To water warriors everywhere
ACKNOWLEDGMENTS

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<tr>
<td>AIS</td>
<td>Aquatic Invasive Species</td>
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<td>BMPs</td>
<td>Best Management Practices</td>
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<td>CAIP</td>
<td>UF/IFAS Center for Aquatic and Invasive Plants</td>
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<tr>
<td>CBSM</td>
<td>Community-Based Social Marketing</td>
</tr>
<tr>
<td>EPA</td>
<td>U.S. Environmental Protection Agency</td>
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<td>FWC</td>
<td>Florida Fish and Wildlife Conservation Commission</td>
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<td>REB</td>
<td>Model of Responsible Environmental Behavior</td>
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<td>TPB</td>
<td>Theory of Planned Behavior</td>
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<td>WTP</td>
<td>Willingness-to-Pay</td>
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<td><strong>LIST OF TERMS</strong></td>
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<tr>
<td><strong>AQUATIC INVASIVE SPECIES</strong></td>
<td>Aquatic species includes both aquatic plant and aquatic animals. Invasive aquatic plants are introduced plants that have adapted to living in, on, or next to water that can grow either submerged or partially submerged. Invasive aquatic animals require a watery habitat, but do not necessarily have to live entirely in water (USDA National Invasive Species Information Center, 2012).</td>
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<td><strong>ATTITUDE</strong></td>
<td>The combination of beliefs and a positive or negative evaluation of an object, issues, person, or event (Fishbein &amp; Ajzen, 1975; Jacobson, 2009).</td>
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<td><strong>BIODIVERSITY</strong></td>
<td>The totality of genes, species and ecosystems in a region. Genetic diversity refers to the variation of genes within species. Species diversity refers to the variety of species within a region. Ecosystem diversity refers to the variety of systems of living things in relationship with their environment within a region. Biodiversity saves the variation of organism which may one day be of use to humans for medical, agricultural or forestry use (Splash &amp; Hanley, 1995).</td>
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<td><strong>BIOLOGICAL CONTROL (AGENT)</strong></td>
<td>Biological control is the use of parasites, predators and pathogens (diseases) to control pests (Shetlar &amp; Hale, 2008). Biological control is the purposeful introduction of natural enemies by scientists as a means of weakening or suppressing invasive species. Biological control is regulated by the United States Department of Agriculture’s Animal and Plant Health Inspection Service.</td>
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CHEMICAL CONTROL

Chemical control in reference to invasive species is most often the use of herbicides. For aquatic plants, chemical control is the application of herbicides directly to aquatic and wetland plants or to the water or soil in which they grow. In Florida, the use of aquatic herbicides is the primary method for managing invasive aquatic and wetland plants such as hydrilla, water hyacinth, water lettuce, torpedo grass, and other wide-spread and highly invasive aquatic weeds.

COGNITIVE HIERARCHY

A predictive model that maps values to behaviors and describes and demonstrates relationships among the concepts (Fulton et al., 1996).

ENVIRONMENTAL PROTECTION AGENCY

A federal agency created in 1970 to protect human health and the environment. In relation to aquatic invasive species, the EPA regulates the registration, approval, and ultimate application and training in the use of aquatic herbicides.

FWC, PLANT MANAGEMENT SECTION

A division of the Florida Fish & Wildlife Commission that is responsible for coordinating funding for controlling invasive aquatic and upland plants on public lands and waterways throughout Florida. The section also has a permitting program and funds research on “more cost effective management techniques” (FWC, 2008).

EXOTIC INVASIVE SPECIES

“An alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health” (National Invasive Species Council, 2006). Most invasive weeds in aquatic and natural areas are of foreign (exotic) origin.
LOCUS OF CONTROL

A generalized expectation about the connection between a person’s characteristics and/or actions and their experienced outcomes (Rodder, Chance, & Phares, 1972). Locus of Control relates to a person’s perception of their ability to affect change as a result of their behavior, which can be internal or external (Lefcourt, 1991).

MAINTENANCE CONTROL

The working philosophy for aquatic and wetland invasive plant control in Florida, “Maintenance control” attempts to keep invasive plants at the lowest possible levels to minimize herbicide use and environmental impacts. The goals of maintenance control are to reduce invasive plant numbers, reduce herbicide usage, and reduce management and environmental costs (Florida Statute 369.20(2)).

MECHANICAL CONTROL

Mechanical control involves the use of machines, devices, and barriers. These methods are usually non-selective and short-term. Most often used for aquatic plant control, large machines can cut, chop, or mow plants. In Florida and throughout the U.S. for more than 100 years, plant managers have developed a variety of machines that are specifically designed to shear, shred, crush, or otherwise remove aquatic weeds from waterbodies.

PATHWAY

Modes, vectors, or routes in which invasive species can be introduced or spread (Lovell & Stone, 2005).

PHYSICAL CONTROL

Physical control refers to hand-pulling or cutting AIS. Plants are sometimes also controlled by artificial alterations such as water level manipulation, dredging, light barriers and dyes, bottom barriers, aeration and fire.
PRO-ENVIRONMENTAL BEHAVIOR

Behavior that intentionally seeks to minimize any negative impacts as a result of one’s actions on the natural and urbanized world (Kollmuss & Agyeman, 2002).

SELF-EFFICACY

This concept relates to whether an individual can carry out specific behaviors and action strategies and whether those behaviors will be effective in realizing specific outcomes. Self-efficacy is best suited to issues relating to environmental education and pro-environmental behavior (Bandura, 1997; Israel, 2002).

SUBJECTIVE NORM

Subjective norm is the combination of perceived expectations from relevant individuals or groups along with intentions to comply with the expectations. Ajzen and Fishbein define this as the "person’s perception that most people who are important to him/her think he/she should or should not perform the behavior in question" (Ajzen & Fishbein, 1980).

VALUES

Within social psychology, values are defined as desirable end states, the manners in which people conduct themselves, or qualities of life held dear (Rokeach, 1973).

UF/IFAS CENTER FOR AQUATIC & INVASIVE PLANTS

A multidisciplinary research, teaching and extension facility created to develop environmentally sound techniques for the management of aquatic and natural area weed species and to coordinate aquatic plant research activities within the State of Florida. The Center was established in 1978 by the Florida legislature. It is divided into two arms—research and information.
FLORIDA FRESHWATER BOATER AND ANGLERS’ AWARENESS AND PERCEPTIONS
OF AQUATIC INVASIVE SPECIES AND ADOPTION OF PREVENTIVE BEHAVIORS

By
Kathryn L. Wilson

August 2012

Chair: Tracy Irani
Major: Agricultural Education and Communication

Aquatic Invasive Species (AIS) pose considerable threats to aquatic ecosystems as well as community and state economies. Florida is home to the most registered boaters in North America and is also a destination for many non-resident boaters and anglers. As such, it is imperative that managers understand the current level of awareness, perceptions, and behavior of boaters in order to best prevent AIS spread.

Registered Florida boaters and non-resident freshwater anglers were surveyed by mail (34% of 4119 responded) to determine their awareness and attitudes towards AIS and the actions they took or would be willing to take in order to prevent the spread of AIS. Respondents believed that AIS present a “very serious” (47%) or “somewhat serious” (35%) threat. While 75% of respondents frequented numerous waterbodies, presenting a higher risk of spreading AIS, 69% indicated that they took preventive action. Boaters and anglers 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". Additionally, 75% indicated that they were “very likely” to take AIS preventive action in the future, signaling a strong intention to act.

Respondents suggested that signs at boat launches, AIS information in boat registration information, fishing regulations, and boater training courses be utilized in order to best
encourage them to take action. Preference for consequences for violators ranged between education (32.5%), self-regulation (31%), fines (30%) and restrictions (27%). This suggests that while boaters and anglers care about this issue, they are mixed on the best way to solve the problem.

Variables from the Model of Responsible Environmental Behavior were evaluated based on their ability to predict whether or not boaters and anglers adopted AIS preventive Best Management Practices. Intention to act, subjective norms, knowledge of action strategies, and attitudes were found to be the strongest predictors of whether or not boaters and anglers adopted BMPs. These factors should be emphasized in the development of an AIS prevention campaign. The campaign should include targeted venues and mandatory boat cleaning and/or inspection stations should also be considered.
CHAPTER 1
ABOUT INVASIVE SPECIES

The Big Picture: Global Invasive Species

Scientists, academicians, and industry leaders acknowledge that invasive species are one of the most serious environmental threats of the twenty-first century (U.S. General Accountability Office, 2002). With economic globalization comes the movement of plants, animals, and other organisms from one part of the world to another through trade, transport, and tourism. While some of these introductions are beneficial, others have mixed impacts that benefit specific groups but cost others and some introductions are detrimental to the ecosystems and the native species that depend on them (McNeely, 2001).

Exotic plant and animal species are introduced into new environments all the time. Some are known to be valuable, such as food and forage crops, but many others cause great harm to native species, public infrastructure, and communities in the affected area. Economic enterprises such as agriculture, forestry, power production, fishery resources, and even international trade can be negatively impacted by the introduction and spread of invasive species (Lovell & Stone, 2005).

Humans rely on many “exotic” or non-native species for food and garden crops and many agricultural practices rely upon the production of non-native plants. Most non-native species do not cause problems, but a small portion of introduced species do cause significant problems for humans and animals alike. Once a non-native or exotic species is released into natural areas—parks, forests, lakes or rivers—it can quickly become a problem.

Invasive species are defined as plant or animal “species that are non-native to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health” (The National Invasive Species Council, 2006, p.
1). A major consequence of invasive species introductions is a loss of biodiversity, or the genetic variability that exist among native species that have evolved to inhabit a particular ecological niche (Pimental, 2003).

Invasive species are an international problem and are considered to be one of the biggest threats to resource conservation (Coblentz, 1990). As of 2005 there were approximately 50,000 foreign species considered to be invasive in the United States and the number continues to increase (Pimental, Zuniga, & Morrison, 2005). Exotic species introduced into foreign ecosystems are considered by some scientists to be the “most pervasive influence affecting biodiversity,” frequently causing environmental crisis (Coblenz, 1990).

Due to increased international trade and travel, geographic boundaries that previously limited the spread of invasive species are becoming less effective barriers. Transportation routes such as roads, canals, ships, and air travel provide numerous pathways for non-native species to overcome geographical boundaries and become established (Rahel, 2007). See Figure 1-1 for a depiction of invasive species introductions. Recreational activities such as gardening, exotic pet ownership, fishing, hunting, and boating also have a major role in the introduction and spread of non-native species (Kubeck, 2008).

**National Impacts**

Economic losses in the U.S. due to invasive species are estimated to be over $120 billion annually in damages and losses, which equates to approximately $1100 per household (Pimental et al., 2005). The Office of Technology Assessment of the U.S. Congress reported in “Harmful Non-Indigenous Species in the United States” that 59 percent of introduced species in the U.S. have caused economic or ecological harm and estimated $97-137 billion dollars in cumulative costs to forestry, fisheries, water uses, utilities, natural areas, and agriculture (USOTA, 1993).
The costs of control or, where possible, eradication are alone estimated to be greater than $9 billion annually in the United States (Pimental, 2003). This estimate includes $5.4 billion on fish, $1 billion on Dreissenid mussels, $1 billion on Asian clams, and more than $500 million on aquatic plants (Pimental, 2003). Invasive aquatic and riparian plants known as “high impact species” (such as salt cedar, purple loosestrife, melaluca, and hydrilla) are conservatively estimated to cost over $100 million annually in control costs alone (USOTA, 1993).

With the rise in global trade over the past 200 years, there are links to exponential increases in invasive species invasions (Ericson, 2005). Of the more than 50,000 exotic species established in the United States, about one in seven has become invasive, causing adverse economic, environmental or human health impacts (Evans, 2003). Nearly 25 percent of U.S. agricultural production is lost to invasive species each year, and many private landowners experience lower property values and/or mitigation costs.

In addition, invasive species place federally listed (as endangered or threatened) species at a higher risk for extinction, since 42 percent of listed species are considered to be “significantly” impacted by invasive species competition or predation (Pimental, 2003). A related study found that invasive plants, animals, and fungi are second only to habitat loss and degradation in terms of endangering native plant species (Wilcove, Rothstein, Dubow, Phillips, & Losos, 1998).

Lodge et al. (2006) provided an evaluation of current U.S. national policies and practices in relation to invasive species introductions and spread. This study concluded that invasions are increasing in number, size of the area affected, and damage to ecosystems, economies, and human welfare. The authors advise that the situation will continue to escalate without a collaboration of federal, state, and local leadership working on detecting new invasions and
responding quickly by controlling the spread of existing invasions. This also includes ensuring coordinated and cost effective prevention and control efforts (Lodge et al., 2006).

Aquatic Invasive Species as a Threat to Freshwater Resources

Freshwater resources are an integral part of human existence. As such, people are dependent on freshwater not only for drinking and potable uses, but also for irrigating food and forage crops, recreation and leisure, and sustaining habitats of native fish and wildlife. The greatest threats to freshwater resources include depletion (quantity) and pollution (quality). Another serious threat to freshwater, particularly surface waters, is the introduction and spread of invasive species and subsequent loss of biological diversity (Coblentz, 1990; Carlton & Geller, 1993; Vitousek, 1994). These non-native species are sometimes moved naturally (e.g. by birds and storm events), but more commonly are spread by humans (Rahel, 2007).

Rivers, canals, estuaries, and harbors are particularly prone to introductions of non-native species as a consequence of being focal points for activities that represent the major vectors for introductions such as shipping and boating (Carlton & Geller 1993; Ruiz et al., 2000), aquaculture (Naylor, Williams, & Strong, 2001), aquarium trade (Padilla & Williams, 2004) and the sale of live seafood and bait (Chapman, Miller, & Coan, 2003).

Aquatic invasive species (AIS) are introduced primarily by trade and transport (aquarium releases, exotic pet releases, ballast tank discharge, horticultural plants, live food and bait, water gardens, etc.) and are most commonly spread by recreational boats and other equipment (Scales & Bryan, 1979; Dove & Malcolm, 1980; Dove & Wallis, 1981; Dove & Taylor, 1982; Johnstone et al., 1985; Joyce, 1992; Mosisch & Arthington, 1998; Buchan & Padilla, 1999; Johnson, Ricciardi, & Carlton., 2001). Some of these activities that result in the introduction of non-native species are intentional, but most are inadvertent (Keller & Lodge, 2007). Figure 1-1 depicts the pathways in which invasive species are initially introduced.
Because these exotic species lack the predators from their native areas to keep them in check, and because they are known to grow quickly and reproduce abundantly when introduced, they pose great risks to native plants and wildlife dependent on balanced ecosystems (Rockwell, 2003). In many situations, they also threaten public safety (flood control), local economies, livelihoods, recreation, water supply, water quality, and even property values (Rockwell, 2003).

Circuna, Meyerson and Gutierrez (2004) noted that inland ecosystems are especially vulnerable to invasive species invasions and that given projected human population growth and associated use of freshwater, immediate action is needed to protect water resources and maintain survival of native species. In addition, since there are fewer methods available for the control of invasive species in freshwater aquatic ecosystems than terrestrial systems, eradication and control are difficult at best (Circuna et al., 2004). Once introduced into an ecosystem, dispersal of AIS may be easier in interconnected freshwater systems than the spread of their terrestrial counterparts (Lodge et al., 1998).

About Aquatic Plants

A diversity of aquatic plants provide important benefits to native fish and wildlife, and to the littoral, or shallow, areas of waterbodies. They stabilize soils, which protects water quality, slows erosion, and provides diverse fish and wildlife habitat, particularly for many species of juvenile fish and associated invertebrates (Madsen, 2009).

Unfortunately, non-native plants that are introduced to waters outside of their native ranges often become a nuisance by hindering human uses of water resources and limiting the ecological benefits of the native plant species they replace (Madsen, 2009). Many of these invasive aquatic plants can form dense canopies on the surface of the water which allows them to capture more light energy than is available near the bottom. These dense plant colonies interfere with human uses such as recreation and water intakes, increase flooding risk and shade out lower-growing
native species. Exotic plants can also be significantly more productive than native species, which can lead to increases in the rate of nutrient loading in the system, a serious concern in Florida where freshwater systems already have high background levels of nutrients due to naturally rich soil and geologic conditions (National Academy of Sciences, 2012).

These dense colonies of invasive plants also have negative impacts on fish and the quality of their habitat. Dense plant beds provide a hiding place for very small forage fish, which can reduce the ability of predatory fish (such as bass and northern pike) to capture their prey. Consequently, this can lead to a large number of small, stunted forage fishes and poor production of game fishes (Madsen, 2009). In addition, the amount of dissolved oxygen under dense plant canopies can be insufficient to support the more desirable fish species and may result in fish kills, especially during summer months when temperatures rise and the water contains less oxygen.

Hydrilla (*Hydrilla verticillata*) beds may provide improved habitat for some warm water fish species such as largemouth bass, but once the stands grow into a dense monoculture, the same fish species can be negatively impacted (Colle, Shireman, Haller, Joyce, & Canfield, 1987). Extensive stands of dense hydrilla have been reported to limit boat access and navigation as well as bank access for anglers in Florida. When plant coverage exceeded 80 percent of a central Florida lake, angler use decreased drastically, which resulted in a 90 percent loss in revenue from the sport fishery, which was valued at nearly $1 million annually (Colle et al., 1987).

