37
A Sense of Personal Responsibility	2	18	3	19	8	50	2	67	2	18	34
Laws or Regulations to Prevent Transport	3	27	3	19	8	50	1	33	4	36	33
Signs at Marinas or Boat Launches	2	18	5	31	6	38	1	33	3	27	30
Fishing or Boating Regulation Pamphlets	4	36	2	13	6	38	1	33	2	18	28
Enforcement Checks on Road or Boat Launch	3	27	3	19	4	25	1	33	3	27	26
Fines Paid by Violators	3	27	3	19	7	44	0	0	4	36	25
TV or Radio Public Service Announcements	2	18	3	19	3	19	1	33	4	36	25
Brochures, AIS ID cards, etc.	1	9	3	19	2	13	2	67	2	18	25
Media Sources (newspapers, radio, TV news)	2	18	1	6	3	19	1	33	5	45	24
Magazine or Newsletter Articles	1	9	2	13	4	25	1	33	3	27	21
Talking with Friends, etc.	2	18	1	6	7	44	1	33	0	0	20
Creel Surveys/Inspection-Education Programs	2	18	2	13	2	13	0	0	3	27	14
Conferences or Workshops	0	0	4	25	2	13	0	0	3	27	13
Presentations to Sporting Associations	1	9	1	6	1	6	0	0	2	18	8
Internet Web Sites	1	9	1	6	1	6	0	0	1	9	6
100th Meridian Initiative	0	0	1	6	1	6	0	0	1	9	4
Billboards	0	0	1	6	2	13	0	0	0	0	4
Traveler Information or Low Power Radio	0	0	1	6	0	0	0	0	0	0	1

Table 17. Percent of all large and small power boat owners who reported that AIS had affected their recreational experience.

Type of Powerboat	% CA	% KS	% MN	% OH	% VT
Small Powerboat	84	91	89	7	76
Large Powerboat	89	78	77	25	71

Table 18. Radio listener preference by boater type in five states surveyed.

State	% Classical	% Country	% Public	% New Age/ Alternative	% Oldies/ Classic Rock	% Talk Radio	% Other
<b>Small Sailboats</b>							
California	9	9	18	18	27	9	9
Kansas	15	15	31	8	8	23	0
Ohio	5	5	32	5	14	32	9
Minnesota	9	18	0	18	36	18	0
Vermont	8	8	31	8	39	8	0
Mean all surveys	9	9	18	18	27	9	9
<b>Large Sailboats</b>							
California	38	0	25	0	38	0	0
Kansas	23	8	23	8	31	8	0
Ohio	15	25	20	0	15	20	5
Minnesota	25	0	25	0	25	0	25
Vermont	16	11	16	21	16	16	5
Mean all surveys	8	18	13	10	28	19	3
<b>Personal Watercraft</b>							
California	0	31	7	17	24	17	3
Kansas	0	20	12	12	40	12	4
Ohio	8	16	8	8	31	31	0
Minnesota	25	50	0	25	0	0	0
Vermont	0	20	0	30	40	20	0
Mean all surveys	7	27	5	18	27	16	2
<b>Duckboats</b>							
California	0	20	20	0	20	40	0
Kansas	17	17	17	17	33	0	0
Ohio	22	22	11	11	11	22	0
Minnesota	9	18	27	9	18	18	0
Vermont	15	8	8	15	15	8	0
Mean all surveys	13	20	17	11	20	18	0
<b>Small Powerboats</b>							
California	10	17	9	8	27	23	5
Kansas	6	34	8	8	23	18	5
Ohio	11	23	9	9	31	17	1
Minnesota	6	23	13	8	28	19	4
Vermont	8	26	14	9	28	11	4
Mean all surveys	8	25	11	8	27	18	4
<b>Large Powerboats</b>							
California	10	11	8	11	25	28	6
Kansas	2	25	15	10	27	19	2
Ohio	12	18	10	10	40	12	3
Minnesota	4	23	12	12	23	23	4
Vermont	17	14	22	7	25	12	3
Mean all surveys	8	18	13	10	28	19	3
<b>Kayaks and Canoes</b>							
California	14	29	14	0	14	29	0
Kansas	0	33	33	0	33	0	0
Ohio	12	15	24	12	17	15	5
Minnesota	12	8	25	12	17	15	5
Vermont	7	27	27	7	27	7	0
Mean all surveys	9	22	25	6	23	13	2
<b>Pontoons</b>							
California	0	0	0	0	0	0	0
Kansas	0	42	0	17	17	17	8
Ohio	8	15	8	8	39	15	8
Minnesota	15	30	15	0	20	10	10
Vermont	7	36	7	7	21	7	14
Mean all surveys	8	31	8	8	24	12	10

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

CALIFORNIA AQUATIC NUISANCE SPECIES AND BOATING SURVEY

Please circle the number which corresponds to the answer closest to your opinion or situation. ALL INDIVIDUAL RESPONSES WILL BE KEPT CONFIDENTIAL For the purpose of this survey, BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.

Q1. AQUATIC NUISANCE SPECIES are plants or animals that enter places where they have NOT always lived. They can be harmful to fish and wildlife, and to commercial and recreational water uses. How much information have you heard or read about each of the AQUATIC NUISANCE SPECIES listed below? (Circle one answer for each item.)

Aquatic Nuisance Species	How much Information have you heard/read about . .			
	A Large Amount	A Moderate Amount	A Small Amount	None
a. Zebra mussels/quagga mussels	1	2	3	4
b. Eurasian watermilfoil	1	2	3	4
c. Purple loosestrife	1	2	3	4
d. Hydrilla	1	2	3	4
e. Chinese mitten crab	1	2	3	4
f. Northern pike	1	2	3	4
g. Giant salvinia	1	2	3	4
h. Egeria densa	1	2	3	4
i. Other (please specify)	1	2	3	4

Q2. In your opinion, how important is it that boaters and anglers take precautions to prevent the spread of each of the following aquatic nuisance species from one body of water to another?

(Circle one answer for each item.)