Non-native aquatic plants are thought to have been introduced into the U.S. as early as the 16th century (Schmitz et al., 1991). The issue of aquatic invasive plants received national attention when water hyacinth (*Eichhornia crassipes*) was introduced and became a wide-spread
problem in the southeast in the 19th century (Rockwell, 2003). The U.S. Fish and Wildlife Service (USFWS) estimated the loss of fish and wildlife due to just two aquatic invasive plants—water hyacinth and alligatorweed (*Alternanthera philoxeroides*)—to be over $20 million by the end of the 1940s (Lynch, King, Chamberlain & Smith, 1947). Hydrilla was introduced to Florida in the 1950s and has since become the most serious invasive aquatic plant in the state, partly because it spreads by fragmentation—the natural and accelerated breaking off of plant fragments that start new plant colonies—and is difficult and costly to control (Rockwell, 2003; W.T. Haller, personal communication, April 18, 2012). Shortly after hydrilla was introduced in Florida, Huser (1968) estimated that $2 million in AIS control efforts in central and southern Florida was correlated to $82 million in “overall benefits” such as the prevention of flood damage, increased land use, recreation, fish and wildlife, and navigation. Today, the impacts from invasive plants, particularly hydrilla in Florida, are fairly well documented and remain costly to control.

Such species place both the recreational and commercial resources of a lake and associated community at risk (Bell, 2005). Aquatic invasive plants can have impacts not only on aquatic ecosystems and the abundance of native species, but also use of water resources, which is important to local and state economies as well as private individuals. For example, Horsch and Lewis (2009) found that the presence of Eurasian milfoil (*Myriophyllum spicatum*) in residential lakes in Wisconsin decreased property value by up to 13 percent.

In South Carolina, dense infestations of hydrilla “rafts” floating into intake screens caused a $4 million loss in hydropower generation which also resulted in the largest fish kill incident in the state (Kirk & Henderson, 2006).
Other Aquatic Invasive Species

Beyond aquatic invasive plants, there are many other AIS species including fish, mollusks, snails, and parasites. One of the most detrimental AIS in North America are the Dreissenid mussel species.

Native to the Black and Caspian Seas, Quagga mussels (Dreissena bugensis) and zebra mussels (Dreissena polymorpha) were first discovered in the 1980s in the Great Lakes and have provided the perfect scary poster child for invasive species in North America. A freshwater mollusk known for its extensive nutrient filtering capacities (phytoplankton, suspended particulates), these mussels attach to substrates and reproduce to form dense populations. The removal of nutrients by these exotic mussels decreases the food source for zooplankton, therefore altering the food web. Water clarity increases and the greater light penetration can cause a proliferation of aquatic plants that can change species dominance and alter the entire aquatic ecosystem (ISDA, 2012).

Quagga and zebra mussels are commonly found on boat trailers, props, and hulls and have quickly spread across the nation. These mussels have driven much of the invasive species awareness campaigns that exist today due to the serious nature of their impacts—including those to water quality; native species biodiversity; beaches; infrastructure such as piers, docks, pilings, and ports; water treatment plants; irrigation pipes; increases in drinking water costs; and damage to individual boats and equipment (Benson, Richerson, Maynard, Larson, & Fusaro, 2012). Quagga and zebra mussel larvae, called “veligers,” are most commonly transported by boats in standing water such as engine cooling water, ballast water, and live or bait wells (Johnson, Ricciardi & Carlton, 2001). For this reason, merely inspecting the boat and removing plants or debris is not enough; hot water (over 140 degrees) is needed to kill mussels and the boat must be drained of standing water and thoroughly dried before safely launching in another waterbody.
In the Great Lakes region alone, where most introductions are linked to commercial shipping and ballast water releases, it is estimated that as much as $500 million is spent annually for mitigation and control of invasive *Dreissenid* mussels. This figure includes increased costs of drinking water facility treatment (ISDA, 2012).

The New Zealand mud snail (*Potamopyrgus antipodarum*) is a highly invasive freshwater species with tremendous reproductive potential. It can overtake and degrade entire ecosystems through its competition with native invertebrates for habitat and food sources. Much like other AIS, these mud snails have no natural predators and reproduce rapidly; they can survive up to 50 days in damp areas and are known to be spread largely by anglers and other human vectors (National Park Service, 2003; Proctor et al., 2007).

In Florida, invasive Island apple snails (*Pomacea insularum*), likely introduced as a result of an aquarium release, are also cause for concern. First discovered in Lake Okeechobee in 1987, the Island apple snail population has expanded exponentially in the subsequent 10 years (FWC, 2006). Although there is not extensive documentation of the impacts associated with the Island apple snail, they are a direct competitor (for food) of the native Florida apple snail (*Pomacea paludosa*) and eat native aquatic plants. Native snail populations have declined in population since the introduction of invasive apple snails which presents a risk for the endangered snail kite (*Rostrhamus sociabilis*), whose primary forage is the native apple snail (Cattau, Martin, & Kitchens, 2010).

**Pathways**

Invasive species may enter a new region by three different means: 1) the importation of a commodity, 2) the arrival of a transport vector and 3) natural spread from a neighboring region where the species is itself alien. All of these can either be intentional or, most commonly, unintentional introductions (Hulme et al., 2008).
Pathways for the introductions of AIS are most frequently transportation and commercial-related pathways involving trade and transport (Keller & Lodge, 2007). These include ballast water releases from maritime commerce and shipping (Carlton & Gellar, 1993); fish bait buckets and live wells of boats (Ludwig & Leitch, 1996); shipments of fish and plants for aquaculturalists, aquarium hobbyists, and water gardeners (Courtenay & Stauffer, 1990; Schmitz et al., 1991); live seafood shipments (Chapman et al., 2003); canals and connected waterway dispersal; and recreational activities involving boating (Rothlisberger, Chadderton, McNulty, & Lodge, 2010; Murry, Pakhomov, & Therriault, 2011).

The aquarium trade is known to be a significant source of non-native plant introductions, and few regulations exist to curb the problem (Cohen, Mirotchnick, & Leung, 2007). Methods for disposal of aquarium plants, snails, and fish tend to range from depositing them on the lawn or garden (low risk of invasion) to disposing of water into outdoor ponds, storm-water drains, lakes, or rivers (very high risk of invasion).

Cohen et al. (2007) conducted a study on the St. Lawrence Seaway in Quebec to quantify invasive plants introduced by the aquarium trade and found that thousands of non-native plant propagules (any part of the plant capable of growth) are introduced to the St. Lawrence River each year by the Montreal aquarium trade alone.

Water gardens are also a source of invasive species introductions. Kay and Hoyle (2001) found that mail and e-commerce exacerbated the introduction of non-native plants and reported that twelve highly invasive aquatic plants, some of which are prohibited by federal law, were intentionally sold by wetland nurseries and water garden dealerships (Kay & Hoyle, 2001). Keller and Lodge (2007) noted that most plants and animals sold by nurseries and exotic pet suppliers were identified by common name only, so consumers, even if knowledgeable, cannot
be certain what species they are receiving because misidentification is common. They also found that 90 percent of plant orders arrived contaminated with unordered live organisms (Keller & Lodge, 2007). Much like the aquarium introductions, these results clearly show that stronger enforcement of laws and an intensive education and outreach effort are needed to prevent further introductions of invasive species through the aquatic and wetland plant industry (Kay & Hoyle, 2001; Keller & Lodge, 2007).

Aquaculture (the farming of marine and freshwater organisms such as fish, mollusks and plants) is also a potential source of AIS introductions. Naylor, Williams, and Strong (2001) reported that aquaculture is even a “leading vector” in worldwide AIS introductions. Though the overall risks of introductions are not well understood, there are some established introductions of mussels, oysters, and clams are examples showing that live seafood shipments and aquaculture are significant AIS pathways (Chapman et al., 2003).

Commercial boating and transport poses great risks to the environment. Over 21 billion gallons of ballast water containing thousands of non-native species are discharged into U.S. waters each year (Aquatic Invasive Species Task Force, 2012). The federal “Lacey Act” was signed into law in 1900 and the “injurious wildlife provision” remains the primary regulation of the federal government to prohibit species that may become invasive and as such, present a high level of risk to American environmental resources (Fowler, Lodge, & Hsia, 2007). Since this law is weakly enforced and not inclusive, state governments are often responsible for preventing new non-native and potentially dangerous species from being introduced.

**Recreational Activities as Pathways**

Recreational activities most likely to transport non-native species are gardening, hunting, hiking, fishing, and boating (Kubeck, 2008). Gardeners need to be aware of known and potential invasive plants to protect native and endangered plants and animals (Johnson, Bossenbroek, &
Kraft, 2006). Since many aquatic plants that become invasive are introduced as a result of the water garden and/or aquarium trade, it also important that problem plants are identified so gardeners and aquarium enthusiasts understand the proper way to dispose of them. The recommended disposal approach is to encourage aquarium owners to pour aquarium wastes directly onto gardens or lawn since invasion risk from this action is minimal (Duggan, 2010).

Hunters and hikers provide secondary spread of invasive species on their clothing and gear and boaters pose a risk to water resources by the accidental transport of non-native organisms carried in bilge water, live wells, bait buckets, and engines (Johnson et al., 2001). Plants and some animals, such as Dreissenid mussels (quagga and/or zebra mussels) can attach to props, outboard engines, and trailers. Anglers can introduce AIS by intentionally stocking fish species, using and/or disposing of live bait in surface waters, or carrying standing water in live wells or coolers and disposing of it in other waterbodies (Schantz, 2005). Examples of introductions as a result of anglers irresponsible introductions include New Zealand mudsnails and rusty crayfish (Orconectes rusticus). New Zealand mudsnails have been spread throughout North America by anglers through transport on fishing rods, boots, and waders (Raloff, 1999).

Movement of an invasive species by human activities (e.g. boating, fishing, recreational water use) is known as “secondary spread” (Johnson et al., 2001; 1996; Murry et al., 2011). Ultimately, the severity and success of secondary spread determines the scale of ecological and economic impacts of an invasive species (Lodge et al., 1998). Transient recreational boating and commercial boating in particular, is now commonly perceived by scientists, policy makers, management agencies as the primary means by which AIS are transported and spread (Johnson et al., 2001).
Recreational Boating as a Primary Vector in the Secondary Spread of AIS

Water-based recreation has led to increased anthropological pressure on freshwater environments with physical, chemical, and biological impacts being documented where motorized activities on lakes and rivers occur frequently (Mosisch & Arthington, 1998). Aside from its potential to change waterbody characteristics, recreational boating is also known to be a major vector for the unintentional transport of aquatic plants (Scales & Bryan, 1979; Dove & Malcom, 1980; Dove & Wallis, 1981; Dove & Taylor, 1982; Johnstone et al., 1985; Joyce, 1992; Puth & Post, 2005; Murray et al., 2011). Trailered boats are also the most effective transport vector of Dreissenid mussels, which are frequently found attached to or mixed in with aquatic plants (Johnson & Padilla, 1996; Schneider, Ellis, & Cummings, 1998; Johnson et al., 2001). Aquatic weeds with attached live zebra mussels were observed in the Great Lakes region on one of every 275 boats in parking lots while owners were preparing to launch into un-infested lakes (Johnson & Carlton, 1996).

Small watercraft that are towed on trailers are known to be the primary vectors in the secondary spread of aquatic plants and animals (Rothlisberger et al., 2010). The distinct possibility exists that every time a boat is transported overland after use in an AIS infested waterbody, it will also be transporting AIS to un-invaded waterbodies (Rothlisberger et al., 2010). Spiny water fleas (Muirhead & MacIsaac, 2005), Eurasian watermilfoil (Buchan & Padilla, 2000) as well as quagga and zebra mussels (Leung et al., 2004) have no doubt been transported by trailered watercraft.

A recent Lake Huron study revealed a “stepping stone” pattern identified with at least five lakes being sequentially invaded once an AIS species was present in Lake Huron, which is directly related to the magnitude of boat traffic from invaded sources (MacIsaac, Borbely, Muirhead, & Graniero, 2004). Buchan and Padilla (1999) reported on survey results of registered...
boaters to estimate dispersion rates of zebra mussels. They found that few in-state boaters traveled long distances with their boats, however, there is still great risk to area waterbodies once a species is introduced since it is highly likely that it will be spread to all areas that boaters frequent. This study of boaters recommended that management efforts such as prevention and education focus on high-frequency long-distance boaters as well as regions with the highest volume of boater traffic and most registered boaters (Buchan & Padilla, 1999).

Small watercraft were also reported to be the highest AIS risk in British Columbia because they can travel long distances, making them ideal for transport of “hull-fouling species” such as quagga and zebra mussels (Murray et al., 2011). The Murray et al. (2011) study demonstrated that secondary spread of AIS is likely attributed to recreational boating, and to date, there is very little education, management or policy directed at limiting the introduction and spread of AIS by recreational boaters.

The spread of five aquatic invasive plants in New Zealand was reported to be associated with boating and fishing. Human water activities are primarily responsible for the spread of AIS, not birds, wildlife, or wind, as occasionally suggested (Johnstone, Coffey & Howard-Williams, 1985). This study also reported boats that came out of launch-areas infested with weeds were much more likely to be exiting the water with attached macrophytes compared to launches that were weed-free (Johnstone et al., 1985).

**Florida Freshwater Resources and Recreation**

There are over 12.8 million registered boats in the United States and Florida leads the nation with nearly one million registered boaters and an estimated 300,000 visitors who bring their boats to the state annually ((National Marine Manufacturers Association, 2000; Florida Department of Highway Safety and Motor Vehicles, 2010). In 2006, freshwater sport-fishing in Florida provided recreational opportunities for over 1.1 million residents (over age 16) and more
than a quarter million non-residents. This generates an annual economic return of more than $2.4 billion (Wattendorf, 2006).

Florida has an estimated 2.5 million acres of freshwater resources which include nearly 8000 lakes and 1400 rivers and streams. Since funding for aquatic plant control in Florida is partially derived from motor boat and commercial boat registrations, the connection between boating and vectors for AIS transport is already established, particularly for recreational boaters /anglers who travel to participate in fishing tournaments. Though economic benefits of boating can be difficult to quantify, it has been shown to play a significant role within state economies. Florida is a major destination for boaters and anglers. Boaters use inland, coastal and brackish waters for fishing and other kinds of recreation, and out-of-state travel to Florida from elsewhere, including recreational boats trailered on highways, is also pervasive (Hayward & Estevez, 1997). Florida currently ranks first in the nation for the most in-state registered anglers (2.8 million), highest angler expenditures ($4.4 billion), as well as the generation of $440 million in state and local taxes generated by sport fishing (Wattendorf, 2006). Of the 2.8 million anglers fishing in Florida in 2006, 1.9 million were residents and 0.9 million were non-residents or tourists. Anglers averaged 17 fishing days per year for a total of 24 million days spent in freshwater by 1.4 million anglers and 23 million days were spent on saltwater by 2 million anglers (Wattendorf, 2006).

Non-resident anglers spent over $1 billion annually in direct retail sales, not including peripheral tourism revenues (USFWS, 2006). The state with the second highest non-resident angler spending is Wisconsin, with only half of the direct retail sales reported for Florida (USFWS, 2006). For this reason, Florida has developed a reputation as the “Fishing Capital of the World.” An economic assessment by Southwick and Associates includes the multiplier or
“ripple effect” on the community caused by these non-resident expenditures (FWC, 2010). Lake Okeechobee alone contributes over $32 million a year to the state’s economy in total recreational value (Hayward & Estevez, 2007). While economic data are often hard to compare due to different assessment methods, it is clear that fishing and boating is a major economic activity in Florida.

**Threats to Florida Freshwater Resources**

There were more than 1300 non-native plant species established in Florida in 2007, 124 of which are considered to cause harm or risk to natural areas. These species are classified by the Florida Exotic Plant Pest Council (2007) as Category I (invasive exotics which alter native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with native species) or Category II (invasive exotic species that has increased in abundance or frequency but have not yet altered Florida plant communities to the same extent as Category I species).

One specific concern about AIS is their effect on an individual’s satisfaction while engaging in recreational activities (Adams, Bucam, Lee, & Hodges, 2010). Aquatic invasive plants in Florida can quickly cover the entire surface of lakes and rivers during summer months making access difficult for boaters, swimmers and other users, eventually leading to reduced recreational use. In 2007, 57 percent of Florida’s public lakes and rivers were infested with floating water hyacinth and water lettuce, and 79 percent were infested with hydrilla (Florida Dept. of Environmental Protection, 2007). Negative economic impacts (loss of recreation and tourism) of aquatic invasive plants in Florida’s natural areas and public waters can be considerable if not for control efforts, which are a constant and growing drain on scarce public resources (Glisson, 1994).
Invasive aquatic plants infest over 93 percent of the 439 public lakes and rivers inventoried in 2008 in Florida. Public freshwater resources comprise 1.26 million acres of freshwater where fishing alone is valued at more than $2.5 billion annually, providing approximately 23,500 jobs (FWC, 2008). The Florida Fish & Wildlife Conservation Commission (FWC) estimates that Florida freshwater generates approximately $55 million each year in state sales and motor fuel tax revenue (FWC, 2012). In Florida, 20-30 million dollars are spent each year on the control of aquatic invasive plants (FWC, 2008). Due to the subtropical climate and long growing season AIS present considerable challenges to management agencies, outdoor enthusiasts, anglers, and the many native species that have evolved to live in this environment over time.

Also, organized competitive sport-fishing has been a steadily increasing use of water resources for the past 20 years. In a national survey of sport fishing, Schramm et al. (1991) found that competitive fishing tournaments or derbies were reported in all surveyed states. Those who frequently participate in competitive sport-fishing travel long distances and habitually “jump” from one waterbody to another. Due to the nature of fishing tournaments, particularly in fishing “destination” states (such as Florida), there is mounting concern that anglers who participate in out-of-state derbies and tournaments present a much higher risk of transporting AIS.