Aquatic Nuisance Species	Taking precautions to prevent the spread Is . . .				
	Very Important	Somewhat Important	Not Very Important	Not at All Important	Don't Know
a. Zebra mussels/ quagga mussels	1	2	3	4	5
b. Eurasian watermilfoil	1	2	3	4	5
c. Purple loosestrife	1	2	3	4	5
d. Hydrilla	1	2	3	4	5
e. Chinese mitten crab	1	2	3	4	5
f. Northern pike	1	2	3	4	5
g. Giant salvinia	1	2	3	4	5
h. Egeria densa	1	2	3	4	5
i. Other (please specify)	1	2	3	4	5



## Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

### KANSAS AQUATIC NUISANCE SPECIES AND BOATING SURVEY

*Please circle the number which corresponds to the answer closest to your opinion or situation. ALL INDIVIDUAL RESPONSES WILL BE KEPT CONFIDENTIAL For the purpose of this survey, BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.*

**Q1. AQUATIC NUISANCE SPECIES** are plants or animals that enter places where they have NOT always lived. They can be harmful to fish and wildlife, and to commercial and recreational water uses. How much information have you heard or read about each of the AQUATIC NUISANCE SPECIES listed below? *(Circle one answer for each item.)*

*How much information have you heard/read about..*

Aquatic Nuisance Species	A Large	A Moderate	A Small	None
	Amount	Amount	Amount	
a. Zebra mussels/quagga mussels	1	2	3	4
b. Eurasian watermilfoil	1	2	3	4
c. Purple loosestrife	1	2	3	4
d. Common carp	1	2	3	4
e. Asian carp (bighead carp, silver carp, & black carp)	1	2	3	4
f. White perch	1	2	3	4
g. Other (please specify)	1	2	3	4

**Q2. In your opinion, how important is it that boaters and anglers take precautions to prevent the spread of each of the following aquatic nuisance species from one body of water to another?**

*(Circle one answer for each item.)*

*Taking precautions to prevent the spread is . . .*

Aquatic Nuisance Species	Very	Somewhat	Not Very	Not at All	Don't
	Important	Important	Important	Important	
a. Zebra mussels/ quagga mussels	1	2	3	4	5
b. Eurasian watermilfoil	1	2	3	4	5
c. Purple loosestrife	1	2	3	4	5
d. Common carp	1	2	3	4	5
e. Asian carp (bighead, silver, & black carp)	1	2	3	4	5
f. White perch	1	2	3	4	5
g. Other (please specify)	1	2	3	4	5

## Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

### MINNESOTA AQUATIC NUISANCE SPECIES AND BOATING SURVEY

Please circle the number which corresponds to the answer closest to your opinion or situation. ALL INDIVIDUAL RESPONSES WILL BE KEPT CONFIDENTIAL. For the purpose of this survey, BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.

- Q1. AQUATIC NUISANCE SPECIES are plants or animals that enter places where they have NOT always lived. They can be harmful to fish and wildlife, and to commercial and recreational water uses. How much information have you heard or read about each of the AQUATIC NUISANCE SPECIES listed below? (Circle one answer for each item.)

*How much information have you heard/read about . .*

<u>Aquatic Nuisance Species</u>	<u>A Large Amount</u>	<u>A Moderate Amount</u>	<u>A Small Amount</u>	<u>None</u>
a. Zebra mussels	1	2	3	4
b. Eurasian watermilfoil	1	2	3	4
c. Purple loosestrife	1	2	3	4
d. Spiny waterflea	1	2	3	4
e. Round goby	1	2	3	4
f. Eurasian ruffe	1	2	3	4
g. Other (please specify)	1	2	3	4

- Q2. In your opinion, how important is it that boaters and anglers take precautions to prevent the spread of each of the following aquatic nuisance species from one body of water to another? (Circle one answer for each item.)

*Taking precautions to prevent the spread is . . .*

<u>Aquatic Nuisance Species</u>	<u>Very Important</u>	<u>Somewhat Important</u>	<u>Not Very Important</u>	<u>Not at All Important</u>	<u>Don't Know</u>
a. Zebra mussels	1	2	3	4	5
b. Eurasian watermilfoil	1	2	3	4	5
c. Purple loosestrife	1	2	3	4	5
d. Spiny waterflea	1	2	3	4	5
e. Round goby	1	2	3	4	5
f. Eurasian ruffe	1	2	3	4	5
g. Other (please specify)	1	2	3	4	5

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

OHIO AQUATIC NUISANCE SPECIES AND BOATING SURVEY

Please circle the number which corresponds to the answer closest to your opinion or situation. ALL INDIVIDUAL RESPONSES WILL BE KEPT CONFIDENTIAL. For the purpose of this survey, BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.

Q1. AQUATIC NUISANCE SPECIES are plants or animals that enter places where they have NOT always lived. They can be harmful to fish and wildlife, and to commercial and recreational water uses. How much information have you heard or read about each of the AQUATIC NUISANCE SPECIES listed below? (Circle one answer for each item.)

		How much information have you heard/read about. . .			
Aquatic Nuisance Species		A Large Amount	A Moderate Amount	A Small Amount	None
a.	Zebra mussels/quagga mussels 1		2	3	4
b.	Eurasian watermilfoii 1		2	3	4
c.	White perch 1		2	3	4
d.	Spiny waterflea 1		2	3	4
e.	Round goby 1		2	3	4
f.	Goldfish 1		2	3	4
g.	Other (please specify) 1		2	3	4

---

Q2. In your opinion, how important is it that boaters and anglers take precautions to prevent the spread of each of the following aquatic nuisance species from one body of water to another?

(Circle one answer for each item.)

		Taking precautions to prevent the spread is . . .				
Aquatic Nuisance Species		Very Important	Somewhat Important	Not Very Important	Not at All Important	Don't Know
a.	Zebra mussels/ quagga mussels	1	2	3	4	5
b.	Eurasian watermilfoii	1	2	3	4	5
c.	White perch	1	2	3	4	5
d.	Spiny waterflea	1	2	3	4	5
e.	Round goby	1	2	3	4	5
f.	Goldfish	1	2	3	4	5
g.	Other (please specify)	1	2	3	4	5

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Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

VERMONT AQUATIC NUISANCE SPECIES AND BOATING SURVEY

Please circle the number which corresponds to the answer closest to your opinion or situation. ALL INDIVIDUAL RESPONSES WILL BE KEPT CONFIDENTIAL For the purpose of this survey, BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.

Q1. AQUATIC NUISANCE SPECIES are plants or animals that enter places where they have NOT always lived. They can be harmful to fish and wildlife, and to commercial and recreational water uses. How much information have you heard or read about each of the AQUATIC NUISANCE SPECIES listed below? (Circle one answer for each item.)

		How much Information have you heard/read about . .			
Aquatic Nuisance Species		A Large Amount	A Moderate Amount	A Small Amount	None
a.	Zebra mussels/quagga mussels 1		2	3	4
b.	Eurasian watermilfoil 1		2	3	4
c.	Purple loosestrife 1		2	3	4
d.	Water chestnut 1		2	3	4
e.	Alewife 1		2	3	4
f.	Sea lamprey 1		2	3	4
g.	Hydrilla 1		2	3	4
h.	Other (please specify) 1		2	3	4

---

Q2. In your opinion, how important is it that boaters and anglers take precautions to prevent the spread of each of the following aquatic nuisance species from one body of water to another? (Circle one answer for each item.)

		Taking precautions to prevent the spread is . . .				
<u>Aquatic Nuisance Species</u>	<u>Very Important</u>	<u>Somewhat Important</u>	<u>Not Very Important</u>	<u>Not at All Important</u>	<u>Don't Know</u>	
a. Zebra mussels/ quagga mussels	1	2	3	4	5	
b. Eurasian watermilfoil	1	2	3	4	5	
c. Purple loosestrife	1	2	3	4	5	
d. Water chestnut	1	2	3	4	5	
e. Alewife	1	2	3	4	5	
f. Sea lamprey	1	2	3	4	5	
g. Hydrilla	1	2	3	4	5	
h. Other (please specify)	1	2	3	4	5	

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Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

Q3. Have you heard of or read about aquatic nuisance species from any of the following sources?  
(Circle one answer for each source.)

	Yes	No	Don't Know
<b>MEDIA SOURCES</b>			
A. Newspaper articles	1	2	3
B. Magazine or newsletter articles	1	2	3
C. Television news or programs	1	2	3
D. Radio news or programs	1	2	3
E. Television public service announcements	1	2	3
F. Radio public service announcements	1	2	3
G. Billboards	1	2	3
H. Internet web sites	1	2	3
<b>EVENTS</b>			
I. Conferences, presentations, or meetings	1	2	3
J. An educational exhibit or display	1	2	3
K. Fishing contests, fishing derbys, or sailboat regattas	1	2	3
L. A booth at a sport show, fishing show, or similar event	1	2	3
<b>FISHING OR BOATING SOURCES</b>			
M. Fishing or boating regulation pamphlets	1	2	3
N. Boat registration materials	1	2	3
O. Creel surveys or inspection-education programs on roads or at boat launches	1	2	3
P. Signs or information provided at a marina or boat launch	1	2	3
Q. Signs or information provided at a bait shop	1	2	3
R. A fishing, boating, sporting, or environmental organization	1	2	3
<b>OTHER SOURCES</b>			
S. Brochures, species identification cards, fact sheets, or other printed materials	1	2	3
T. Books	1	2	3
U. Educational videos	1	2	3
V. Hot line or information clearinghouse	1	2	3
W. Other (please specify) _____	1	2	3

Q4. Of the sources of information that you circled in Question 3, which four were your BEST sources of information about aquatic nuisance species? (Write the letter for each item you select in the spaces provided below.)

\_\_\_\_\_

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

Q5. How effective would each of the following be in getting YOU to take steps to prevent the spread of aquatic nuisance species? (Circle one number for each item.) In the last column, please tell us which ones ALREADY led you to take action. (Circle Yes or No for each item.)

HOW EFFECTIVE WOULD THIS BE IN GETTING YOU TO TAKE ACTION ...	Would be	Would be	Would NOT	This already	
	very effective	somewhat effective	be very effective	led me to take	action
A. Talking with friends or acquaintances	1	2	3	Yes	No
B. A sense of personal responsibility	1	2	3	Yes	No
C. A desire to keep aquatic nuisance species out of our lakes or streams	1	2	3	Yes	No
D. A desire to prevent damage to my boat or equipment	1	2	3	Yes	No
E. Laws or regulations to prevent the transport of aquatic nuisance species	1	2	3	Yes	No
F. Enforcement checks on the road or at boat launches to catch violators	1	2	3	Yes	No
G. Fines that must be paid by violators	1	2	3	Yes	No
H. Media sources (newspapers and radio and TV news/programs)	1	2	3	Yes	No
I. Television or radio public service announcements	1	2	3	Yes	No
J. Billboards	1	2	3	Yes	No
K. Magazine or newsletter articles	1	2	3	Yes	No
L. Internet web sites	1	2	3	Yes	No
M. Fishing or boating regulation pamphlets	1	2	3	Yes	No
N. Conferences or workshops for boaters and anglers	1	2	3	Yes	No
O. Brochures, species identification cards, fact sheets, or other printed materials	1	2	3	Yes	No
P. Signs at marinas or boat launches	1	2	3	Yes	No
Q. Creel surveys or inspection-education programs on roads or at boat launches	1	2	3	Yes	No
R. Videos or other presentations to boating, lake, and sporting associations	1	2	3	Yes	No
S. Traveller information or low power radio broadcasts along roads	1	2	3	Yes	No
T. 100th Meridian Initiative to prevent Western spread of aquatic nuisance species	1	2	3	Yes	No

GO TO THE TOP

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

- Q6. Of the items that you said "would be VERY EFFECTIVE" in Question 5, which would be MOST effective in getting you to take steps to prevent the spread of aquatic nuisance species? (Write the letter for each item you select in the spaces provided below.)

\_\_\_\_\_

The next questions are about your recreational use of ALL boat(s) during the 2000 boating season. Your answers will help us determine the movement of boats between waterbodies.

- Q7. Did you USE a boat or boats during the 2000 boating season? (Circle one.)
1. YES
  2. NO IF NO, SKIP TO QUESTION 18 ON PAGE 7)

- Q8. What type of boat(s) did you use during 2000? (Circle all that apply.)

- a. Small sailboat (less than 20 feet)
- b. Large sailboat (20 feet or longer)
- c. Personal watercraft (Get ski)
- d. Duckboat
- e. Small powerboat (less than 20 feet)
- f. Large powerboat (20 feet or longer)
- g. Canoe or kayak
- h. Other type of boat (please specify) \_\_\_\_\_

- Q9. Thinking about all boats you used during the 2000 boating season, about how long was the boat(s) IN the water before being moved to a different waterbody? Do NOT include time on a boat lift. (Fill in the number of times during the 2000 boating season for each time period.)

- a. I never moved ANY boat(s) to a different waterbody
- b. One day or less \_\_\_\_\_ times
- c. 2 to 4 days \_\_\_\_\_ times
- d. 5 to 14 days \_\_\_\_\_ times
- e. 15 to 30 days \_\_\_\_\_ times
- f. More than 30 days \_\_\_\_\_ times

**Remember to write in  
the number of times**

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

Q10. About how long was the boat(s) OUT of the water before you put it in a DIFFERENT waterbody than it was PREVIOUSLY used in? Include the amount of time on a trailer, on a boat lift, on a rack, or transported on a road. (Fill in the number of times during the 2000 boating season for each time period.)