There were an estimated 7500 freshwater fishing tournaments held in Florida in the three years between 2009-2011 (B. Wattendorf, personal communication March 21, 2012). Given the number of AIS present in Florida waterways, non-resident anglers who travel with their boats to participate in tournaments have a good chance of bringing an “aquatic hitchhiker” back with them to their home states. The risks occur both ways, since it is also possible that non-resident anglers could also introduce new AIS to Florida waters.
While Florida currently does not have *Dreissenid* mussels, the ecological and economic impacts in other states would be expected to occur in Florida. Hayward and Estevez (1997) studied the suitability of Florida freshwaters for zebra mussel invasion and reported that there is a high likelihood that mussels will reach north Florida and a moderate likelihood that they will reach south Florida. The St. Johns River and Lake Okeechobee were noted as being susceptible to mussel invasion given their low acidity and high mineral content. The authors assert that educational programs held the most promise for prevention of zebra mussel introductions to Florida. Since this 1997 report was published, *Dreissenid* mussels have spread to many others states in rapid succession (see Appendix A for current map of mussel infestation).

Lee, Adams and Rossi (2007) conducted a study on economic impacts of a zebra mussel introduction on Lake Okeechobee and reported that the expected net economic impact from zebra mussels is well over $240 million over a 20 year period. Other research provides evidence for prevention as a “sensible management option that is economically justified since the introduction of invasive mussels is likely, coupled with their potential to induce severe economic and environmental damage and the uncertainty regarding the feasibility of eradication (Lee et al., 2007). Lake Okeechobee is a very popular destination for both Florida and non-resident anglers and is host to several large-scale fishing tournaments each year. Out-of-state boaters present a high risk because they are the most likely vectors for transporting invasive mussels to Lake Okeechobee (Lee et al., 2007). Adams (2007) found that there are several fishing tournaments and organizations that draw participants from the entire United States, Canada, and even from international locations.

**Prevention: The Importance of Education and Outreach**

A survey of invasive species management and prevention programs in the 50 states would yield vast and highly variable results. Some states focus on containing or even, where possible,
eradicating what they already have, whereas others spend resources on prevention and education to limit new introductions. There is no universal policy and only recently have geographical regions begun to address their common problems.

States that target outreach and educational campaigns towards boaters tend to have a greater chance of preventing introductions and secondary spread of AIS, as well as increasing public knowledge and understanding of AIS management efforts (Jensen, 2010). The level of prevention and education regarding AIS varies greatly from state-to-state. Within the last five years, many states, such as Maine, Idaho, Montana, Wyoming, and Colorado have implemented mandatory boat inspection programs that target “high risk” boats traveling on highways or entering boat launches. These programs also have a strong educational component, with communication campaigns and widely-utilized logo and taglines. Other states, such as Oregon have initiated educational programs with voluntary boat inspections. Some states, such as Florida, focus more on control efforts than education and have minimal prevention programs. Targeting boats that are traveling from one waterbody to another or between states is known to be an effective way to stop, curb, or at least slow the spread of AIS in North America.

**Boaters as the Primary Target for Education**

It is well-documented that recreational boaters are the most likely mode of AIS secondary spread (Johnson, 2001; Jensen, 2010; Murray et al., 2011). Boaters are a user group ideally suited to the spread of AIS, yet have not been specifically targeted for AIS education/outreach in Florida. Prevention and education may reduce the number and severity of introductions and secondary spread, and could save the state of Florida money needed for control efforts. A concentrated outreach campaign targeting freshwater boaters and anglers could increase public awareness of AIS issues and management as well as encourage desired AIS preventive behaviors.
Florida registered boaters who boat primarily on freshwater (lakes, reservoirs, rivers, springs, and streams) in Florida are stakeholders in the AIS issue; assessing their knowledge, attitudes, and behavior in regard to AIS could provide critical information to management agencies on how to most effectively develop and disseminate a communication campaign targeting the biggest user group in the state. Out-of-state freshwater anglers who purchase fishing licenses for three days, a week, or on an annual basis present a significant risk of bringing new introductions into the state. Alternately, they could also (along with Florida registered boaters who travel out of the state with their boats) move AIS to other states or provinces.

A communication campaign that identifies and explains current AIS issues in Florida could be beneficial to the general public, but boaters and anglers, given their direct connection to freshwater resources and AIS spread, should be considered the primary “public” or audience. If Florida boaters understand that AIS is a problem and are knowledgeable of the steps that they can take to limit or stop the spread of AIS, they might be more likely to adopt those behaviors. Targeting non-resident anglers would also be beneficial in protecting Florida lakes and rivers. Understanding the issue and knowing there is something they can do to help that is within their “locus of control” can help prevent future introductions of AIS. Knowledge of effective communication techniques and modes of engaging stakeholders in AIS issues could be beneficial to agencies combating the introduction, secondary spread, and public awareness of AIS.

**Purpose and Objectives**

This study will provide a baseline assessment of Florida registered boaters’ and non-resident freshwater anglers’ knowledge and attitudes of AIS issues, spread, and management. Specifically, the objectives of this research are to assess the following:

- Florida boaters’ and non-resident freshwater anglers awareness of AIS issues management, and vectors for spreading;
• Attitudes regarding AIS issues, spread, and management on behalf of Florida boaters and non-resident freshwater anglers;

• Florida boaters’ and non-resident freshwater anglers’ current behavior relating to AIS issues and spread; and

• Factors that predict boater and angler AIS preventive behaviors (BMPs).

**Significance of Research**

The data collected in this study will provide information to management agencies regarding the Florida boating public’s perceptions, attitudes, current knowledge, and means of accessing information on AIS. In addition, it will assess potential predictors of boater and angler behavior and adoption of Best Management Practices (BMPs) in relation to AIS prevention, information that can lead to well-informed management and outreach programs that will best target key stakeholders in both content and communication channels. In Florida, the FWC’s Invasive Plant Management Section manages invasive species and will benefit from increased knowledge about boater and angler awareness and perceptions of AIS.

The Florida Statutes authorize the FWC to direct the control of noxious aquatic weeds “so as to protect human health, safety, and recreation and, to the greatest degree practicable, prevent injury to plant and animal life and property” (Florida Statutes 369.20(2). Since $20-30 million is spent annually on the control of aquatic invasive plants in Florida by FWC alone, it can be inferred that AIS present significant risks and problems in Florida waterbodies (FWC, 2008).

Management agencies struggle with funding issues, management decisions, stakeholder desires, and perceptions of the general public. The management of AIS has been compared to that of prescribed burns, programs that focus on prevention of serious fires or maintenance can be difficult for the public to understand. The FWC has historically utilized a program for AIS known as “maintenance control.” The maintenance control strategy is to “keep invasive species at the lowest feasible levels that technology, funding and current conditions will allow” (FWC,
However, if invasive species, and plants in particular, present great risks to the public, but the public never sees AIS get that bad because they are maintained regularly, the public might wonder if AIS are truly a significant issue (Jeff Schardt—FWC, personal communication December 2012).

Boaters and anglers may have more experience, knowledge and attitudes of the impacts and risks posed by AIS and they have been implicated in the dispersal of AIS for some time (Griffiths, Schloesser, Leach, & Kovalak, 1991; Johnson et al., 2001; Johnson et al., 2006). Traveling boaters without an awareness of AIS introductions and impacts present a high risk to all freshwater resources, not just in their resident state but also to other destinations throughout North America. This survey and assessment will also provide recommendations for outreach approaches and the most effective communication channels. In a time of government deficits and reduced public spending, identifying effective pathways for communicating with key stakeholders is crucial. It will be possible to create an educational campaign by targeting appropriate audiences that can “improve public knowledge and inform values regarding conservation issues, reinforce positive social norms, teach new skills, and foster support for conservation laws and policies” (Jacobson, 2009 p. 23).
Figure 1-1. Pathways of Initial Invasive Species Introductions. [Reprinted with permission from Hulme et al., 2007. Grasping at the routes of biological invasions: A framework for integrating pathways into policy. (p. 406, Figure 2) Journal of Applied Ecology, 45].
CHAPTER 2
THE HUMAN DIMENSIONS OF AQUATIC INVASIVE SPECIES

Human dimensions research related to conservation and the environment presents a wealth of literature and information on the factors that influence an individual’s behavior. The theoretical framework for this study consists of behavioral theories often utilized in human dimensions and conservation research due to their focus on knowledge and attitudes in regard to practice and behavior. While several theories are used in environmental behavior studies, this research model draws specifically from responsible environmental behavior and the theory of planned behavior. This study focused on boater and angler behavior in regard to the spread of AIS, but explored other constructs such as awareness and attitudes.

Human dimensions research posits that conservation issues are also human issues (Jacobson, 1998). Effective communication can bridge the gap between what people do not understand and what they need to know to do be part of the solution. As Teague states, “Most wildlife management problems start as biological problems, but eventually become people problems” (Teague, 1979). One can argue that all wildlife management problems are socially defined as such. Effective communication and education can ultimately lead to changes in behavior that help protect and conserve our native fish and wildlife (Jacobson, 1998). If AIS issues become (or be seen as) more salient and relevant to the public, the chances of stakeholders adopting behaviors that prevent the spread of AIS will greatly increase.

Assessing Florida boater and non-resident freshwater anglers’ awareness and attitudes regarding AIS issues, spread, and management is intimately connected to the human dimension aspects of conservation and wildlife research. The AIS issue is as much a human issue as a biological one in regard to introduction and spread, as well as perceptions of the problem and knowledge of the various management options.
Jensen (2010) evaluated the level of AIS knowledge and awareness of boaters in four regions of the United States (Northwest, Midwest, Great Plains, and Northeast) and found that effective AIS outreach can motivate boaters to act. The study also demonstrated that if outreach is a priority, is consistent, directed through appropriate channels, and frames the value of personal actions effective at preventing AIS spread, boaters will be more likely to understand AIS issues and act more responsibly. In order to adequately address the multitude of impacts associated with AIS, effective educational campaigns should be developed and implemented. Behavioral theory and models are very useful tools in understanding why people chose to take action (or not) and the best ways in which to reach stakeholders with messages that are salient, targeted, and capable of influencing behavior.

**Introduction to Models**

Many early environmental behavioral studies assumed that knowledge was a necessary pre-condition for behavioral change through its influence on a person’s attitude (Chaffee & Roser, 1986; Zimmermann, 1996). While this assumption was considered valid for many years, more recent studies have argued against the direct link between knowledge and attitude. Recent studies contend that the link is often not always strong enough to effect desired behavioral changes (Frick, Kaiser, & Wilson, 2004; Hwang, Kim & Jeng, 2000; Oskamp, 2002). Moreover it has repeatedly been found that knowledge alone does not necessarily translate into behavior (Rothlisberger et al., 2010; Zhong, 2007; Hungerford & Volk, 1990; Hwang et al., 2000; McKenzie-Mohr, 2008).

The Theory of Planned Behavior has been used in many previous studies regarding environmental attitudes and subsequent behaviors (Ajzen & Fishbein, 1980). The Model of Responsible Environmental Behavior is based on the Theory of Planned Behavior, but adds knowledge of issues, action strategies, commitment/intention, sense of responsibility, as well as
outside situational factors (Hines, Hungerford, & Tomera, 1987). Some research has been conducted in recreational and leisure applications of these theories which is closely related to the practice of boating and angling (Ajzen, 1992; Cottrell, 2003).

Ajzen and Fishbein’s (1980) research (Theory of Reasoned Action which led to the development of the Theory of Planned Behavior) demonstrated that in order to find a positive correlation between attitudes and behaviors, the scientist has to measure the attitude towards that specific behavior—attitude measurements must be narrowly targeted to define the real issue (Kollmuss & Agyeman, 2002). Essentially, Ajzen & Fishbeins’ (1980) work showed that attitudes do not directly determine behavior, but they do influence behavioral intentions. These intentions are part of the puzzle of factors that shape peoples’ actions. The other major contribution of these theories addresses the power of beliefs. As Ajzen & Fishbein (1980) state “the ultimate determinants of any behavior are the behavioral beliefs concerning its consequences and normative beliefs concerning the prescriptions of others.”

The publishing of the Theory of Planned Behavior directly led to the evolution of the theory in the form of the Model of Responsible Environmental Behavior. The Model of Responsible Environmental Behavior will be the primary theoretical framework used in this study due to the desire for a better understanding and predicting behavior as it relates to boater and anglers’ role in AIS spread and related issues.

Most studies have consistently demonstrated that intentions are good predictors of behaviors (Madden, Ellen, & Ajzen, 1992; Vining & Ebreo, 2002). The two models (Theory of Planned Behavior and the Model of Responsible Environmental Behavior) share this premise as well as the construct attitude. In both models, attitudes are assumed to have a direct influence on an individuals’ intention to act. In addition to possessing the intention to act, the Model of
Responsible Environmental Behavior asserts that two additional broad factors are necessary: cognitive (issue, action strategy, and skill knowledge) and affective (attitudes, personal responsibility, and locus of control) components. The premise is that if cognitive and affective factors can be changed, behavioral intentions can be influenced, which can ultimately result in environmentally desirable behavior (Hwang et al., 2000).

**Theory of Planned Behavior**

The main premise in the Theory of Planned Behavior (TPB) is that attitudes, norms, and control are necessary to affect a change in behavior with the emphasis of the theory linking attitudes to action or behavior. Ajzen (1992) maintains that attitudes toward the behavior, subjective societal norms regarding the specific behavior and perceived control over the desired behavior are “found to predict behavioral intentions with a high degree of accuracy (p.206).” The TPB is an empirically derived behavior model that identifies determinants of behavior change while recognizing that intention to change a behavior will not occur if the individual is unable to act upon the intention (Fishbein & Ajzen, 1980). The TPB differs from Ajzen’s earlier Theory of Reasoned Action because it adds perceived behavioral control to the model (Kollmuss & Agyeman, 2002). By adding this element, Ajzen (2002) tried to address situations in which the individual has little control over the context or available resources necessary to perform or complete the desired behavior. A key underlying mechanism to the TRA and the TPB is based on the *expectancy–value* theory, which asserts that attitudes are predicted by beliefs about the likelihood that a given behavior will lead to a certain consequence, multiplied by one’s own evaluation of those perceived consequences (Atkin & Rice, 2001).

Ajzen’s TBP (1985) suggested that the main determinants of a person’s behavior are the strength of their intention (beliefs, attitudes) as well as their ability to act (capacity, skill,
understanding). The TBP is regularly used in conservation and recreation studies, and has been linked to an individual’s choice to engage in leisure activities (Ajzen & Driver, 1992).

**Behavioral beliefs**

Behavioral beliefs are attitudes towards the consequences of a specific behavior (Ajzen, 2002). If the individual perceives that the potential of a favorable outcome outweighs the potential negative outcomes that are possible, it is more likely that they will engage in the desired behavior. In this case, they will likely engage in the behavior if the boater/angler believes that the value of undertaking preventive measures to stop the spread of AIS outweighs the time and effort required to adopt the preventive behaviors.

According to the TPB, behavioral beliefs influence attitudes towards a targeted behavior (Ajzen, 1988). Fishbein & Ajzen (1975) hypothesize that an attitude is developed through three main influences: it is learned, it prompts action, and actions are either favorable or unfavorable towards the idea/object.

**Normative beliefs**

Normative beliefs represent an individual’s perceptions of a specific behavior, which is heavily influenced by the judgment and opinions of significant others in their life, such as spouses, friends, family, members of an organization, or those held in high regard (Ajzen, 2002). If the behavior of interest is adopted by opinion leaders and members of specific groups with whom an individual aligns himself, it is likely that the individual will also adopt that specific behavior (Ajzen, 2002). The individual’s perceived social pressure by people who matter to them is referred to as a “social norm,” which will influence whether or not the individual decides to engage in the behavior or not.

In regard to AIS, if boaters and anglers are encouraged to partake in preventive measures by influential others, they will be more likely to adopt the same behaviors. Thus, if popular
boating and fishing organizations were to promote AIS preventive behaviors, and influential opinion leaders were to model said behaviors, it would be likely to become a part of the boating and fishing culture and an expected norm for those engaging in freshwater recreational activities. For example, Aipanjiguly, Jacobson, and Flamm (2003) found that normative influences were one of the most important factors in whether or not a boater decided to take action to protect manatees in Florida (e.g. slow down in posted areas).

**Control beliefs**

Control beliefs relate to an individual's beliefs about the existence of factors that may facilitate or hinder the implementation and performance of a specific behavior (Ajzen, 2002). If an individual feels that there are significant factors in place that will prevent them from acting or otherwise make the behavior difficult, they will be less likely to engage in the behavior. An individual’s perceived behavioral control refers to the individual’s opinions regarding the level of difficulty necessary to perform the desired behavior. Perceived difficulty may exist at the physical, situational, or personal level; if an individual believes that the level of difficulty required is too high in performing a specific behavior, they are unlikely to do it (Ajzen, 2002). For example, if boaters/anglers perceive that there is too much required of them (energy, bending over/climbing) or they have to go out of their way because equipment is not available (boat cleaning equipment), they may face a disincentive to participate. If boaters and anglers feel that engaging in AIS preventive behaviors is going to be difficult, they will likely not adopt the behaviors.

**Theory of planned behavior related studies**

The TPB provides a model to determine how people think about particular behaviors and can be used to test or verify reasons for inaction and action within a specific population. There are three main elements regarding behavior in this context (the spread of AIS by boaters and
They include: 1) action—inspecting boat/equipment and removing AIS, 2) target—all AIS and debris including plants, animals, and mud, and 3) context—boat and/or equipment at the point of water access to accomplish the task (Jensen, 2010).

Another lesson that arose from TPB studies is that specific prescriptions work better to change behavior than general requests. Identifying, promoting, and modeling the desired action or behavior helps to normalize it. According to 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. 168). If we can encourage boaters and anglers to take specific steps to prevent the spread of AIS, they will be more likely to adopt preventive practices than if there is a vague, general appeal concerning the issue. In other words, people must clearly understand what is being asked of them in order to modify their behavior.