- a. I never moved ANY boat(s) to a different waterbody
- b. One day or less \_\_\_\_\_ times
- c. 2 to 4 days \_\_\_\_\_ times
- d. 5 to 14 days \_\_\_\_\_ times
- e. 15 to 30 days \_\_\_\_\_ times
- f. More than 30 days \_\_\_\_\_ times

Remember to write in the number of times

Q11. If you moved any boat(s) to a different waterbody than it was previously used in, how far apart were the different bodies of water? (Fill in the number of times during the 2000 boating season for each distance category.)

- a. I never moved ANY boat(s) to a different waterbody
- b. Ten miles or less \_\_\_\_\_ times
- c. 11 to 50 miles \_\_\_\_\_ times
- d. 51 to 150 miles \_\_\_\_\_ times
- e. 151 to 500 miles \_\_\_\_\_ times
- f. More than 500 miles \_\_\_\_\_ times

Remember to write in the number of times

Q12. During the 2000 boating season, did you TRANSPORT (By truck, trailer, car top, etc.) any boat(s) to waters OUTSIDE the state where the boat is licensed? (Circle one.)

- 1. YES  
= = = >
- 2. NO

<ul style="list-style-type: none"> <li>a. How many different times did you transport boat(s) to another state or province in 2000? _____ times</li> <li>b. Please list each state or province that you transported boat(s) to in 2000. _____</li> </ul>
---

Q13. During the 2000 boating season, did you move any boat(s) along connected waterways (such as rivers or canals) or along the coast FROM waters that you knew were infested with any of the aquatic nuisance species listed in Question 1 INTO uninfested waters? (Circle one.)

- 1. YES = = = >
- 2. NO
- 3. DON'T KNOW

<ul style="list-style-type: none"> <li>a. Please list the names of the waterways that you went to and from in the boat(s):</li> <li>WENT TO (uninfested waters): _____</li> <li>WENT FROM (infested waters): _____</li> <li>WHICH AQUATIC NUISANCE SPECIES: _____</li> </ul>
--



Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

Q14. Before you transport the boat(s), do you take any special steps to prevent the transport of water or aquatic nuisance species from one body of water to another? (Circle one.)

- 1. YES
- 2. NO      = = = >
- 3. I never moved ANY boat(s) to a different waterbody

**(IF NO)** If you do not take any special precautions, why not? (Circle all that apply.)

- a. I don't believe it will prevent the eventual spread of aquatic nuisance species
- b. It's inconvenient, I don't have time to take precautions
- c. I don't know exactly what I'm supposed to do
- d. I didn't boat on infested waters
- e. I don't believe aquatic nuisance species are a problem
- f. Boat washing equipment was not readily available
- g. Other (please specify) \_\_\_\_\_

Q15. During 2000, did you boat on waters that you knew were infested with ANY of the aquatic nuisance species listed in Question 1 on the front page? (Circle one.)

- 1. YES      = = = >
- 2. NO
- 3. DON'T KNOW

**(IF YES)** How did you know that the waters you boated on were infested with an aquatic nuisance species? (Circle all that apply.)

- a. Sign or poster at boat launch or marina
- b. Brochure, fact sheet, or flyer
- c. Fishing, boating, or waterfowl regulation pamphlet
- d. Internet web site
- e. Watercraft educator/inspector
- f. Media sources (newspaper, radio, TV)
- g. Hot line or information clearinghouse
- h. Heard about it from a friend or relative
- i. Other (please specify) \_\_\_\_\_

Q16. If you do boat on infested waters, how likely is it that YOU will take precautions in the future to prevent the spread of aquatic nuisance species between bodies of water? (Circle one.)

- 1. Very likely
- 2. Some what likely
- 3. Not very likely
- 4. Not at all likely
- 5. I never boat on infested waters

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

Q17. After removing boat(s) from the water, how often do you do the following?  
(Circle one answer for each item.)

Steps Taken:	Almost Always	Some-times	Never	Does Not Apply
a. Conduct visual inspection of boats and equipment for aquatic plants and animals	1	2	3	4
b. Drain water from boats, including live wells, bilge, and bait buckets	1	2	3	4
c. Avoid release of unwanted live bait into the water	1	2	3	4
d. Remove aquatic plants and animals from boats and equipment	1	2	3	4
e. Flush motor's cooling system with tap water	1	2	3	4
f. Rinse boat with high pressure and/or hot water	1	2	3	4
g. Allow boat to dry for at least five days	1	2	3	4
h. Other (please specify)_____	1	2	3	4

Q18. Have aquatic nuisance species caused problems for you or affected your recreational experience during the 2000 boating season? (Circle one.)

1. YES = = = >
2. NO
3. DON'T KNOW

a. Please list all impacts, the aquatic nuisance species that were involved, and any associated costs you have experienced.

Q19. How much MORE would you be willing to spend for a boating or fishing license if the additional money was used to fund activities to prevent the spread of aquatic nuisance species and to reduce their harmful effects? (Circle one.)

1. \$1
2. \$2
3. \$3
4. \$4 to \$5
5. \$6 to \$10
6. More than \$10
7. Would NOT be willing to spend more

Appendix A. Five State Aquatic Nuisance Species and Boating Survey 2000

[Note: Beginning five pages were the first page from each state-specific survey. Pages 2-8 were identical on all surveys.]

Please answer the following questions about yourself. This information will be used only to compare people's answers, it will not be used to identify you in any way.

Q20. What types of radio stations do you usually listen to? (Circle all that apply.)

- a. Classical music
- b. Country music
- c. Public radio
- d. New/alternative rock music
- e. Oldies/classic rock music
- f. Talk radio
- g. Other (please specify) \_\_\_\_\_

Q21. Are you male or female? (Circle one.)

- 1. Male
- 2. Female

Q22. In what state or province is your primary residence located? \_\_\_\_\_

Q23. What is your zip code or postal code? \_\_\_\_\_

Q24. In what year were you born? \_\_\_\_\_

Q25. What recommendations or other comments would you like to make about the spread of aquatic nuisance species in your state's or province's waters?

Thank you for your time and cooperation.

Please return this questionnaire in the enclosed postage-paid envelope to:

Minnesota Center for Survey Research, University of Minnesota  
2331 University Avenue SE, Suite 141  
Minneapolis, Minnesota 55414-3067  
(612) 627-4282

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Cover Letter for California



COOPERATIVE EXTENSION  
UNIVERSITY OF CALIFORNIA

## SEA GRANT EXTENSION PROGRAM

February 1, 2001

Dear California Boater,

Lakes and streams in California provide some of the best recreational opportunities available in the region. However, many natural resources, including game fish, water quality, and habitat, are affected by pollution and other environmental changes.