The Conceptual Model of Responsible Environmental Behavior

Hines, Hungerford, and Tomera (1986/87) conducted a meta-analysis of 128 pro-environmental behavior studies in an effort to better understand the variables that influence an individual’s decision to adopt responsible environmental behavior. Hines et al., (1986) argued that the numerous factors found by various studies clearly indicated the potential presence of interconnectedness among variables to influence behavioral action. It was found that an individual who expresses an intention to take action is more likely to engage in that action (much like the TPB suggests), but that intention is influenced by cognitive knowledge, cognitive skills, and personality factors (Hines et al., 1986/87).

The meta-analysis that led to the development of the Model of Responsible Environmental Behavior (REB) included cognitive, psycho-social, and demographic variables. Cognitive variables included factors relating to knowledge of the environment or a specific aspect of an
environmental issue. Psycho-social variables included factors relating to individual personality characteristics including perceptions of themselves and others which includes attitudes, locus of control, economics, personal responsibility, and verbal commitment to taking action (Hines et al., 1986/87). Demographic variables included in the study included age, income, education, and gender; none of which were found to be significant in relation to responsible environmental behavior (Hines et al., 1986/87).

The following variables were found to be directly related to the presence of responsible environmental behavior: knowledge of issues, knowledge of action strategies (and associated skills), locus of control, attitudes, verbal commitment, and individual sense of responsibility (Hines et al., 1986/87). Situational factors were also added to the model to account for extenuating circumstances and social pressures. The REB is highly relevant to human dimensions of conservation and invasive species because if the public and primary users of resources do not think their actions will make a difference, they will not be likely to act in a way that curbs the spread of AIS to protect the habitat they prefer for recreation.

**Knowledge and awareness of issues**

The realization that knowledge alone has not necessarily led to behavior changes moved scientists to segregate knowledge into three different forms (Hines et al., 1986; Hungerford & Volk, 1990; Hwang et al., 2000). Hines et al. (1986) found that individuals with greater knowledge of environmental issues and also greater knowledge of action strategies associated with the issue were more likely to engage in responsible environmental behaviors than those without the knowledge (Hines et al., 1986/87).

Individuals must be familiar with the environmental problem or issue as well as its causes in order to act in the desired responsible manner. These forms of knowledge deal with the “knowing what” of an issue (Frick et al., 2004, p. 1599). If boaters and anglers do not know
about the issue of AIS and associated impacts, they will not know what is expected of them in relation preventive behavior. Some knowledge is likely necessary for action.

Derrick, Miller, and Andrews (2008) examined the effects of risk communication interventions among a group of anglers and found that knowledge of fish trimming methods and safe levels of consumption increased. Results also showed that anglers were more likely to avoid “risky” fish species after the intervention.

Conventional environmental issue campaigns were based on early linear models of pro-environmental behavior. These models assumed that environmental knowledge leads to a sympathetic attitude towards the issue, which in turn leads to the desired behavior (Kollmuss & Agyeman, 2002). It is necessary to have awareness of the AIS issue in order to take strategic action to stop their spread, which most commonly requires some kind of educational campaign targeting boaters and anglers. However, this is likely only one piece of the puzzle in promoting AIS prevention.

**Knowledge of action strategies (and associated skills)**

In addition to knowledge and awareness of an issue, Hines et al. (1986) found that knowledge of specific strategies is also essential for behavior adoption. This can be considered the “how-to knowledge” (Rogers, 2003, p. 173). In contrast to issues awareness, action-strategies knowledge is more procedural and considered a better predictor of pro-environmental behavior (Kaiser & Fuhrer, 2003).

A study conducted by Rothlisberger et al. (2010) of AIS transport via trailered boats demonstrated that though boater awareness in the Great Lakes area may be higher than other parts of the country, they also lack experiential information about the spread of AIS by small crafts as well as the effectiveness of preventive techniques. To date, educational outreach in the Great Lakes region has focused on pre-launch inspections and communication campaigns to
educate the general public about the dangers of AIS, not how to prevent the spread (Rothlisberger et al., 2010). This research suggests that it is not enough for an individual to know that an issue exists; they also need to know how she/he needs to act in order to appropriately address the problem. Boaters and anglers have been found to be uncertain about what exact steps are required to prevent the spread of AIS and others may undertake measures that are not really addressing the problem (Rothlisberger et al., 2010; Kubeck, 2008). To date, management has focused more on mitigating AIS impacts through control and, where possible, eradication, than prevention (Simberloff, Parker, & Windle, 2005; Lovell & Drake, 2009). Management actions with the objective of educating boaters on proper AIS removal techniques may be a resourceful, more effective and complementary means of reducing the spread of AIS (Drury & Rothlisberger, 2008). With regard to prevention techniques, placing boat inspection and cleaning stations at high-trafficked lakes already infested with AIS might be more effective at slowing their spread, at least at a landscape-level, than at un-invaded lakes (Drury & Rothlisberger, 2008).

There seems to be a consistency issue in AIS prevention that can be improved with the communication of clear prescriptions to the problem, the more specific the better (for example, clean live wells with hot water and allow to dry five or more days). The courses of action which are possible and available in a given situation must be known if action is expected or desired (Hines et al., 1986/87). Also relating to this is the perception that an individual has the right skill in appropriately applying the knowledge and action strategy to the problem. Hines et al. (1986/87) reported that assuming skills evolve naturally from knowledge is erroneous. For this reason, it is included in the REB model.

Lindgren (2006) conducted a face-to-face survey of anglers in Manitoba to gauge AIS awareness and preventive practices. Although angler AIS awareness was relatively high, many
anglers had not adopted simple preventive practices such as properly discarding of unused live bait and removing plants from the boat trailer. This suggests that knowledge alone is not enough to instigate action.

Mueting and Gerstenberger (2011) compared boater behaviors prior to and following the quagga mussel infestation at Lake Mead in Nevada. They found that although boaters were more aware of the mussel issue following the invasion, their cleaning habits had not significantly changed. The authors recommended increasing boater awareness about AIS issues and suggested that it is also imperative that education focus on effective cleaning and preventive techniques.

Data are lacking on the efficacy of the recommended AIS preventive measures, and also documentation of boater compliance with various preventive practices. The Rothlisberger et al. study (2010) included observation and a survey of boaters in the Great Lakes region and demonstrated that: 1) boats leaving the Great Lakes were three times as likely to be carrying attached or entangled vegetation than those arriving; and 2) there seems to be three different types of recreational boaters—those who keep their boat on the same body of water all season, those who visit three different waterways in a two-week period, and professional fishing guides that visit more than five waterbodies every two weeks. In addition, their research showed that high-pressure washing can remove over 90 percent of small-bodied organisms.

The same study found that more than two-thirds of boaters do not always take steps to clean their boats to prevent the spread of AIS. Visual inspections of boats and hand removal of plants, mud, and debris can reduce the amount of plants on boats by 88 percent, high pressure washing was found to be equally effective and low pressure washing was found to be less effective. This research supports the prevalent opinion that many boaters simply have not yet
adopted consistent and effective AIS preventive habits which clearly indicates that additional management and educational efforts are necessary (Rothlisberger et al., 2010).

General behavioral actions recommended for curbing the spread of AIS by trailered watercraft include: 1) inspect and remove plants, animals, mud and debris; 2) drain all standing water from the boat (bilge, live/bait wells, motor, bait buckets, etc.) before leaving the launch; 3) remove and destroy any live bait or fish; 5) rinse your boat with hot or high-pressure water; and 6) dry for at least five days (Zook & Phillips, 2009). In addition, wiping the hull has been reported to be a fairly common practice among boaters that can also address AIS spread (D. Jensen, personal communication November 25, 2011).

The associated skills required to carry out specific action strategies, Rogers (2003) called principles knowledge. The skills required to take action relate to the functioning principles underlying how an innovation works. While the action strategies knowledge is focused on “how to” knowledge, Hines et al. (1986), described the skill knowledge to be vital in influencing “whether an individual converts this knowledge into action” in problem solving (p.6).

**Locus of control**

In order for an individual to change their behavior they must feel as though they can bring about change through their own actions. Personality factors also include the “locus of control,” which is the person’s perception of their ability to affect change as a result of their behavior (Rodder et al., 1972). Those with a strong internal locus of control believe that their behavior has the power to bring about change; those with an external locus of control, in contrast, feel that their actions are not significant enough to change the status quo (Peyton & Miller, 1980). This concept is based on the belief that some people do not engage in desired behavior because they attribute change to “chance or powerful others” (Hines et al., 1986/87). Related to this concept is
“self efficacy,” or the idea that one who chooses to carry out specific behaviors will do so with the belief that their behavior is effective at realizing a specific outcome (Bandura, 1997).

A study testing REB in reference to visitors of an urban forest trail in Korea found that locus of control and attitude was more important than knowledge or personal responsibility when it comes to the intention to act (Hwang et al., 2000). The authors suggest that education and interpretation efforts need to focus more on strengthening the internal locus of control. This makes sense in relation to AIS prevention as well because if boaters and anglers do not perceive that their actions can or will truly make a difference in the spread of AIS, they will not be likely to take the time to take action.

Attitudes

Individuals with strong pro-environmental attitudes should be more likely to engage in pro-environmental behaviors. Attitudinal factors included in Hines et al. (1986/87) study were those that dealt with an individual’s feelings, pro or con, favorable or unfavorable, with regard to specific aspects of an environmental problem. In the meta-analysis, the authors found that there were essentially two different types of attitudes under study: attitudes towards the environment as a whole and attitudes towards taking environmental action, both of which are positively correlated to responsible environmental behavior (Hines et al., 1986/87).

Attitudes and perceptions are key components that can influence an individual’s behavior. Closely related to attitudes are beliefs which relate directly to how aware an individual is to a particular issue (Kollmuss & Agyeman, 2002). Ajzen (1991) suggests that behavioral beliefs, or an individual’s attitude towards a specific behavior, are a determinant of intention to act, which is the precursor to action. It is these behavioral beliefs that produce a favorable or unfavorable attitude towards the targeted behavior (Ajzen, 1991). Attitudes are presumed to influence
behavior, with positive attitudes (towards a specific issue or action) promoting pro-environmental behaviors while negative or unfavorable attitudes lead to no action.

Diekmann and Preisendoerfer (1992) found that environmental attitudes do not always have a significant impact on pro-environmental behavior. The authors suggested that people choose pro-environmental behaviors when the cost to do so is low, which can include time, effort, and monetary costs (Diekmann & Preisendoerfer, 1992). Attitudes are more likely to only indirectly influence behavior (Kollmuss & Agyeman, 2002). In the case of AIS, attitudes may have some influence on whether or not a boater or angler is likely to adopt AIS preventative behaviors (intention), but most likely will not be enough to elicit action, as the REB predicts. Additionally, previous research demonstrates that different user groups (e.g. boaters, anglers, duck hunters, shoreline homeowners) can have very different attitudes about AIS issues and management preferences (Slipke, Maceina, & Grizzle, 1998; Kirk & Henderson, 2006; Kyle, Abasher, & Graefe, 2003).

Slipke, Maceina and Grizzle (1998) found that angler use decreased by 33 percent when hydrilla coverage was at a maximum in Florida’s Lake Seminole. Though largemouth bass anglers indicated that they preferred a high amount of hydrilla coverage, anglers who sought other species preferred less, and homeowners preferred even less hydrilla coverage. A South Carolina study suggested that while anglers and waterfowl hunters had positive experiences and perceptions of hydrilla for fishing and hunting, boating and hydropower generation were negatively impacted (Kirk & Henderson, 2006). A similar study in Alabama found that relatively moderate levels of aquatic plant management were associated with the highest levels of recreation-based economic effects on the economy surrounding Lake Guntersville (Bergstrom, Teasley, Cordell, Souter, & English, 1996).
Recreationists are more willing to support user fee-based prevention and control activities when they have strong ties to a specific place and have an idea what the funds will be used for. If inadequate funding is preventing management agencies from implementing education and preventive strategies that would help boaters take action in stopping the spread of AIS, perhaps fee-programs can help. Kyle, Abasher, and Graefe (2003) found that people using public lands were more willing to support a user-fee program if there was some component of “place identity,” a factor that magnified recreationists’ attitudes toward a fee program and additional funding. As place identity increased in relevance, attitudes toward the fee program became more positive. This suggests that a more place-based approach might be necessary to obtain the necessary “buy in” and financial support from the boating and angling public.

**Individual sense of responsibility**

This concept relates to an individual’s sense of obligation or duty to undertaking a desired behavior. Those who possess a greater sense of obligation or duty are more likely to engage in pro-environmental behaviors. In the meta-analysis, this responsibility was expressed either in reference to the environment as a whole or a specific aspect (air pollution, recycling, water quality, etc.). It was found that those individuals who felt some degree of personal responsibility toward the environment (both as a whole or just some component) were more likely to have reported acting in responsible environmental ways (Hines et al., 1986/87).

Jensen (2010) found that boaters in two of the five states he surveyed indicated that a sense of personal responsibility had motivated them to adopt preventive AIS behaviors. However, this was not found to be the case in all states, though many boaters in the sample (across the five states) thought it (a sense of personal responsibility) would be somewhat or very effective at getting boaters to take action.
Situational factors

In addition to the aforementioned factors related to an individual’s likelihood to engage in environmentally responsible behavior, Hines et al. (1986/87) added “situational factors.” These factors include such constraints as economics, available infrastructure, social pressures, and opportunities to choose other options. Situational factors may vary depending on the context.

In the case of boater and angler behavior regarding the spread of AIS, situational factors are likely a large variable in explaining why some take action and others do not. Situational factors in regard to AIS preventive measures would likely include: social normative pressures (they do not feel that other boaters/anglers take action); lack of available space or equipment to properly wash or decontaminate boats; lack of economic resources at home to take action (high pressure hose, cleaning tools); or the circumstances surrounding the experience (ramp area too crowded or small).

Attachment to a local natural resource can also influence environmentally responsible behavior in an individual’s everyday life (Vaske & Kobrin, 2001; Halpenny, 2010). Encouraging an individual’s personal connection to a natural setting may increase their tendency to undertake responsible environmental behavior (Vaske & Kobrin, 2001). Relating this to AIS prevention, boaters and anglers may be more likely to inspect and clean their boat and equipment if they have a strong connection to the place in which they recreate. Boaters and anglers that regularly use the same bodies of water for recreation would possibly be more likely to adopt preventive behaviors in order to protect their preferred recreational site from being taken over by AIS. Place attachment could be considered another situational factor in the REB model.

It is worth noting that situational factors do not always have a negative effect on whether or not an individual chooses to undertake responsible environmental behavior (Hines et al., 1986/87). Other effects are possible. For example, an individual could choose to clean their boat
and equipment not just because there is equipment available and it reduces the likelihood of transporting AIS, but also because it protects their investment in the equipment itself. In this case, this motivation could possibly be emphasized as a double benefit.

**Intention**

Intention is an indication of an individual's readiness to implement a specific behavior and it is assumed to be an immediate antecedent of behavior in the TPB (Ajzen, 2002). Ajzen and Fishbein (1975) assert that the strength of an intention is signified by the likelihood of the individual engaging in the desired behavior. A focal point of the Theory of Planned Behavior is that intention to perform a certain behavior is directly related to an individual’s action (Ajzen & Fishbein, 1980). According to the model of environmental responsible behavior, intention to act is influenced by cognitive components (issues, action-strategies, and skills knowledge) and the affective components known as personality factors: attitudes, locus of control, and personal responsibility (Hines et al., 1986).

The communicated willingness to take action can provide an indication about an individual’s willingness to participate in responsible environmental behavior. Despite the use of the term “verbal” by the authors, the studies were assessed by written measurements, thus commitment is a measure of intention and does not necessarily need to be expressed verbally (Hines et al., 1986/87). In the meta-analysis, those who expressed the intention to undertake or adopt an action in regard to an environmental problem were more likely to have reported actually doing so (Hines et al., 1986/87).

If boaters and anglers possess the attitude, subjective norm, and perceived behavioral control in regard to stopping the spread of AIS, then their likelihood of engaging in pro-environmental behaviors (preventive measures) greatly increases. For example, Hrubes, Ajzen, and Daigle (2001) applied the TPB to the prediction and explanation of hunting behaviors
through a mail survey where it was found that hunting intentions contributed to hunting frequency. Hunting intentions were strongly influenced by attitudes, subjective norms, and perceptions of behavioral control. These predictors were associated with the underlying beliefs of the hunters (Hrubes et al., 2001).

Economic research evaluating the “Willingness-to-Pay” concept can provide a useful framework to view user preference and commitment, and evaluates the strength of an intention to act. When utilities are measurable in monetary willingness to pay (WTP) or willingness to accept (WTA) compensation, these parameters represent the marginal monetary value of specific characteristics even in regard to environmental services (Farber, Costanza, & Wilson, 2002). Though a useful tool, WTP studies have been critiqued for oversimplifying values and failing to capture actual preference, particularly in regard to public goods, which individuals do not generally purchase directly (Diamond & Hausman, 1994).

Milon et al. (1986) investigated Orange and Lochloosa Lakes in Central Florida to assess AIS impacts to fishery resources and found that anglers were willing to pay up to $25 per year for a “weed stamp” that would address better control. Bell (1998) evaluated fishery risk from AIS in Lake Tarpon, Florida and found that anglers, on average, were willing to pay about $26 per person annually to reduce the infestation of aquatic weeds. More recently, a study demonstrated that users of all recreational freshwater resources would be willing to pay up to $14 per year to control AIS (Bell & Bonn, 2004). The same study also demonstrated that it is not only recreational value that is lost when AIS cause problems, but jobs and wages are also affected in the local communities that are dependent on the freshwater resources to attract people to the area (Bell & Bonn, 2004).
The Lake Kissimmee Chain of Lakes, a very popular bass fishing destination, was found to have nearly 500,000 visitors per year, which provides significant revenue to local economies (Bell, 2005). There would be major economic consequences on the local community if the level of AIS was to become denser and visitation decreased. Bell (2005) reported that users of the Kissimmee Chain would be willing to pay $12.64 per year to use the lake if a regular AIS control program (primarily for hydrilla) was initiated. About 83 percent of all users of Lake Toho in the Kissimmee Chain of lakes felt that AIS posed a serious problem for recreation. Duckworth (2006) found that 65 percent of Kissimmee Chain stakeholders perceived that aquatic weeds negatively impacted enjoyment of lake-oriented activities.

Adams et al. (2010) conducted a study on public preferences and values for management of aquatic invasive plants in state parks and discovered that the typical Florida resident is willing to pay approximately $6.15 (per visit) to control AIS, $3.81 to increase the abundance of native plants, and $4.99 to increase native animal species. Recreational users in 63 river and lake state parks indicated that they were willing to pay a total of $35 million a year to keep aquatic invasive plants from becoming “numerous and dense” in Florida’s parks and natural areas.

Similarly, McIntosh, Shogren, and Finnoff (2010) found, in a national valuation survey, that the average person was willing to make a one-time payment of $48 annually to delay “low to high impacts,” which equates to nearly $4 billion if all U.S. households participated. The federal government, for comparison, invests only $394 million (annually) for invasive species prevention and Early Detection/Rapid Response programs for both aquatic and terrestrial species (McIntosh et al., 2010).

**Responsible Environmental Behavior and AIS**

Behavior, the ultimate target of most behavioral intervention strategies, is a product of situational factors and intention in the REB. Ultimately, preventing the spread of AIS is the
responsibility of individual’s (e.g. boaters and anglers) and their willingness to take action. This relates to behavior, which is affected by many interrelated issues and processes. Early behavioral theory attributes an individual’s decision to act to various external and internal factors. External factors include institutional, economic, and social variables. Internal factors include knowledge and awareness (about the particular issue), attitudes and motivation, emotion, locus of control, responsibilities and priorities (Kollmuss & Agyeman, 2002).

The focus of this study is on AIS prevention, which centers on individual boater and angler behavior. Most of the research on behavior is conducted through self-reported measures such as surveys, which can lead to “social desirability bias” (Maccoby & Maccoby, 1954; Peterson & Kerin, 1981). Social desirability bias is the tendency for individual’s to present oneself in the best possible light, even if responding anonymously. The result is that data are often biased toward respondents' perceptions of what is "correct" or socially acceptable (Maccoby & Maccoby, 1954). For this reason, it is important to note that this research utilized a questionnaire that requests boaters and anglers to report their awareness, attitudes, and behavior. It is actually their perceived behavior because it was self-reported and not directly observed.

Johnson et al. (2001) conducted an observational study at boat launches in Michigan and found mussels frequently attached to aquatic plants which were entangled on boat props and trailers. The authors of this study recommend targeted educational and prevention campaigns for boaters that travel and intensive efforts to increase boater behaviors that prevent the spread of AIS.

Kubeck (2008) reported on a qualitative study in Oregon to evaluate the behavior and associated barriers that prevent people (hunters, recreational anglers, exotic pet/aquarium owners, and gardeners) from changing behaviors that would help stop the introduction of
invasive species. Research discovered barriers such as a lack of information about what preventive behaviors entail and the belief that preventive behaviors are too difficult to perform (Dierking, Chan, Kubeck, Cone, & Wolters, 2009).

**Other Responsible Environmental Behavior Related Studies**

Sia, Hungerford, and Tomera (1985-86) tested the Model of Responsible Environmental Behavior and found that the best predictors for engaging in responsible environmental behavior were: 1) the level of environmental sensitivity, 2) the perceived knowledge of environmental action strategies, and 3) the perceived skill in using environmental action strategies.

Cottrell (2003) tested the REB Model on recreational boaters in Maryland and found a relationship between professed knowledge of environmental issues, general environmental concern, and verbal commitment. Verbal commitment was actually found to be the strongest predictor, since it is a direct measure of intention. This was closely followed by professed knowledge of the issue. If boaters and anglers understand the issue and are committed to “doing their part” to stop the spread of AIS, they will be much more likely to adopt preventive behaviors but also to contribute to a normative influence in regard to their peers.

Similarly, Mobley, Vagias, and DeWard (2010) also reported that environmental concern was a stronger predictor of REB than other background characteristics. They also found that those that read environmental literature (e.g. magazines, newsletters, books) were more likely to act. This suggests that boaters and anglers who belong to a fishing, hunting, angling or conservation group that receive publications with articles on AIS might be more receptive to preventive behaviors.

Twenty years after the Hines et al., (1986/87) REB model was proposed, it was tested again using a meta-analysis of 57 studies relating to pro-environmental behavior (Bamberg & Moser, 2007). The authors found results similar to those proposed by Hines et al. (1986),
particularly the strong correlation between psycho-social variables and responsible environmental behavior. Bamberg & Moser’s (2007) study confirmed that behavioral intention mediated the impact of all other psycho-social variables and added moral norms as an additional predictor of responsible environmental behavior. These studies indicate that the REB model still functions well as a predictor of desired action in regard to an individual’s environmental impacts.

The REB has also been used to survey attitudes regarding forest conservation (Hwang et al., 2000), household waste management (Barr, 2003), and recycling behaviors (Nemiroff & McKenzie-Mohr, 1992), among others. Hwang et al. (2000) found that locus of control and attitudes were more important than knowledge and personal responsibility in terms of intention to act, suggesting that interventions should focus on changing the internal locus of control.

**Modifications to the REB Model for Predicting AIS Preventive Behavior**

The proposed integrated and extended model that guided this study was informed by constructs from responsible environmental behavior and theory of planned behavior, as previously discussed. The model was modified for the purpose of this study due to existing research on similar populations linking the importance of subjective norms and self-efficacy. See Figure 2-1 for a depiction of the modified REB Model used.

**Florida Boaters and Normative Influences**

Research on Florida boaters and non-resident freshwater anglers is sparse but two studies on manatee conservation in Florida suggest that normative influence may be a larger variable than the Model of Responsible Environmental Behavior advocates in this specific case. Aipanjiguly et al. (2003) conducted a study on boater behavior in regard to manatees and results showed that boaters were more supportive of increased public education than more regulations, and that greater knowledge of the issue correlated to increased support for manatee conservation. Results also suggested that there is a strong normative influence on boaters’ intentions and subsequent
actions. Boaters were found to be highly motivated to comply with law enforcement and were more likely to cooperate if they knew others were doing it (Aipanjiguly et al., 2003).

Similar communication strategies would be required for reducing the spread of AIS as the need to influence boaters’ behavior through an understanding of their knowledge, beliefs, attitudes, behavioral intentions, and normative influences toward the issues is mandatory for conservation.

Self-Efficacy

This key construct emphasizes the role of an individual’s perceived capability of successfully performing specific behaviors. Those who are confident that they can carry out the recommended practices are more likely to attempt them, and ultimately adopt the behavior (Bandura, 1997). Self-efficacy is often used in environmental education contexts instead of locus of control since it is considered by some to be more important to an individual’s decision to participate and adopt behavior than generalized beliefs of control (Smith-Sebasto, 1995; Israel, 2002). Locus of control, used in the traditional REB, shares some commonalities with social cognitive theory’s concept of self-efficacy, which is a person’s confidence in performing a particular behavior (Lefcourt, 1991). The theory hypothesizes self-efficacy as a predictor of behavior or behavioral intent (Compeau, Higgins, & Huff, 1999). The concept asserts that those with high self-efficacy are more likely to adopt and implement desired behaviors (Bandura, 1977). The level of competence or belief about one’s ability to execute a specific behavior influences the decision to take action. Individuals acquire expectancies about what they can and cannot do over time, which factor into whether or not they think their actions will make a difference.

Bandura (1986) asserts that in order to achieve self-directed behavior change, individuals need to have knowledge of reasons to alter risky behavior. The author also is adamant that
individuals must also possess the means and resources to do so. These means and resources include self-motivation and self-guidance. Bandura (1990) also differentiates between the possession of skills and the ability to use them effectively and consistently. Successful behavior change, therefore, requires not only skills but also resilient robust self-belief in one’s ability to utilize personal control (Bandura, 1990). A person’s belief about their competence affects what they choose to do and how much effort they are willing to put into the desired behavior change. When a sense of self-efficacy is lacking, individual’s do not manage situations effectively, even though they might know what to do and possess the skills to do so (Bandura, 1990).

Critiques of the Theory of Reasoned Action, the earliest version of what would become the TPB, suggest that it fails to capture efficacy. For this reason, Ajzen revised the Theory of Reasoned Action in the form of the TPB, which adds perceived behavioral control as a proxy for efficacy. In the TRB, it is suggested that a high level of perceived control should strengthen a person’s intention to perform the behavior, which in turn should increase effort and determination (Ajzen, 2002). Both perceived behavioral control and the concept of self-efficacy are concerned with an individual’s ability to perform a behavior (Ajzen, 2002). Critiques of TPB address the issue of actual control versus perceived control as a way to better capture action. In response to the TPB critiques and other behavioral models, the REB model incorporated the concept of action skills, which is thought to better addresses control beliefs (Hines et al., 1986/87).

**Educational Campaigns**

Communication and education about natural resources conservation is becoming an essential component in natural resource management and sustainable development (Jacobson, 1999). However, for communication about natural resources to be meaningful, it is necessary for scientists and stakeholders to engage in dialogue that will promote the mutual exchange of ideas.
and information in order to better understand stakeholders’ thinking and influence behaviors accordingly (Saunders, 2008). Two-way communication is likely necessary to promote mutual understanding and stakeholder buy-in.

Environmental problems, such as AIS, have been classified as preventive innovations due to their complex and uncertain nature (Rogers, 2003; Thakadu-Tsompi, 2010). Preventive innovations are new ideas that an individual adopts to avoid the possible occurrence of some future event that is undesired (Rogers, 2003). The complex nature of these innovations presents an additional challenge to educational campaigns.

While environmental communication and environmental education are intimately connected, they are different. Environmental communication focuses more on behavior change and adoption of desired behaviors while environmental education encourages positive values in regard to the environment (Feek & Morry, 2003). Prior environmental communication studies have primarily focused on environmental risk communication (e.g. toxic waste, pollution, environmental public health, safety), while other studies have focused on environmental conservation and communication (e.g., water and energy conservation).

Public communication campaigns can be defined as “purposive attempts to inform or influence behavior in large audiences within a specified time period using an organized set of communication activities and featuring an array of mediated messages in multiple channels generally to produce noncommercial benefits to individuals and society” (Rice & Atkin, 2001, p.3). Most successful public communication campaigns utilize aspects of social marketing, which emphasize a focus on audience orientation and strategic attempts to package the social product in a way that appeals to the targeted audience. Social marketing concepts also tend to employ a combination of campaign components in order to attain realistic goals (Rice & Atkin,
When seeking to influence behavior through a communication campaign, decision-makers choose between promoting positive behaviors (e.g., wear your seat belt, recycle) or to preventing problematic behaviors (e.g., drunk driving, forest fires, littering). Traditionally, prevention campaigns directed at a particular sector of the public have presented fear appeals to focus awareness on the potential negative consequences of behavior rather than promoting the desirability of a positive alternative (Rice & Atkin, 2001, p.8). This approach can work in cases where harmful outcomes are genuinely threatening or positive products are insufficiently compelling, but social marketing suggests that promoting positive behaviors can be more effective (McKenzie-Mohr, 2008). In terms of content, messages in public communication campaigns can focus on awareness (information-only), instruction (step-by-step action strategies), or persuasion (why the individual should adopt the desired behavior).

Past research suggests that educational preventive campaigns generate moderate to strong influences on cognitive outcomes, less influence on attitudinal outcomes, and still less influence on behavioral outcomes (Atkin, 2001). However, chances of success can be improved by greater diversification of pathways, products, incentives, and channels beyond the approaches conventionally used in public communication campaigns (Rice & Atkin, 2001, p.15). Success stories in public health (e.g., seat belt use, AIDS and STDs) and the environmental field such as Smokey the Bear, and the Give a Hoot, Don’t Pollute programs provide valuable examples of highly successful educational campaigns.

Another example is the Are you doing your bit? campaign that focused on five specific environmental behaviors (water conservation, energy saving, sustainable transport use, waste management and noise reduction). In this example, citizens are encouraged to find out the ‘facts’
by benefitting from the various cost savings that can be realized, their awareness is increased. The campaign recognizes the significance of the need for incentives and the necessity for environmental action to be seen as normative behavior. This kind of campaign is more likely to be successful than an ‘information–action’ kind of approach (Barr, 2003).

Rice & Atkin (2001) suggested that effective campaigns are characterized by “theoretical guidance and rigorous evaluation, substantial quantity of message dissemination over sustained periods, widespread receptivity to the advocated action and accompanying persuasive incentives, and supplementation of mediated messages by campaign-stimulated factors such as informal interpersonal influences and social engineering policy initiatives” (p.16).

A Florida manatee conservation study compared attitudes, knowledge, and behavioral intentions of boaters who had received educational materials to those who did not. Results indicated that it is necessary to better target boaters, create media messages about ecosystem health, make messages more salient to boater experiences, and increase the variety and duration of intervention while boaters are engaging in undesirable behaviors (Morris, Jacobson, & Flamm, 2007). These manatee and conservation studies can have great applicability for developing a Florida AIS educational campaign since there is not much available data on the behavior of Florida boaters.

While some states have dedicated a significant amount of resources for developing AIS specific outreach programs, many others have not. To date, evaluation of AIS prevention programs in regard to boater attitudes, knowledge, and actual behavior changes have been rare, with the exception of a handful of studies (Lindgren, 2006; Kubeck, 2008; Jensen, 2010). Boaters, in particular, tend to be the target audience given the potential for boats to transport AIS from one waterbody to another (Johnson et al., 2001).
**AIS educational campaigns.** The most common forms of outreach, incentives, and disincentives aimed at reducing the introduction and spread of AIS include “shot-gun approaches.” These are described by Jensen (2010) as the following:

- Civil penalties
- Road checks
- Watercraft inspections
- Information in fishing/boating/hunting regulations
- Creel surveys (targeting anglers)
- Signs/posters at boat launches and bait shops
- Billboards along high-trafficked highways
- Public Service Announcements (PSAs) on TV and radio
- Mass media coverage
- AIS conferences and workshops with homeowners and sport or environmental organizations
- Fact sheets, brochures, books, and videos
- Booths, displays, or exhibits
- Fishing contests and derbies
- Internet websites
- Radio broadcasts/traveler information systems along major highways

Education on AIS introductions, issues, and prevention directed at both targeted stakeholders and the general public are widely recognized as part of the answer to slowing and/or stopping the spread of AIS (Johnson et al., 2001; Pimental, 2003; Lindgren, 2006; Jensen, 2010).

The states in the Great Lakes region provide excellent opportunities to study AIS management and spread, since many AIS have been introduced over the years to the area due to
its role in global commerce. Recreational boating is an important aspect to the Great Lakes economy, with over 4.3 million registered boaters spending over $2.3 billion annually (U.S. Army Corps of Engineers, 2008). For this reason, the area provides a rich source of information about boater awareness and behaviors regarding the spread of AIS. Much of the literature, studies, policy, and science in the AIS field come from the Great Lakes area. Thus, the stakeholders in the Great Lakes area tend to be more aware, in general, of AIS issues, spread, and management (Rothlisberger et al., 2010).

Research suggests that existing educational campaigns are not enough to motivate boaters to take preventive action (Rothlisberger et al., 2010). This is not unexpected since there are a multitude of social marketing studies that show rates of behavior change are relatively low in cases where compliance benefits society more than the individual, and the action requested is perceived as inconvenient (McKenzie-Mohr, 2008). If educational efforts are continued, but augmented by more action-oriented measures such as staffed boat inspection and cleaning stations as well as disincentives and enforcement for non-compliance, the research findings suggest that the situation would likely improve. In addition, the Rothlisberger et al. (2010) study suggests that, given different types of boaters, different types of communication approaches may be necessary. The authors suggest that management efforts better target and communicate with those boaters considered to be at high-risk, for example, recreational boaters that travel long distances.

An example of an existing invasive species education effort is the environmental risk campaign focused on the transportation of firewood by campers in the Pacific Northwest. Depending on its origins, firewood is known to contain at least 20 invasive insects, pathogens, or other deleterious species. Runberg (2011) measured the effectiveness of the communication
campaign and provide an audience analysis. Although there was an increase in campers’
exposure to information about invasive species associated with firewood after the completion of
the campaign, there were still knowledge gaps and misconceptions. In addition, results suggest
that the campaign should have tested messages before launching the campaign since risk
messaging efforts need to effectively and efficiently communicate invasive species risks, a
recommendation for any conservation communication campaign.

Regional and national campaigns that emphasize the importance of boat cleaning when
leaving a waterway are becoming more-widely used, such as the Clean Boats/Clean Waters
campaign, the Stop Aquatic Hitchhikers Campaign or the Protect Your Waters campaign
(Michigan Sea Grant, 2012; Aquatic Nuisance Species Task Force, 2012). Another example of
existing invasive species education and prevention campaigns are individual state programs.

The state of Idaho asserts that they have the “most aggressive and comprehensive exotic
mussel prevention program in North America” (Idaho State Department of Agriculture, 2012,
p.15). The state’s AIS prevention program, managed by the Idaho State Department of
Agriculture (ISDA) consists of mandatory boat inspections, AIS “sticker fees,” enhanced
monitoring programs, and a public awareness campaign (ISDA, 2011). Boaters who travel are a
greater risk for the secondary spread of AIS, thus are targeted with higher fees to fund a greater
proportion of the prevention program. The fees and mandatory boat inspections associated with
the program have been another way in which boaters become “aware” of the issue, whether they
support or understand the idea of preventing AIS or not (T. Woolf, personal communication,
September 15, 2010). Idaho has detected 38 mussel-contaminated boats since the
commencement of their prevention program in 2008, and Washington has decontaminated over
In the past couple years. In 2011, boat inspection stations in Idaho reported out-of-state boats came from 49 states and many Canadian provinces (ISDA, 2011).