One particular change that has become more of a problem in recent years is aquatic nuisance species in marine and freshwaters. These are plants or animals that enter habitats where they are not native, where they have not always lived, grown, and reproduced. Aquatic nuisance species can be introduced in a number of ways. For example, some of these invaders hitch a ride in the ballast water of ocean-going vessels and find a new home in Great Lakes or coastal ports.

Because the presence of aquatic nuisance species is a national issue, many state and regional agencies have been studying their presence in marine and freshwaters. The results of this research will be used to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

You are one of a small number of boaters who are being asked to provide opinions about water-transported aquatic nuisance plant and animal species. Your name was drawn in a random sample of California's licensed boat owners. In order for the results to truly represent the thinking of all boaters, it is important that each questionnaire be completed and returned. The questionnaire can be completed by any adult in your household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so your name can be checked off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

If you have any questions about this study, please write or call Rossana Armson at the University of Minnesota at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. on weekdays, central standard time. Collect calls will be accepted. She would be happy to answer your questions. Thank you for your assistance.

Sincerely,

A handwritten signature in cursive script that reads "Jodi Cassell".

**Jodi Cassell**  
**Marine Advisor and Project Leader**

P. S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because they are coordinating the mailings.

In accordance with applicable State and Federal laws and University policy, the University of California does not discriminate in any of its policies, procedures or practices on the basis of race, religion, color, national origin, sex, marital status, sexual orientation, age, veteran status, medical condition, or handicap. Inquiries regarding this policy may be addressed to the Affirmative Action Director, University of California, Agriculture and Natural Resources, 300 Lakeside Drive, 8th Floor, Oakland, CA 94612-3560. (415) 937-0997.

University of California, The United States Department of Agriculture, and The United States Department of Commerce cooperating.

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Reminder Postcard Text for California

Last week a questionnaire seeking your opinion about aquatic nuisance species and boating practices was mailed to you. We are very interested in your opinions about the impact of aquatic nuisance species on your state's streams, lakes, and rivers. Your name was drawn in a random sample of boaters in your state.

If you have already completed and returned the questionnaire, please accept our sincere thanks! If not, please answer the questions and return it today. Because the survey has been sent to only a small sample of boaters in your state, it is extremely important that your opinions be included, if the results are to accurately represent the opinions of all boaters.

If you did not receive the survey, or it has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 University Avenue SE, Suite 141  
Minneapolis, Minnesota 55414-3067

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Follow Up Letter for California



COOPERATIVE EXTENSION  
UNIVERSITY OF CALIFORNIA

## SEA GRANT EXTENSION PROGRAM

February 23, 2001

Dear California Boater,

About three weeks ago, I wrote to you seeking your opinion about aquatic nuisance species and boating practices. As of today, we have not yet received your completed questionnaire.

This survey has been undertaken to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was drawn through a scientific sampling process in which every licensed boat owner in California had an equal chance of being selected. In order for the results of this study to be truly representative of the opinions of all California boat owners, it is important that each questionnaire be completed and returned. As mentioned in my previous letter, the survey can be completed by any adult in the household.

In the event that your survey has been misplaced, a replacement is enclosed. If you have any questions about the survey, please write or call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. weekdays, central standard time.

Your cooperation is greatly appreciated.

Sincerely,

A handwritten signature in black ink that reads "Jodi Cassell".

Jodi Cassell  
Marine Advisor and Project Leader

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Final Postcard Text for California

#### **PLEASE SEND US YOUR COMPLETED SURVEY!**

I am writing to you about a boating survey that was recently sent to you. You were one of the boat owners who was selected to participate, but we have not yet received your completed survey.

Because the survey was sent to only a few boat owners, it is extremely important that your opinions be included in the results. We really want to hear from you, even if you didn't boat in 2000. **Your input is important!**

If you have not yet returned your completed survey, please do it as soon as possible. If your survey has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away. Your name and address will be deleted from our mailing list when your survey is received. Thank you for your participation.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 Univ Avenue SE, Suite 141, Mpls MN 55414

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Cover Letter for Kansas

UNIVERSITY OF MINNESOTA

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*Twin Cities Campus*

*Minnesota Center for Survey Research*

*Suite 141  
2331 University Avenue S.E.  
Minneapolis, MN 55414-3067  
612-627-4282*

**November 3, 2000**

Dear Kansas Boater,

Lakes and streams in Kansas provide some of the best recreational opportunities available in the region. However, many natural resources, including game fish, water quality, and habitat, are affected by pollution and other environmental changes.

One particular change that has become more of a problem in recent years is aquatic nuisance species in marine and freshwaters. These are plants or animals that enter habitats where they are not native, where they have not always lived, grown, and reproduced. Aquatic nuisance species can be introduced in a number of ways. For example, some of these invaders hitch a ride in the ballast water of ocean-going vessels and find a new home in Great Lakes or coastal ports.

Because the presence of aquatic nuisance species is a national issue, many state and regional agencies have been studying their presence in marine and freshwaters. The results of this research will be used to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

You are one of a small number of boaters who are being asked to provide opinions about water-transported aquatic nuisance plant and animal species. Your name was drawn in a random sample of Kansas' licensed boat owners. In order for the results to truly represent the thinking of all boaters, it is important that each questionnaire be completed and returned. The questionnaire can be completed by any adult in your household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so we may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

I would be happy to answer any questions you have about this study. Please write or call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. on weekdays, central standard time. Collect calls will be accepted. Thank you for your assistance.

Sincerely,



Rossana Armson  
Director

P.S. Five states are participating in this effort; California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because we are coordinating the mailings.



## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Reminder Postcard Text for Kansas

Last week a questionnaire seeking your opinion about aquatic nuisance species and boating practices was mailed to you. We are very interested in your opinions about the impact of aquatic nuisance species on your state's streams, lakes, and rivers. Your name was drawn in a random sample of boaters in your state.

If you have already completed and returned the questionnaire, please accept our sincere thanks! If not, please answer the questions and return it today. Because the survey has been sent to only a small sample of boaters in your state, it is extremely important that your opinions be included, if the results are to accurately represent the opinions of all boaters.

If you did not receive the survey, or it has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 University Avenue SE, Suite 141  
Minneapolis, Minnesota 55414-3067

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Follow Up Letter for Kansas

UNIVERSITY OF MINNESOTA

*Twin Cities Campus*

*Minnesota Center for Survey Research*

*Suite 141  
2331 University Avenue S.E.  
Minneapolis, MN 55414-3067  
612-627-4282*

November 27, 2000

Dear Kansas Boater,

About three weeks ago, I wrote to you seeking your opinion about aquatic nuisance species and boating practices. As of today, we have not yet received your completed questionnaire.