Similar AIS education and prevention programs have now been implemented in Washington, Oregon, Montana, and Nevada. Colorado maintains that states that have implemented education and inspection programs have significantly slowed or even stopped the spread of AIS species and that even slowing the spread of mussels could save the state hundreds of millions of dollars annually (Colorado Department of Natural Resources, 2012).

ISDA launched a public awareness and outreach campaign in 2008 that included the development of brochures, billboards, posters, stickers, radio spots (public service announcements), YouTube videos, and educational mailers included in utility bills. Communication materials such as posters, fliers, buttons, and stickers were disseminated to fishing supply stores and guides (T. Woolf, personal communication, September 15, 2010).

Colorado has developed YouTube videos that detail prevention steps and explain the concerns associated with AIS (CDNR, 2012).

Many states and countries include a regulatory component in AIS prevention and education. The Idaho example discussed above, for instance, combines both regulations (mandatory boat inspections and fee) and education (face-to-face conversation at boat inspection stations, communication campaign). This multifaceted approach seems to hold great promise. Based on the personal experience of two years of boat inspection training and implementation, requiring boaters to stop provides an excellent educational opportunity that may prove to have a lasting influence on boater behavior. Regulation, when appropriate, promotes natural resources protection. In a study on the Truckee watershed in Nevada, Davis, and Moeltner (2010) found that losses to freshwater fisheries caused by an infestation of the New Zealand mud snail would
be substantial, which warranted an “immediate investment in preemptive strategies via public outreach and awareness campaigns.” If NZ mudsnails are introduced, the authors recommend efforts to control human behavior to avoid further spread which should include inspection stations for boats and gear, post-visit mandatory cleaning, and/or access restrictions (Davis & Moeltner, 2010).

Though there are more AIS educational campaigns existing today than in the past, there is little documentation on whether or not these campaigns are reaching their target audiences and attaining the goal of increased adoption of AIS prevention BMPs. A baseline assessment (such as this research) can assist in the development of an appropriate AIS educational campaign and also a means of comparison after it is implemented. In addition, a baseline study can help assess the most effective means of reaching boaters, and whether or not the target population would be supportive of educational campaigns, regulatory approaches, or a combination of both.
CHAPTER 3
METHODOLOGY

The ecological and economic impacts associated with aquatic invasive species (AIS) were discussed in earlier sections, which also identified boaters as a primary vector of secondary AIS spread and justified the need to better understand boater and angler awareness and perceptions of Florida AIS issues. The Theory of Planned Behavior (TPB) and the Model of Responsible Environmental Behavior (REB) were introduced and discussed within the context of their influence on boater and angler behavior. A need for research targeting Florida boater and anglers’ current knowledge, attitudes, and behavior regarding the spread of AIS was established in order to provide a baseline assessment from which to develop future outreach and prevention efforts. Thus, the primary goal of this study was to provide an analysis of Florida registered boater and non-resident freshwater angler awareness, perceptions, practices, and barriers to adopting AIS preventive measures. It also explored general boating and fishing practices as well as modes of communication best suited for more effective outreach in an effort to prepare the management agency (FWC) with information on which to base a preventive communication campaign.

The stakeholders for this research include natural resource professionals, especially those working in AIS, management, and native species conservation. This chapter describes the research design, target population, sample selection, instrumentation, data collection methods, and statistical procedures used for data analysis in this study. The objectives of this project were to develop a survey which will determine:

- Florida boaters’ and non-resident freshwater anglers awareness of AIS issues management, and vectors for spreading;
- Attitudes regarding AIS issues, spread and management on behalf of Florida boaters and non-resident freshwater anglers;
Florida boaters’ and non-resident freshwater anglers’ current behavior relating to AIS issues and spread; and

Factors that predict boater and angler AIS preventive behaviors (BMPs).

**Research Design**

The survey instrument was based on an existing instrument (Jensen, 2010) but was modified to meet specific goals for this project. A mail survey was designed to determine the current level of awareness of, general attitudes towards, and behavior related to the spread and associated impacts of AIS.

Descriptive research was used in order to accomplish objectives 1-3 of this project. Descriptive research is the “summarizing of data to help understand the information,” in this case, the awareness and opinions of boater and anglers regarding AIS (Agresti & Finlay, 2009, p.3). Inferential statistics were utilized for objective four, in order to explore predictive variables associated with boater and angler behavior in relation to AIS preventive measures. There were two additional questions that required a different (qualitative) approach. In addition, open-ended questions were analyzed qualitatively for themes and trends.

**Target Population and Sample**

Following development of the survey, it was necessary to focus on developing the target audience in order to obtain a representative sample of freshwater boaters and anglers’ awareness, attitudes, and behavior regarding AIS. Any Florida boater who uses public waterways must renew their registration either annually or every other year in order to comply with the law. Since the boater population of this study focuses on recreational boaters, only individuals possessing recreational vessels were sampled. A recreational vessel is “Any vessel that is manufactured and used primarily for non-commercial purposes; or leased, rented, or chartered to a person for the person’s noncommercial use” (DHSMV, 2010). All commercial vessels were removed from the
population of registered boaters. A commercial vessel is defined as “Any vessel primarily engaged in the taking or landing of saltwater fish or saltwater products or freshwater fish or freshwater products, or any vessel licensed pursuant to section 379.361, Florida Statutes from which commercial quantities of saltwater products are harvested, from within and without the waters of this state for sale either to the consumer, retail dealer, or wholesale dealer, or any other vessel, except a recreational vessel as defined in section 327.02, Florida Statutes” (Florida Dept. of Highway Safety & Motor Vehicles, 2010).

The Florida Department of Highway Safety and Motor Vehicles (DHSMV) maintain a database of vessels and trailers that are licensed to operate on Florida’s roads and waterways. It is assumed that this database represents all of Florida’s active boating population (currently registered vessels), excluding the following categories that are exempt from annual registration: (1) non-motor-powered vessels, (2) vessels used entirely on private lakes and ponds, (3) vessels owned by the United States Government, (4) vessels used exclusively as a ship’s lifeboat, and (5) vessels with a current registration number from another state or country and that are temporarily using Florida waters for less than 90 consecutive days (DHSMV, 2010).

One survey instrument was used for both registered boaters and non-resident anglers. An assumption of the angler population was that the majority of non-resident anglers would either trailer their boats to Florida waters or utilize a resident’s boat. These non-resident freshwater anglers likely bring their boats and spend time and resources on Florida’s lakes and rivers and will provide valuable information on the level of risk posed by a population that has not been assessed.

**Florida Registered Boaters**

There were a total of 717, 671 registered boaters in Florida based upon the dataset from DHSMV. It was necessary to eliminate some members of this population most likely to be
saltwater boaters because this research is focused on freshwater AIS issues. After consulting freshwater biologists with FWC and local boat dealers, it was determined that most freshwater boats are 20 feet or less. In order to best target freshwater boaters, all of the registered boaters with vessels over 20 feet were removed from the population. The survey questions relating to specific freshwater AIS would not be relevant if registered boaters with large boats (>20’) are most likely to utilize marine waters (and not inland lakes). Also included in the original database were commercially owned vessels and duplicates of people who had more than one registered boat. These boaters were also removed from the population, which resulted in 140,101 total boaters being removed from the total population (N=717,671).

**Non-Resident Freshwater Anglers**

There are approximately 200,000 non-resident freshwater anglers that apply for Florida fishing licenses annually (B. Wattendorf, personal communication, October 15, 2011). Non-resident anglers may apply for an annual, 3-day, or 1-day license to fish. The number of non-resident anglers in the FWC database depends very much on the time of year at which the request for the angler database was made. Since this request was made in September 2011, only non-resident anglers who were “currently licensed” are represented. This list only includes those anglers who had a valid license at the time the programmer downloaded the data, which means that many of the short-term license holders (IE: three day or one week) are not represented in the population. With this exception, this population, unlike the boater population, was targeted extremely well given that they had recently purchased a freshwater fishing license. In the case of the boaters however, modifications had to be made to the population given the inability to discern between salt and freshwater boaters.

The angler database received from FWC included a total of 39,726 licensed anglers who had valid licenses at the time of the data request. This figure included some Florida addresses.
because FWC requires that only those anglers who claim residency in Florida qualify for an in-state license. Those whose primary residence is located out-of-state are required to purchase an out-of-state license. Florida addresses were removed from the population under the assumption that a majority of those residents have a boat in Florida and are therefore not indicative of typical non-resident freshwater anglers. Also, all non-resident freshwater anglers who lived outside of the United States were removed from the population which reduced the total population from which the sample was drawn to 34,009 non-resident anglers.

**Pilot and Sample Generation**

From these populations, 66 boaters and 33 anglers were selected at random for a pilot study, the proportion of which equals the breakdown of boaters to anglers in the study (two-thirds boaters and one-third anglers). The pilot study yielded a total response rate of 40 percent, with the most significant finding being that even with the larger boats removed, there were still a large frequency of saltwater-only boaters (n=15). Based on this information, it was clear that more modifications to the potential sample population were needed in order to adequately target freshwater boaters. It was decided to also remove those boaters residing in coastal communities from the population since the dataset still included too many saltwater-only boaters. The survey review panel agreed that the best strategy to better target freshwater boaters would be to remove all boaters residing in coastal communities under the assumption that the closer a boater is to saltwater, the more likely they are to be a saltwater-only boater. This reduced the boater population to 261,585 of the original 717,671 registered boat owners. This strategy would hopefully provide a more concentrated target population and increase the frequency of respondents who were freshwater boaters. Two-thirds of the survey sample was derived from registered Florida boaters with boats 20 feet or less in length and do not live in coastal communities in Florida.
Florida registered boaters and non-resident anglers randomly drawn from their respective populations are combined into a single population for the purpose of this research. Boaters and anglers took the same survey. The total population of boaters (with vessels 20 feet or less in non-coastal communities) and non-resident freshwater anglers (that live outside of Florida but within the U.S.) constitute a total population of 295,594, from which the sample was drawn (see Table 3-1). Those included in the pilot study were removed from the population before the sample was drawn. A simple random sample of 4500 randomly assigned into nine treatment groups was selected from this population (N=295,594) in order to conduct an experiment on the timing and amount of cash incentives (see Appendix H). Of the 4500 names and addresses in the sample, 3000 were chosen from the boater population and 1500 were chosen from the angler population in order to more accurately represent each population. If combined before the sample was drawn, there would have been too many boaters (N=261,585) and not enough anglers (N=34,009). In the survey, a published table was used to establish the sample size necessary in order to be representative of the larger boating and non-resident angler population. From this, it was determined that 1111 obtained responses would be required to provide a confidence level of 95 percent and a sampling error of +/-3 percent (Israel, 2009).

**Instrumentation**

The instrument developed by Jensen (2010) was modified for the specific scope and objectives of this research in order to solicit Florida-specific information. Modifications were made to the survey instrument per an expert panel of UF/IFAS and FWC representatives. Jensen (2010) measured differences in boater AIS awareness in five different states and utilized the same questions for each state except for a section on state-specific AIS species of concern. Seven cognitive interviews, in addition to the pilot study, were conducted with Florida boaters and anglers in order to ensure clarity and precision of the instrument and to test it on members of the
target population. Revisions were made to the survey instrument regarding language and question structure in order to increase clarity and minimize question non-response based upon the pilot test results and these cognitive interviews (see Appendix C for final instrument).

A screener question is the first query regarding the boater’s primary use—marine, freshwater, both, or neither. If boaters/anglers respond that they boat only in saltwater or brackish water, they are asked to not complete the survey but return it in a postage-paid envelope. If boaters/anglers fish in both saltwater and freshwater, they were asked to continue through the survey. If boaters/anglers responded that they do “neither” (saltwater nor freshwater) because they have not boated in the past year, they were also asked to not complete the survey, but return it. Little is known about this population of freshwater boaters and anglers, so it is valuable to assess how many registered boaters (with vessels 20’ and under who do not reside in coastal communities) do not use their boat or boat only in saltwater.

Four questions were utilized measuring boater and angler awareness and knowledge to accomplish objective one (Table 3-2). Respondents were asked how much awareness they had of six AIS species (chosen by the expert panel), and rated their awareness on a likert scale from “a lot of information” to none. For those respondents who indicated that they boated or fished on waterbodies with AIS present, the subsequent question was how they knew about AIS (signs at launches, observed it, educational materials, heard about it from a friend, etc.). They were also asked about where they saw/heard information on AIS and their level of knowledge regarding the management of aquatic plants in Florida (the most common form of AIS management in the state).

Several questions were utilized to measure objective two, which evaluated attitudes toward AIS on behalf of boaters and anglers (see Table 3-2). Respondents were asked to rate their
perception of the level of risk and seriousness posed by AIS. They were also asked if they agreed or disagreed (on a likert scale) with six statements about threats posed by AIS in regard to environmental and economic impacts, as well as the need for management. Respondents were asked what kinds of measures they thought would help boaters and anglers take steps to prevent the spread of AIS, they were also given the choice of “boater/anglers are not responsible for preventing the spread of AIS.” The subsequent question concerned attitudes towards consequences for those who knowingly do not take steps to prevent AIS spread. Respondents were later asked to rate the top three “most effective” kinds of motivators or information to encourage boaters/anglers to prevent the spread of AIS.

Respondents had the option of choosing that they do not think preventive steps would prevent the eventual spread of AIS or that they do not think AIS are a problem. This query measured attitudes of those who reported that they did not take steps to prevent the spread. They were also asked to rate their attitudes towards certain fishing habitats (native emergent grasses, open water, etc.).

Boaters and anglers were asked if they thought AIS had caused any problems for them, what percentage of plant cover they preferred, and their attitudes towards AIS chemical, mechanical, biological, and physical control methods (Table 3-3). Finally, respondents were asked to rate their attitudes towards the most effective sources of information for AIS prevention and the trustworthiness of specific organizations. This information can greatly assist in the development of an educational campaign, since it identifies trusted sources.

A major focus of this research, and the majority of questions in the instrument, measure objective three, boater and angler behavior (Table 3-4). Respondents were asked what kinds of boating they do, if applicable, how frequently, what waterbodies, and if they also boat in
brackish or saltwater. Those boaters and/or anglers that boated/fished in freshwater in 2011 were directed to questions regarding how often they fished, how many different waterbodies, and what for purpose and species they fish. Subsequently, they were asked if they have participated in fishing competitions. If so, they are asked to report how far they traveled to compete, and how often they travel for this purpose.

Respondents were also asked if they boated on waters where they knew AIS were present and what kind of measures would be effective at getting them to take steps in regard to preventing introductions and spread of AIS. One of the options, “has already led me to take action,” measures behavior but also evaluates the types of actions and mediums that would be most effective for reaching this target audience.

High risk boater behavior refers to those that travel with their boats to different waterbodies. Relatively little risk is posed to those who only use one waterbody, do not transport their boat, or remain in one area. Respondents were asked to indicate if they frequent more than one waterbody, how long their boat(s) remain in the water, how long their boat(s) are out of the water between visits, how far apart the different waterbodies are, and whether or not they transported their boat(s) out-of-state. These questions assess the extent of risk posed by boaters and anglers who travel with boats and equipment.

Respondents were asked if they “take steps to prevent the transport of AIS” upon leaving a waterbody to determine AIS preventive behavior. If they select “no,” they are directed to another question referencing why they do not take steps; one of the options in this list also measures behavior, which is “I didn’t boat on infested waters.” Following this line of questioning, boaters and anglers are also asked how often they take specific steps (always, usually, sometimes, never, or does not apply) which include: conducting a visual inspection of their boat/equipment; drain
standing water; dispose of live bait properly; remove plants and debris from boat/equipment; wash/rinse; wash/rinse with hot and/or high pressure water; flush motor; dry for at least five days; and wipe down. Respondents were also given an option to write in “other” steps they take to prevent the spread of AIS.

Variables from the conceptual REB model were utilized to evaluate objective four, which was to identify predictors of boater and angler AIS preventive behaviors. The predictive variables in the REB include those associated with pro-environmental behavior, which in this case are BMPs recommended for preventing the spread of AIS. These include: attitudes, self-efficacy (modified from locus of control for this study), personal responsibility, personality factors, knowledge of issues, knowledge of action strategies, action strategy skills, intention, situational factors, and demographics (added to personality factors for this study).

Together, attitudes, self-efficacy, personal responsibility, and demographics contribute to “personality factors” in the REB. Although boater and angler attitudes were measured in objective two, they provided information on their attitudes towards AIS issues, spread, and management. The attitudes measured in objective four differ since they are specific to boater and angler attitudes towards AIS BMPs.

Attitude items included questions about the risk/threat posed by AIS and the need for prevention of new AIS introductions (Table 3-5). Questions measuring self-efficacy include those alluding to whether respondents believe that preventive steps on their part will reduce or stop the eventual spread of AIS. The measurement for personal responsibility included a question on whether feeling a strong sense of personal responsibility was a motivating factor for taking preventive steps.
Influencing intention to act are personality factors, knowledge of issues, and a combination of knowledge of action strategies and possessing the skills/ability to carry out those action strategies. Measures for awareness (objective one) serve as knowledge of issues in this case. Knowledge of action strategies and action skills were measured by respondents indicating whether they always, usually, sometimes, or never take specific preventive steps (does not apply was also an option). In addition, those that indicated that they did not take preventive steps were directed to another line of questions about why they did not and “I don’t know what I am supposed to do” was an option.

Measuring intention to act included two types of questions. One question asked how likely respondents would be to take preventive action in the future. Options for responses included very likely, somewhat likely, neutral, not very likely, not likely at all, or do not boat on infested waters. Intention to act was also measured by willingness-to-Pay (WTP) questions. WTP refers to questions on the economic value placed on a specific non-market good or service if an imagined market did exist or they had to pay taxes or a user fee. Hypothetical WTP questions in this case measure the intention to act in relation to AIS prevention measures, much like the Ajzen and Driver (1992) study treating WTP for public goods as a behavioral intention in research associated with recreation and leisure activities.

Hines et al. (1986) emphasized that one remaining category of predictive variables that can “interrupt the pathway to action” exists in the REB: that of situational factors (p.7). They cite economic constraints, social pressures, and opportunities to choose different actions as situational factors. However, in this case, normative influence (related to social pressures), lack of infrastructure and equipment, and other resource constraints (economics, time, crowding at boat ramps, etc.) were added as potential situational factors.
Data Collection

The UF Behavioral/Non-medical Institutional Review Board (IRB) is responsible for reviewing and monitoring research with human subjects conducted under the auspices of the University of Florida. The IRB must approve of methods and interaction with human subjects in this survey to ensure there is no risk to participants. All correspondence with the sample, including the survey instrument must be IRB-approved prior to initiating contact. “Informed consent” language is included in the cover letters sent to all members of the sample. See Appendix B for IRB approval documentation. The survey was conducted and data collected only after the University of Florida IRB approved the study.

Procedure

The survey instrument was reviewed by an expert panel through the University of Florida and the FWC that included representation from agronomy, aquatic invasive plant management, fisheries, communication, marketing, and survey design. After databases for the boater and angler addresses and information were collected from the DHSMV and FWC, and modified as previously described, the random sample was drawn and organization for the printing, mailing, postage and billing was finalized.

A pilot test was sent to 100 members of the population, who were randomly selected from the population in November -December 2011. Those who received the pilot test were removed from the population after they were drawn in order to ensure that they would not be included in the final sample. Seven cognitive interviews were also conducted during this time frame, after which the survey was finalized and distributed to the sample (n=4500) between January 25 to February 28, 2012. The survey was administered via U.S. mail utilizing a four-wave mailing that consisted of a pre-letter, survey with cover letter and reply envelope, reminder postcard, and a second survey with different cover letter as recommended in Dillman, Smyth and Christian’s
(2009) Tailored Design Method. The Tailored Design Method is based on a social exchange perspective and includes using “multiple motivational features in compatible and mutually supportive ways to encourage high quantity and quality of response” (Dillman, Smyth & Christian, 2009, p.16).

Dillman et al. (2009) recommend using “multiple contacts, each with a different look and appeal” for maximizing response rates (p. 242). A sequence of four contacts were implemented in this study, which included: 1) an advance letter that alerts the participant that they have been chosen for the study and the questionnaire will be arriving in a few days; 2) the questionnaire with a cover letter and self-addressed postage-paid reply envelope; 3) a reminder post card; and 4) a follow up letter and questionnaire to all non-respondents. The surveys had individual identification numbers so that respondents are not contacted once they have submitted their survey. All correspondence with the survey sample was conducted through the UF/IFAS Center for Aquatic & Invasive Plants which included official letterhead and mailing envelopes.

The purpose of the advance letter is to introduce the study and request the participation of the participant (Dillman et al., 2009). Hembroff, Rusz, Rafferty, McGee, and Ehrlich (2005) found that by sending an advance letter the odds of respondents returning their survey increased by 28 percent. The advance letter in this study contained a single page letter from the UF/IFAS Center for Aquatic & Invasive Plants introducing the project. It alerted the 4500 participants that they had been selected in a random sample and a survey would be forthcoming, and requesting a response (see Appendix D). One-thousand of the total 4500 participants also received either $2 or $5 dollar incentive at this time, enclosed with the advance letter.

The second mailing was the questionnaire itself, a cover letter, and an addressed postage-paid “business reply mail” return envelope which was mailed in a 6 x 9” envelope (see Appendix
E for cover letter and Appendix C for survey instrument). This mailing was sent 3-5 days following the advance letter. One-thousand random participants also received either $2 or $5 dollars cash incentive with this mailing.

The third contact was a 6 x 9” post card, which was mailed to everyone (with the exception of mail that was returned with bad addresses) and included a reminder (for those boaters who had yet to respond) and/or a thank you (for those who had). The intention of the post card is meant to both express appreciation and serve as a reminder for those who “meant to” fill out the survey but hadn’t yet completed it. The post card was mailed about one week after the survey was mailed (see Appendix F). Repeated studies suggest that almost half of return envelopes are postmarked within 2 or 3 days of receiving the post card (Dillman et al., 2009).

The fourth and final mailing, a replacement questionnaire, was sent to the boaters and anglers who had not yet responded. This final mailing was sent three weeks after the post card, or about 30 days after the original survey was sent. The cover letter of the replacement questionnaire differed from the letter accompanying the first questionnaire (see Appendix G). The strongest aspect of this cover letter is the first paragraph where recipients are told that their completed survey has not yet been received, which sets a personal tone and encouraged them to respond (Dillman et al., 2009, p. 255). Cash incentives of $2 or $5 were also included for 1000 participants receiving this final request.

A local printer/publisher in the Gainesville area provided mail services for all four contacts which included the bulk of the printing and mailing services. These services included:

- CASS™ Certify & NCOA Verify customer-supplied database(s);
- Supply rejected, corrected, and verified address records back to the scientist;
- Pre-sorted and applied IntelligentMail™ barcode for automation; and
- Use of the Gainesville Bulk Mail Entry Unit via the UF Document & Mail Center.
The two mailings with survey questionnaires (mailing 2 & 4 respectively) required slightly different handling. The printer/publisher provided the following services:

- ½ fold 8 ½ x 11” booklet for mailing;
- Sorting / handling / inserting #10 envelope into ½ folded booklet; and
- Affixing 3 tabs per USPS regulations for automated mailing by county.

The UF Document and Mail Center provided “business reply mail” services to ensure that only returned surveys had postage paid in lieu of providing a stamped response envelope in each package regardless if the participant responds or not.

Survey experts have reported that cash incentives tend to facilitate increased response rates, so cash incentives were incorporated into two-thirds (n=3000) of the sample (n=4500) as an embedded experiment to measure any increased response rates (Dillman et al., 2009, p. 18).

Dillman et al. (2009) suggested that substantial payments are not as effective at increasing response rates as small token cash incentives that are provided in advance. Contrary to popular thought, the promise of a reward after completing a request (to complete the survey in this case) has been shown to provide less motivation than the token provided prior to or accompanying the survey (Church, 1993; James & Bolstein, 1992, 1992; Johnson & McLaughlin, 1990; Dillman et al., 2009).

The leverage-salience theory asserts that respondents are motivated by different factors in survey design. Respondents could be motivated by different aspects of the survey (leverage), how much emphasis is put on each aspect (salience), or the token provided (Groves, Singer, & Corning, 2000). For this reason it is important for appeals to respondents to participate be “broadly based in an attempt to encourage all types of survey recipients to respond” (Dillman et al., 2009, p. 21). Also relevant and related to this model is the basic concept of social exchange.
Social exchange theory suggests that an individual’s decision to voluntarily take action is motivated by the return these actions are expected to bring from others (Blau, 1964).

The cash incentive experiment was incorporated to test response rates comparing zero, $2 and $5 dollar incentives, as well as collecting information on the timing of the incentives. The cash incentive experiment is relevant to this report because it may have directly influenced response rates, but the comprehensive results of this embedded experiment have not yet been determined and are beyond the scope of the current report. The sample was broken into nine treatment groups in which one-third of the sample receives no money (control), one-third receives $2 and one-third receives $5 (see Appendix H). Nine treatment groups are necessary to also differentiate between the three different times the incentives were mailed to respondents. Of those that received $2, one-third received the money with the advance letter, one-third received the money with the first survey mailing, and approximately one-third (those in the treatment group that had not responded) received the money with the final survey mailing. The same process was followed for those who received the $5 cash incentives. No individual in the sample was sent a cash incentive more than one time. See Appendix H for response rates and the nine treatment groups.

Survey Error

There are four types of survey error which can affect validity and reliability of using surveys to assess public knowledge and attitudes towards a subject. Coverage error occurs when “not all members of the population have a known, non-zero chance of being included in the sample for the survey and when those who are excluded are different from those who are included on measures of interest” (Dillman et al., 2009, p. 17). For this research, all boaters with vessels 20 feet and under that did not reside in coastal communities were included in the population and therefore, had the same chance of being chosen for the sample. The only
exception is family members with the same address as another individual, but listed separately in
the boater database. There were several such cases that were removed if found, but given the size
of the database, it is likely that two or more individuals with the same address were included in
the sample population (likely very few). However, since there are likely some boaters who reside
in coastal communities that boat in freshwater and have boats over 20’ in size, this undoubtedly
resulted in some coverage error as well.

*Sampling error* occurs when not every person in the population is sampled and precision is
limited. Usually this occurs in the form of a subset of the population that is used for the sample
that does not adequately represent the broader population. The survey sampled all registered
boaters with vessels less than 20 feet in the pilot test to eliminate sampling error in this study.
However, the pilot test indicated that a high proportion of boaters who resided in coastal
communities only recreated in saltwater. Therefore, those boaters residing in coastal
communities were also removed from the population before the final sample was drawn. The
initial FWC database request was for all non-resident anglers within the year, which included the
entire population of out-of-state freshwater anglers. Non-resident anglers with Florida addresses
were also removed from the population to reduce the potential of sampling error. The removal of
Florida anglers also ensured that the group was treated as a minority, or sub-group, who has a
residence in Florida part of the year (in addition to their primary residence).

*Non-response error* occurs when all surveys are not returned. This error occurs when the
“people selected for the survey who do not respond are different from those who do respond in a
way that is important to the study” (Dillman et al., 2009, p.17). Since 100 percent response rates
are rare, one should be cautious in generalizing findings to a larger population if evidence of
non-response error is found. It is difficult to compare the surveyed population to a general
population or existing data since little is known about this population. Non-response error is a difficult error to account for in this study. However, the multiple contacts (advance letter, survey, post card, second survey) aided in limiting non-response error (Dillman et al., 2009). Also, the cash incentive was designed to address the non-response error by providing a social exchange motivator which likely facilitated the participation of many of those that otherwise would have been non-respondents.

Finally, measurement error results from inaccurate answers to questions which result from question wording or other structural issues. Questions should be detailed but easy to understand and include instructions on exactly what respondents are expected to do. A pilot test and cognitive interviews were utilized in order to avoid confusing wording and question structure. The pilot study (n=100) and the cognitive interviews (n=7) resulted in question modifications before finalizing the survey.

Data Analysis
Quantitative research methods were utilized to achieve the objectives of this study which were to assess boater and angler awareness, attitudes, behavior, and predictive factors associated with AIS preventive practices. Data for objectives 1-3 were analyzed using SPSS: An IBM Company© (version 18). Descriptive statistics were calculated including mean and standard deviation (likert-scale items). Correlations were calculated for each of the predicted relationships. Frequency tables were generated in SPSS for each question with the exception of qualitative and special-type questions (such as ranked and weighted questions).

Objective four, assessing predictive factors to determine the effort boaters/angers take regarding preventive action required a different methodological approach. Variables that influence or predict whether or not a boater/angler takes AIS preventive steps (BMPs) were assessed using inferential statistics in SAS and SPSS statistical software. A question in the
survey asking respondents if they took specific preventive steps and how often was utilized to assess behavior as the dependent variable (see Table 3-6 for the BMP index).

First, it was necessary to build an index of the AIS preventive steps (BMPs) that would serve as a “score” for each respondent (Table 3-6). The frequency measure for each BMP was re-coded from 0-3 with 0 being “never,” 1 being “sometimes,” 2 being “usually,” and 3 being “always.” Each respondent was given a score based on the number and frequency of BMPs that they perform divided by the total number of points possible.

In addition, respondents were given the option of “does not apply.” This answer could be legitimate if there were extenuating circumstances, such as someone that only uses one waterbody or a boater living on a lake and keeping their boat in the water or on a boat lift. After cross-referencing those that selected “does not apply” with other questions where they would have indicated that they only use one waterbody, those who legitimately selected “does not apply” were omitted from the analysis. This way, a “does not apply” selection does not imply a penalty in the score; instead it reduces the number of points possible for those with legitimate “does not apply” answers. Those that did not select an answer for a BMP category or used more than one waterbody but selected “does not apply” were counted as 0s, thus reducing their overall BMP score.

In the Model of Responsible Environmental Behavior (REB), the dependent variable was “responsible environmental behavior” (e.g. adoption of AIS BMPs results in a high BMP index score). The independent variables included: personality factors (attitudes, self-efficacy, personal responsibility), knowledge of issues, knowledge of action strategies and skills, intention to act, and situational factors.
It was necessary to create indices (much like the BMP index) for both knowledge of issues (specific species) and intention (willingness-to-pay). Respondents were asked how much they had heard about specific aquatic invasive species (knowledge) and values were enumerated or coded so that 0 was “none,” 1 was “a small amount,” 2 was “a moderate amount,” and 3 was “a large amount.” Scores were generated for each respondent based on their knowledge of each species divided by the number of points possible. The individual species listed included: 1) hydrilla, 2) water hyacinth, 3) water lettuce, 4) armored catfish, 5) Island apple snail, and 6) quagga/zebra mussels. For “issue,” a measure of knowledge, respondents were given a score based on how serious of a threat that they perceived AIS to be. Those who selected “not serious at all” were assigned a 1, “not very serious” a 2, “neutral” a 3, “somewhat serious” a 4, and “very serious” a 5. In addition, respondents were also given the option of selecting “don’t know.” The distribution of means of the BMP index for each value (1-5) was examined to see if “don’t know” answers were similar to other values. In this case, “don’t know” answers aligned with “not very serious” and were thus assigned a value of 2 to be tallied in the score for each respondent who selected “don’t know” (Table 3-7).

A similar index was created to measure intention by the willingness-to-pay (WTP) question. Respondents were asked to indicate whether they would pay $10, $5, $2, $1, or no dollars for certain AIS-related preventive or control measures. A score was generated from their responses by tallying each respondent’s answer as the respective dollar values. The AIS prevention/control measures that respondents were asked to indicate their willingness-to-pay levels included: 1) boat cleaning stations, 2) signs and materials at boat ramps, 3) communication and outreach campaigns, and 4) management and control of AIS.
An attitude score was generated for each respondent, with 1 being “strongly disagree,” 2 being “disagree,” 3 being “neither agree nor disagree,” 4 being “agree,” and 5 being “strongly agree.” Boaters and anglers were asked to report their level of agreement or disagreement with five statements: 1) AIS pose threats to the environment, 2) AIS pose threats to local, state, and regional economies, 3) AIS threaten the health and abundance of native fish and wildlife, 4) if left unmanaged, aquatic invasive plants can take over Florida waterways, and 5) if left unmanaged, native aquatic plants can take over Florida waterways. In addition, respondents were given the option to select “don’t know” as a response in the attitudes measure. It was necessary to calculate the distribution of means of the BMP index for each value (1-5) to see if “don’t know” answers were similar to other values. In this case, “don’t know” answers were at the median value for responses and were thus assigned a value of 3.75 to be tallied in the score for each respondent (between “neither agree nor disagree” and “agree”).

For self-efficacy, a measure replacing locus of control in personality factors, respondents were asked about their level of agreement with the statement “There are steps I can take to prevent the spread of AIS.” Respondents were given a score from 1-5 where 1 was “strongly disagree,” 2 was “disagree,” 3 was “neither agree nor disagree,” 4 is “agree,” and 5 is “strongly agree.” Respondents were also given the option of selecting “don’t know” and again, the distribution of means for each value (1-5) was analyzed to see where “don’t know” responses fell on the spectrum of possible values. In this case, “don’t know” responses were most similar to “neither agree nor disagree” with regard to the BMP index and were tallied with the score of 3s.

A factor analysis was used to ensure that all measures in the attitudes variable were related to the underlying construct (Table 3-7). It was found that one statement relating to native plants taking over waterways was not an important contributor to the underlying construct and was thus
removed. The rest of the measures had comparable factor loadings (e.g. were found to measure the same construct). The eigenvalue for the primary component was 2.891, and it was found to explain 72.3% of the total variation of the four remaining items (Table 3-10). The actual index score was calculated as the mean of the four items.

Factor analysis was also utilized for “laws, regulations and fines,” measuring situational factors in the REB. The eigenvalue for the construct was 2.206, and it was found to explain 73.5% of the total variation of the three items. The factor loadings for these three items were similar and thus measure the same construct (Table 3-11). The actual index score was calculated as the mean of the three items.

Two variables, one measuring boater and angler knowledge of action strategies and the other measuring situational factors (availability of boat washing equipment) were treated as categorical variables due to the large number of missing data (skip logic questions). For these questions an 88 was assigned to those who did not answer the question due to skip logic (e.g. they reported that they took steps to prevent the spread of AIS). Of the remaining respondents, those who indicated that they did not take steps to prevent the spread of AIS, a 1 was assigned to those who reported that they did not take action because they did not know what to do and a 0 to those who did not select this as the reason for not taking action. Similarly, a 1 was assigned to those who reported that they did not take steps to prevent the spread of AIS because there was no boat washing equipment available. A 0 was assigned to the remaining respondents who did not indicate a lack of equipment was the reason they did not take action.

Once all indices were created, the full model, with the exception of actions skills, for which no measure in the survey was deemed appropriate, was tested using regression analysis. This allowed for the relative strength of each independent variable as a predictor of behavior
(adoption of AIS BMPs) to be calculated. This, in turn, led to the development of a reduced model comprised only of those variables found to be good predictors of behavior.