This survey has been undertaken to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was drawn through a scientific sampling process in which every licensed boat owner in Kansas had an equal chance of being selected. In order for the results of this study to be truly representative of the opinions of all Kansas boat owners, it is important that each questionnaire be completed and returned. As mentioned in my previous letter, the survey can be completed by any adult in the household.

In the event that your survey has been misplaced, a replacement is enclosed. If you have any questions about the survey, please write or call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. weekdays, central standard time.

Your cooperation is greatly appreciated.

Sincerely,



Rossana Armson  
Director

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Final Postcard Text for Kansas

#### **PLEASE SEND US YOUR COMPLETED SURVEY!**

I am writing to you about a boating survey that was recently sent to you. You were one of the boat owners who was selected to participate, but we have not yet received your completed survey.

Because the survey was sent to only a few boat owners, it is extremely important that your opinions be included in the results. We really want to hear from you, even if you didn't boat in 2000. **Your input is important!**

If you have not yet returned your completed survey, please do it as soon as possible. If your survey has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away. Your name and address will be deleted from our mailing list when your survey is received. Thank you for your participation.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 Univ Avenue SE, Suite 141, Mpls MN 55414

Appendix B: Survey Cover Letters and Reminder Postcard Text

Cover Letter for Minnesota

## UNIVERSITY OF MINNESOTA

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*Minnesota Sea Grant College Program  
Office of the President for Research and  
Dean of the Graduate School*

*2305 East 5th Street  
Duluth, MN 55812-1445  
#####  
#####*

October 30, 2000

Dear Minnesota Boater,

Lakes and streams in Minnesota provide some of the best recreational opportunities available in the region. However, many natural resources, including game fish, water quality, and habitat, are affected by pollution and other environmental changes.

One particular change that has become more of a problem in recent years is aquatic nuisance species in marine and freshwaters. These are plants or animals that enter habitats where they are not native, where they have not always lived, grown, and reproduced. Aquatic nuisance species can be introduced in a number of ways. For example, some of these invaders hitch a ride in the ballast water of ocean-going vessels and find a new home in Great Lakes or coastal ponds.

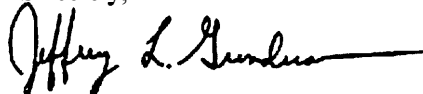
Because the presence of aquatic nuisance species is a national issue, many state and regional agencies have been studying their presence in marine and freshwaters. The results of this research will be used to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

You are one of a small number of boaters who are being asked to provide opinions about water-transported aquatic nuisance plant and animal species. Your name was drawn in a random sample of Minnesota's licensed boat owners. In order for the results to truly represent the thinking of all boaters, it is important that each questionnaire be completed and returned. The questionnaire can be completed by any adult in your household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so we may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

If you have any questions about this study, please write or call Rossana Armson at the University of Minnesota at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. on weekdays, central standard time. Collect calls will be accepted. She would be happy to answer your questions. Thank you for your assistance.

Sincerely,



Jeffrey L. Gunderson  
Director

P. S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota Center for Survey Research because they are coordinating the mailings.

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Reminder Postcard Text for Minnesota

Last week a questionnaire seeking your opinion about aquatic nuisance species and boating practices was mailed to you. We are very interested in your opinions about the impact of aquatic nuisance species on your state's streams, lakes, and rivers. Your name was drawn in a random sample of boaters in your state.

If you have already completed and returned the questionnaire, please accept our sincere thanks! If not, please answer the questions and return it today. Because the survey has been sent to only a small sample of boaters in your state, it is extremely important that your opinions be included, if the results are to accurately represent the opinions of all boaters.

If you did not receive the survey, or it has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 University Avenue SE, Suite 141  
Minneapolis, Minnesota 55414-3067

Appendix B: Survey Cover Letters and Reminder Postcard Text

Follow Up Letter for Minnesota

UNIVERSITY OF MINNESOTA

Minnesota Sea Grant College Program      2805 East 16th Street  
Office of Vice President for Research and      Duluth, MN 55812-1445  
Dean of the Graduate School      #####  
#####

November 20, 2000

Dear Minnesota Boater.

About three weeks ago, I wrote to you seeking your opinion about aquatic nuisance species and boating practices. As of today, we have not yet received your completed questionnaire.

This survey has been undertaken to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

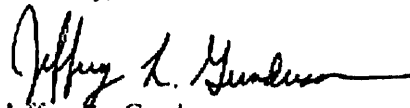
I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was drawn through a scientific sampling process in which every licensed boat owner in Minnesota had an equal chance of being selected. In order for the results of this study to be truly representative of the opinions of all Minnesota boat owners, it is important that each questionnaire be completed and returned.

As mentioned in my previous letter, the survey can be completed by any adult in the household. The University of Minnesota's Center for Survey Research is assisting us with this project and you will be returning the survey directly to them, in the envelope provided.

In the event that your survey has been misplaced, a replacement is enclosed. If you have any questions about the survey, Rossana Armson at the Minnesota Center for Survey Research would be happy to help you. Please write or call her collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. weekdays, central standard time.

Your cooperation is greatly appreciated.

Sincerely,



Jeffrey L. Gunderson  
Director

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Final Postcard Text for Minnesota

#### **PLEASE SEND US YOUR COMPLETED SURVEY!**

I am writing to you about a boating survey that was recently sent to you. You were one of the boat owners who was selected to participate, but we have not yet received your completed survey.

Because the survey was sent to only a few boat owners, it is extremely important that your opinions be included in the results. We really want to hear from you, even if you didn't boat in 2000. **Your input is important!**

If you have not yet returned your completed survey, please do it as soon as possible. If your survey has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away. Your name and address will be deleted from our mailing list when your survey is received. Thank you for your participation.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 Univ Avenue SE, Suite 141, Mpls MN 55414

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Cover Letter for Ohio



Ohio Sea Grant College Program  
Franz Theodore Stone Laboratory  
Great Lakes Aquatic Ecosystem  
Research Consortium (GLAERC)  
Center for Lake Erie Area  
Research (CLEAR)

October 30, 2000

1541 Research Center  
1314 Kinnear Road  
Columbus, OH 43212-1194

████████████████████  
████████████████████  
████████████████████  
**Please contact Minnesota  
with questions (see below)**

Dear Ohio Boater,

Lakes and streams in Ohio provide some of the best recreational opportunities available in the region. However, many natural resources, including game fish, water quality, and habitat, are affected by pollution and other environmental changes.

One particular change that has become more of a problem in recent years is aquatic nuisance species. These are plants or animals that enter habitats where they are not native, where they have not always lived, grown, and reproduced. Aquatic nuisance species can be introduced in a number of ways. For example, some of these invaders hitch a ride in the ballast water of ocean-going vessels and find a new home in Great Lakes or coastal ports.

Because the presence of aquatic nuisance species is a national issue, many state and regional agencies have been studying their presence in marine and freshwaters. The results of this research will be used to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

You are one of a small number of boaters who are being asked to provide opinions about water-transported aquatic nuisance plant and animal species. Your name was drawn in a random sample of Ohio's licensed boat owners. In order for the results to truly represent the thinking of all boaters, it is important that each questionnaire be completed and returned. The questionnaire can be completed by any adult in your household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so we may check your name off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

If you have any questions about this study, please write or call Rossana Armson at the University of Minnesota at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. on weekdays, central standard time. Collect calls will be accepted. She would be happy to answer your questions. Thank you for your assistance.

Sincerely,

A handwritten signature in cursive script that reads "Jeffrey M. Reutter".

Dr. Jeffrey M. Reutter  
Director

P. S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because they are coordinating the mailings.

Stone Laboratory Ohio's Lake Erie Laboratory Since 1895  
Field Station Address: Box 119, Put-in-Bay, OH 43456-0119



## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Reminder Postcard Text for Ohio

Last week a questionnaire seeking your opinion about aquatic nuisance species and boating practices was mailed to you. We are very interested in your opinions about the impact of aquatic nuisance species on your state's streams, lakes, and rivers. Your name was drawn in a random sample of boaters in your state.

If you have already completed and returned the questionnaire, please accept our sincere thanks! If not, please answer the questions and return it today. Because the survey has been sent to only a small sample of boaters in your state, it is extremely important that your opinions be included, if the results are to accurately represent the opinions of all boaters.

If you did not receive the survey, or it has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 University Avenue SE, Suite 141  
Minneapolis, Minnesota 55414-3067

Appendix B: Survey Cover Letters and Reminder Postcard Text

Follow Up Letter for Ohio



Ohio Sea Grant College Program  
Franz Theodore Stone Laboratory  
Great Lakes Aquatic Ecosystem  
Research Consortium (GLAERC)  
Center for Lake Erie Area  
Research (CLEAR)

November 20, 2000

1541 Research Center  
1314 Kinnear Road  
Columbus, OH 43212-1194

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████████████████████  
Please contact Minnesota  
with questions (see below)

Dear Ohio Boater,

About three weeks ago, I wrote to you seeking your opinion about aquatic nuisance species and boating practices. As of today, we have not yet received your completed questionnaire.

This survey has been undertaken to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

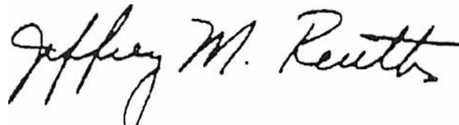
I am writing to you again because of the significance each questionnaire has to the usefulness of this study. Your name was drawn through a scientific sampling process in which every licensed boat owner in Ohio had an equal chance of being selected. In order for the results of this study to be truly representative of the opinions of all Ohio boat owners, it is important that each questionnaire be completed and returned.

As mentioned in my previous letter, the survey can be completed by any adult in the household. The University of Minnesota's Center for Survey Research is assisting us with this project and you will be returning the survey directly to them, in the envelope provided.

In the event that your survey has been misplaced, a replacement is enclosed. If you have any questions about the survey, Rossana Armson at the Minnesota Center for Survey Research would be happy to help you. Please write or call her collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. weekdays, central standard time.

Your cooperation is greatly appreciated.

Sincerely,



Dr. Jeffrey M. Reutter  
Director

P.S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because they are coordinating the mailings.

Stone Laboratory Ohio's Lake Erie Laboratory Since 1895  
Field Station Address: Box 119, Put-in-Bay, OH 43456-0019

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### 2<sup>nd</sup> Reminder Postcard Text for Ohio

#### **PLEASE SEND US YOUR COMPLETED SURVEY!**

I am writing to you about a boating survey that was recently sent to you. You were one of the boat owners who was selected to participate, but we have not yet received your completed survey.

Because the survey was sent to only a few boat owners, it is extremely important that your opinions be included in the results. We really want to hear from you, even if you didn't boat in 2000. **Your input is important!**

If you have not yet returned your completed survey, please do it as soon as possible. If your survey has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away. Your name and address will be deleted from our mailing list when your survey is received. Thank you for your participation.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 Univ Avenue SE, Suite 141, Mpis MN 55414

Appendix B: Survey Cover Letters and Reminder Postcard Text

Final Letter for Ohio



Ohio Sea Grant College Program  
Franz Theodore Stone Laboratory  
Great Lakes Aquatic Ecosystem  
Research Consortium (GLAERC)  
Center for Lake Erie Area  
Research (CLEAR)

March 26, 2001

1541 Research Center  
1314 Kinnear Road  
Columbus, OH 43212-1194

████████████████████  
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████████████████████  
Please contact Minnesota  
with questions (see below)

Dear Ohio Boater,

Several months ago, a survey was sent to you seeking your opinions about aquatic nuisance species and boating practices. We greatly need your input on this issue. Of the five states in this study, only Ohio has too few completed surveys.

Please help us by taking a few minutes today to complete the survey. It can be completed by any adult in the household. We really do need to hear from you!

In the event that your survey has been misplaced, a replacement is enclosed. If you have any questions about the survey, Rossana Armson at the Minnesota Center for Survey Research would be happy to help you. Please write or call her collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m., weekdays, central standard time.

Your cooperation is greatly appreciated.

Sincerely,

**Dr. Jeffrey M. Reutter**  
Director

P.S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because they are coordinating the mailings.

Stone Laboratory Ohio's Lake Erie Laboratory Since 1895  
Field Station Address: Box 119, Put-in-Bay, OH 43456-0119

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Cover Letter for Vermont



207 MORRILL HALL  
COLLEGE OF AGRICULTURE AND LIFE SCIENCES  
UNIVERSITY OF VERMONT  
BURLINGTON, VT 05405-0106

Phone: 802-655-3681 Fax: 802-656-4675 <http://crs.uvm.edu>

October 30, 2000

Dear Vermont Boater,

Lakes and streams in Vermont provide some of the best recreational opportunities available in the region. However, many natural resources, including game fish, water quality, and habitat, are affected by pollution and other environmental changes.

One particular change that has become more of a problem in recent years is aquatic nuisance species in marine and freshwaters. These are plants or animals that enter habitats where they are not native, where they have not always lived, grown, and reproduced. Aquatic nuisance species can be introduced in a number of ways. For example, some of these invaders hitch a ride in the ballast water of ocean-going vessels and find a new home in Great Lakes or coastal pom.

Because the presence of aquatic nuisance species is a national issue, many state and regional agencies have been studying their presence in marine and freshwaters. The results of this research will be used to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

You are one of a small number of boaters who are being asked to provide opinions about water-transported aquatic nuisance plant and animal species. Your name was drawn in a random sample of Vermont's licensed boat owners. In order for the results to truly represent the thinking of all boaters, it is important that each questionnaire be completed and returned. The questionnaire can be completed by any adult in your household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so your name can be checked off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

If you have any questions about this study, please write or call Rossana Armson at the University of Minnesota at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. on weekdays, central standard time. Collect calls will be accepted. She would be happy to answer your questions. Thank you for your assistance.

Sincerely,



Fred Schmidt  
Co-Director

P. S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because they are coordinating, the mailings.

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An Equal Opportunity Employer

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Reminder Postcard Text for Vermont

Last week a questionnaire seeking your opinion about aquatic nuisance species and boating practices was mailed to you. We are very interested in your opinions about the impact of aquatic nuisance species on your state's streams, lakes, and rivers. Your name was drawn in a random sample of boaters in your state.

If you have already completed and returned the questionnaire, please accept our sincere thanks. If not, please answer the questions and return it today. Because the survey has been sent to only a small sample of boaters in your state, it is extremely important that your opinions be included, if the results are to accurately represent the opinions of all boaters.

If you did not receive the survey, or it has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 University Avenue SE, Suite 141  
Minneapolis, Minnesota 55414-3067

Appendix B: Survey Cover Letters and Reminder Postcard Text

Follow Up Letter for Vermont



207 MORRILL HALL  
COLLEGE OF AGRICULTURE AND LIFE SCIENCES  
UNIVERSITY OF VERMONT  
BURLINGTON, VT 05405-0106

Phone: 802-656-3631 Fax: 802-656-4675 <http://crs.uvm.edu>

October 30, 2000

Dear Vermont Boater,

Lakes and streams in Vermont provide some of the best recreations] opportunities available in the region. However, many natural resources, including game fish, water quality, and habitat, are affected by pollution and other environmental changes.

One particular change that has become more of a problem in recent years is aquatic nuisance species in marine and freshwaters. These are plants or animats that enter habitats where they are not native, where they have not always lived, grown, and reproduced. Aquatic nuisance species can be introduced in a number of ways. For example, some of these invaders hitch a ride in the ballast water of ocean-going vessels and find a new home in Great Lakes or coastal pom.

Because the presence of aquatic nuisance species is a national issue, many state and regional agencies have been studying their presence in marine and freshwaters. The results of this research will be used to evaluate how well various public and private organizations are educating the public about aquatic nuisance species and to assist these organizations in the design of educational programs and materials.

You are one of a small number of boaters who are being asked to provide opinions about water-transported aquatic nuisance plant and animal species. Your name was drawn in a random sample of Vermont's licensed boat owners. In order for the results to truly represent the thinking of all boaters, it is important that each questionnaire be completed and returned. The questionnaire can be completed by any adult in your household.

You may be assured of complete confidentiality. The questionnaire has an identification number for mailing purposes only. This is so your name can be checked off the mailing list when your questionnaire is returned. Your name will never be placed on the questionnaire.

If you have any questions about this study, please write or call Rossana Armson at the University of Minnesota at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. on weekdays, central standard time. Collect calls will be accepted. She would be happy to answer your questions. Thank you for your assistance.

Sincerely,



Fred Schmidt  
Co-Director

P. S. Five states are participating in this effort: California, Kansas, Minnesota, Ohio, and Vermont. You will be returning your questionnaire directly to the University of Minnesota because they are coordinating the mailings.

---

An Equal Opportunity Employer

## Appendix B: Survey Cover Letters and Reminder Postcard Text

### Reminder Postcard Text for Vermont

#### **PLEASE SEND US YOUR COMPLETED SURVEY!**

I am writing to you about a boating survey that was recently sent to you. You were one of the boat owners who was selected to participate, but we have not yet received your completed survey.

Because the survey was sent to only a few boat owners, it is extremely important that your opinions be included in the results. We really want to hear from you, even if you didn't boat in 2000. **Your input is important!**

If you have not yet returned your completed survey, please do it as soon as possible. If your survey has been misplaced, please call me collect at (612) 627-4282 between 9:00 a.m. and 4:00 p.m. I will send you another one right away. Your name and address will be deleted from our mailing list when your survey is received. Thank you for your participation.

Sincerely,

Rossana Armson, MCSR Director  
University of Minnesota  
2331 Univ Avenue SE, Suite 141, Mpis MN 55414



Appendix C: IRB Human Subjects Letter

10/00 TUE 13:29 FAX 218 726 6556 MN SEA GRANT

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University of Minnesota

*Twin Cities Campus*

*Research Subjects' Protection Program*

*Institutional Review Board: Human Subjects Committee (IRB)  
Institutional Animal Care and Use Committee (IACUC)*

*Mayo Mail Code 820  
1528 Mayo Memorial Building  
420 Delaware Street S.E.  
Minneapolis, MN 55455-0822*

November 30, 2000

*612-626-5654  
Fax: 612-626-6661  
irb@u.mn.edu  
iacuc@u.mn.edu  
<http://www.research.umn.edu/subjects.htm>*

Jeffrey Gunderson  
University Of Mn/duluth  
UMD-Nat Rsrc Res Inst-Adm  
Duluth MN 55812

Re: "Multi-State Survey to Evaluate Effectiveness of ANS Boater Education Program"

Human Subjects Code Number: 0011E73721

Dear Mr. Gunderson:

The IRB: Human Subjects Committee determined that the referenced study is exempt from review under federal guidelines 45 CFR Part 46.101(b) category #2 SURVEYS/INTERVIEWS; STANDARDIZED EDUCATIONAL TESTS; OBSERVATION OF PUBLIC BEHAVIOR.

The code number above is assigned to your research. That number and the title of your study must be used in all communication with the IRB office.

Upon receipt of this letter, you may begin your research. If you have questions, please call the IRB office at (612) 626-5654.

The IRB wishes you success with this research.

Sincerely,

*Carol Siegel*  
Carol Siegel  
Assistant Director

CS/ki

CC: Douglas Jensen