**Descriptive and Special-Type Questions.** For two ranking questions, a weighted score was generated for each respondent with 3 points applied to all answers for “most important,” 2 points for “2nd most important,” and 1 point for “3rd most important.” The first question of this type asked respondents to indicate which of the 20 measures or sources of information/motivation provided would be most effective at getting boaters/anglers to take AIS preventive steps. The second asked respondents to indicate which information sources of the 19 provided would be the most effective at providing AIS-related information on education and prevention.

Descriptive Analysis was used for open-ended questions. The open-ended questions included a general comments and recommendations question at the end of the survey as well as a skip logic question in which respondents who indicated they had experienced problems with AIS were asked to describe the issue or problem. These responses were coded into categories and themes with Weft QDA software. The Constant-Comparative technique was utilized.
Table 3-1. Breakdown of boater and angler populations

<table>
<thead>
<tr>
<th>Group</th>
<th>Removed from population</th>
<th>Sample Population remaining</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boater Population: Original DHSMV database of registered boaters</td>
<td>-</td>
<td>717,671</td>
</tr>
<tr>
<td>Boaters with vessels over 20’, Commercial vessels, and duplicates removed</td>
<td>140,101</td>
<td>577,570</td>
</tr>
<tr>
<td>Boaters residing in coastal communities removed</td>
<td>315,985</td>
<td>261,585</td>
</tr>
<tr>
<td>Angler Population: Original FWC database of current non-resident freshwater anglers</td>
<td>-</td>
<td>39,726</td>
</tr>
<tr>
<td>Anglers: Florida addresses and those from outside of US removed</td>
<td>5,717</td>
<td>34,009</td>
</tr>
<tr>
<td>Total combined population of registered boaters and non-resident anglers from which random sample was drawn</td>
<td></td>
<td>295,594</td>
</tr>
</tbody>
</table>

Table 3-2. Measuring boater/angler awareness of AIS issues, spread, and management

<table>
<thead>
<tr>
<th>Survey Question</th>
<th>Awareness Measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 2: How much information have you heard or read about each of the AIS listed?</td>
<td>Specific species knowledge</td>
</tr>
<tr>
<td>Question 3A: [IF you boated on waters where you knew AIS were present], How did you know that the waters you boated on were infested with an AIS?</td>
<td>How boaters/anglers knew waters they frequented were infested with AIS</td>
</tr>
<tr>
<td>Question 28: Have you heard or read about AIS from any of the following source?</td>
<td>Information sources</td>
</tr>
<tr>
<td>Question 26: How much do you know about the following control methods?</td>
<td>Knowledge of AIS control methods</td>
</tr>
<tr>
<td>Question 18: Have you seen or heard others you know taking steps to stop the spread of AIS?</td>
<td>Awareness of others’ actions</td>
</tr>
<tr>
<td>Question 19: Do you think most boaters and anglers take steps to stop the spread of AIS?</td>
<td>Awareness of others’ actions</td>
</tr>
<tr>
<td>Survey Question</td>
<td>Attitude Measured</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>---------------------------------------------------------</td>
</tr>
<tr>
<td>Question 4: How serious of an issue do you think AIS are?</td>
<td>Seriousness of AIS threat</td>
</tr>
<tr>
<td>Question 16A.5: I do not take action because I do not believe AIS are a problem (yes/no)</td>
<td>Seriousness of AIS</td>
</tr>
<tr>
<td>Question 5: Do you agree or disagree with the following statements about AIS management?</td>
<td>AIS management</td>
</tr>
<tr>
<td>Question 6: In your opinion, which three best methods would best help boaters &amp; anglers prevent the spread of AIS?</td>
<td>Boaters/angers can help prevent spread of AIS</td>
</tr>
<tr>
<td>Question 7: If a boater/angler does not take steps to prevent the spread of AIS, but knows that they are present where they boated and can be prevented, what kind of consequence should exist?</td>
<td>Consequences of non-compliance</td>
</tr>
<tr>
<td>Question 8/9: How effective would the following (measures) be in getting you to take action?</td>
<td>Sources of motivation/preference for source</td>
</tr>
<tr>
<td>Question 21E: Please rate the desirability of the following fish habitats (very desirable-very undesirable, don’t know)</td>
<td>Preference for fishing habitat</td>
</tr>
<tr>
<td>Question 23: Have AIS caused problems for you?</td>
<td>Experience of AIS-related problems</td>
</tr>
<tr>
<td>Question 25: Do you favor or oppose use of the following aquatic plant management control methods?</td>
<td>Preference for or opposition to AIS control methods</td>
</tr>
<tr>
<td>Question 27: What is your preferred coverage of aquatic plants in a given lake or river (0% being none and 100% being completely covered)?</td>
<td>Preference for percent coverage of aquatic plants</td>
</tr>
<tr>
<td>Question 29: Please rank which sources would be most effective at providing AIS information?</td>
<td>Preference for information source</td>
</tr>
<tr>
<td>Survey Question</td>
<td>Behavior measured</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------------</td>
<td>------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Question 3: During 2011, did you boat on waters where you knew AIS were present?</td>
<td>Boat or fish where AIS present</td>
</tr>
<tr>
<td>Question 3: I boat on infested waters (yes, no, don’t know).</td>
<td>Level of risk</td>
</tr>
<tr>
<td>Question 11: Considering the boats you used during 2011, for how long was the boat(s) IN the water before being moved to a different waterbody (on average)?</td>
<td>Level of risk: time boat in water</td>
</tr>
<tr>
<td>Question 12: About how long was the boat(s) OUT of the water before you put it in a different waterbody (on average)?</td>
<td>Level of risk: time boat out of water</td>
</tr>
<tr>
<td>Question 13: During the 2011 boating season, did you TRANSPORT and use any boat(s) to waters OUTSIDE the state where the boat is registered?</td>
<td>Level of risk: distance between waterbodies, transport out-of-state</td>
</tr>
<tr>
<td>Question 22: Have you participated in fishing competitions?</td>
<td>Compete in fishing competitions</td>
</tr>
<tr>
<td>Question 16: Upon leaving a waterbody, do you take any steps to prevent the transport of AIS?</td>
<td>Perceived behavior</td>
</tr>
<tr>
<td>Question 17: After removing your boat(s) from the water, how often do you do the following? (BMPs)</td>
<td>Use and frequency of preventive steps (BMPs)</td>
</tr>
</tbody>
</table>
Table 3-5. Independent Variables’ Relationship to Boater/Angler Adoption of AIS BMPs (objective four)

<table>
<thead>
<tr>
<th>Survey question</th>
<th>Variable measured</th>
</tr>
</thead>
<tbody>
<tr>
<td>Question 5: Do you agree or disagree with the following statements about AIS management?</td>
<td>Personality factors: attitude</td>
</tr>
<tr>
<td>Question 8B: A sense of personal responsibility would/not be effective at getting me to take action.</td>
<td>Personality factors: personal responsibility</td>
</tr>
<tr>
<td>Question 16A.1: I do not take action because I do not believe it will prevent the eventual spread of AIS.</td>
<td>Personality factors: self-efficacy</td>
</tr>
<tr>
<td>Question 2: How much information have you heard or read about each of the AIS listed?</td>
<td>Knowledge of issues: specific species</td>
</tr>
<tr>
<td>Question 4: How serious of an issue do you think AIS are?</td>
<td>Knowledge of issues</td>
</tr>
<tr>
<td>Question 16A.3: I do not take action because I do not know what to do.</td>
<td>Knowledge of action strategies</td>
</tr>
<tr>
<td>Question 18: Have you seen or heard other boaters or anglers you know taking steps to stop the spread of AIS?</td>
<td>Normative influence</td>
</tr>
<tr>
<td>Question 19: Do you think the majority of boaters and anglers take steps to stop the spread of AIS?</td>
<td>Normative influence</td>
</tr>
<tr>
<td>Question 8A: Talking with friend or acquaintances would/not be effective at getting me to take action.</td>
<td>Normative influence</td>
</tr>
<tr>
<td>Question 8F: Laws or regulations to prevent the transport of AIS would/not be effective at getting me to take action.</td>
<td>Situational factors: lack/presence of laws &amp; regulations</td>
</tr>
<tr>
<td>Question 8G: Enforcement checks to educate users and/or to catch violators would/not be effective at getting me to take action.</td>
<td>Situational factors: lack/presence of enforcement</td>
</tr>
<tr>
<td>Question 8H: Fines that must be paid by violators would be effective at getting me to take action.</td>
<td>Situational factors: lack/presence of fines/penalties</td>
</tr>
<tr>
<td>Question 16A.6: I do not take action because there is not boat washing equipment available.</td>
<td>Lack of infrastructure/equipment</td>
</tr>
<tr>
<td>Question 20: If you boat on waters with AIS, how likely is it that you will take steps to prevent the spread of AIS in the future?</td>
<td>Intention: likelihood of adopting BMPs in the future</td>
</tr>
<tr>
<td>Question 24: 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 AIS and to reduce their harmful effects?</td>
<td>Intention: Willingness-to-Pay</td>
</tr>
</tbody>
</table>
### Table 3-6. Subscale indices representing BMP Index (dependent variable)

<table>
<thead>
<tr>
<th>Best Management Practice (BMP) for AIS Prevention</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conduct visual inspection of boats/equipment for aquatic plants, animals, and mud</td>
<td>2.46</td>
<td>1.044</td>
</tr>
<tr>
<td>Drain water from boats, including motor, live wells, bilge, and bait buckets</td>
<td>2.63</td>
<td>.961</td>
</tr>
<tr>
<td>Dispose of unwanted bait, worms, and fish parts in the trash</td>
<td>2.66</td>
<td>1.417</td>
</tr>
<tr>
<td>Remove aquatic plants and animals from boats and equipment</td>
<td>2.57</td>
<td>1.052</td>
</tr>
<tr>
<td>Wash or rinse boat, trailer, and equipment</td>
<td>1.99</td>
<td>1.232</td>
</tr>
<tr>
<td>Wash or rinse boat, trailer, and equipment with high pressure and/or hot water</td>
<td>1.01</td>
<td>1.352</td>
</tr>
<tr>
<td>Flush motor’s cooling system with tap water</td>
<td>1.43</td>
<td>1.404</td>
</tr>
<tr>
<td>Allow boat/equipment to dry 5 or more days</td>
<td>1.64</td>
<td>1.247</td>
</tr>
<tr>
<td>Wipe down hull and other equipment with a towel</td>
<td>1.20</td>
<td>1.274</td>
</tr>
</tbody>
</table>

### Table 3-7. Subscale indices representing Knowledge

<table>
<thead>
<tr>
<th>Knowledge index items</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrilla (n=1092)</td>
<td>1.81</td>
<td>1.015</td>
</tr>
<tr>
<td>Water hyacinth (n=1064)</td>
<td>1.43</td>
<td>1.041</td>
</tr>
<tr>
<td>Water lettuce (n=1013)</td>
<td>.87</td>
<td>.935</td>
</tr>
<tr>
<td>Armored catfish (n=1030)</td>
<td>.65</td>
<td>.876</td>
</tr>
<tr>
<td>Island apple snails (n=1022)</td>
<td>.49</td>
<td>.785</td>
</tr>
<tr>
<td>Mussels (n=1033)</td>
<td>.87</td>
<td>.987</td>
</tr>
<tr>
<td>Seriousness of Issue (n=1101)</td>
<td>2.02</td>
<td>1.467</td>
</tr>
</tbody>
</table>

### Table 3-8. Subscale indices representing Intention (Willingness-to-Pay)

<table>
<thead>
<tr>
<th>WTP Index Items</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat cleaning stations (n=1054)</td>
<td>2.12</td>
<td>2.639</td>
</tr>
<tr>
<td>Signs at launches (n=1056)</td>
<td>1.86</td>
<td>2.190</td>
</tr>
<tr>
<td>Outreach and communication (n=1035)</td>
<td>1.44</td>
<td>2.043</td>
</tr>
<tr>
<td>AIS control &amp; management (n=1066)</td>
<td>2.69</td>
<td>2.925</td>
</tr>
</tbody>
</table>
Table 3-9. Subscale indices representing Attitudes

<table>
<thead>
<tr>
<th>Attitude Index Items</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>AIS pose threats to environment (n=1111)</td>
<td>4.46</td>
<td>.857</td>
</tr>
<tr>
<td>AIS pose threats to local economies (n=1110)</td>
<td>4.33</td>
<td>.919</td>
</tr>
<tr>
<td>AIS pose threats to native fish &amp; wildlife (n=1108)</td>
<td>4.42</td>
<td>.907</td>
</tr>
<tr>
<td>If left unmanaged invasive plants can take over FL waterways (n=1111)</td>
<td>4.52</td>
<td>.782</td>
</tr>
<tr>
<td>If left unmanaged native plants can take over FL waterways (n=1109)</td>
<td>4.05</td>
<td>1.242</td>
</tr>
</tbody>
</table>

Table 3-10. Factor Loadings for Attitude Index

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor</th>
<th>Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Threats to environment (question 5.1)</td>
<td>.899</td>
<td>.809</td>
</tr>
<tr>
<td>Threats to the economy (question 5.2)</td>
<td>.873</td>
<td>.763</td>
</tr>
<tr>
<td>Threats to native fish &amp; wildlife (question 5.3)</td>
<td>.836</td>
<td>.070</td>
</tr>
<tr>
<td>Aquatic invasive plant take-over (question 5.5)</td>
<td>.787</td>
<td>.619</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.89</td>
<td></td>
</tr>
<tr>
<td>Percent of variance explained</td>
<td>72.3</td>
<td></td>
</tr>
</tbody>
</table>

Table 3-11. Factor Loadings for Laws, Enforcement, and Fines

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor</th>
<th>Communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Laws (question 8.6)</td>
<td>.841</td>
<td>.708</td>
</tr>
<tr>
<td>Enforcement (question 8.7)</td>
<td>.878</td>
<td>.771</td>
</tr>
<tr>
<td>Fines (question 8.8)</td>
<td>.852</td>
<td>.727</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.21</td>
<td></td>
</tr>
<tr>
<td>Percent of variance explained</td>
<td>73.5</td>
<td></td>
</tr>
</tbody>
</table>
CHAPTER 4
RESULTS

The sample size for this study was 4500, and each of these boaters and anglers were sent survey correspondence via first class mail. Participants reviewed a cover letter complete with consent language and were then asked to complete a 12 page survey. Surveys were returned via first class mail in a pre-addressed postage-paid envelope with a unique identification number. Although 4500 advance letters were initially sent out, 381 were returned due to bad addresses and an issue with a “return to sender” stamp on outgoing envelopes. Unknown to the researchers and the printer, this phrase on the envelope did not allow those with temporary forwarding addresses (those who reside in more than one location) to receive the mail per US mail policy. Of the total questionnaires mailed out once the bad addressed were removed (N=4119), 1398 questionnaires were returned. Of the 1398 returned questionnaires, 1118 were completed by freshwater boaters or anglers who had boated or fished in Florida in the past year. Three were removed since they were retuned blank, which indicates a refusal to complete the survey, leaving a total of 1395 responses yielding a response rate of 33.9%. Participants indicated on the remaining 277 questionnaires that they did not boat/fish in the past year or boated in saltwater-only.

In terms of structural organization, this chapter presents descriptive statistics and frequency tables depicting objectives one through three and the demographic characteristics of the study subjects. This is followed by presentation of the results of objective four, exploring predictive factors that potentially influence boater and anglers’ decision to adopt AIS preventive BMPs. Finally, qualitative data from open-ended is presented by category. Select quotes representing major comment categories and sentiments are also reported.
Socio-demographic Characteristics

The basic demographic characteristics in this study included: gender; age; location of primary residence; whether respondents boat, fish, both, or not in Florida; and whether respondents boated or fished in Florida freshwater in 2011. Since it was known that some of the respondents would be saltwater-only boaters, a filter question was first. Although some respondents only boated or fished, the majority reported that they both boated and fished (68%, n=950). Of the 1395 that responded to the survey, 11% indicated that they did not boat in the past year (n=158). When those who did not boat in the past year were removed (n=1237), an additional 8.5% reported that they boated/fished in saltwater only (n=119). The remaining 1118 valid responses (e.g. freshwater boaters and anglers) completed the survey (see Table 4-1).

The respondents who completed the demographic gender question (n=1085) were predominately male (91%, n=987) and the age range was from 16-93 years old (mean age was 59 years old). Seventy percent of the valid responses (n=787), were from Florida (e.g. registered boaters) and 30% (n=333) were from out-of-state (e.g. non-resident anglers), which was consistent with the number of surveys sent to each group. The most out-of-state respondents came from Georgia (n=80), Alabama (n=34), Kentucky (n=32), Indiana (n=28), Ohio (n=21), Illinois (n=19), Pennsylvania (n=11), and Tennessee (n=10).

Of the freshwater respondents, 93% (n=1032) reported that they used a boat in 2011. Of those that boated, a majority used a small powerboat less than 20 feet in length (77%, n=775), 18% used a large powerboat over 20 feet (n=183), 18% used a Jon boat (n=179), and 17% used a kayak or canoe (n=170). It is important to note that many boaters have multiple vessels and were asked to list all boats they owned.

Of the respondents, 83% indicated that they fished in freshwater in the past year (n=924). Sixty-one percent fished for sport (n=848), 21% for food purposes (n=287), and less than one
percent for work (n=8). Anglers were asked to select all of the species that they fish for in Florida. The majority of anglers (73%, n=670) indicated that they fish for largemouth bass, 62% for crappie (n=570), and 57% for bluegill (n=522). Fewer anglers fished for catfish (32%, n=296), striped bass (13%, n=117), or other (7%, n=68).

Other demographic questions included what kinds of radio stations respondents most frequently listened to, what kinds of communication methods they preferred, and their level of trust with various agencies and groups. A majority of respondents indicated that they preferred country and oldies or classic rock. For the “other” category, the most frequent responses were Jazz, Christian, and gospel (Table 4-2).

Most respondents indicated that they strongly prefer mail over all other communication modes, followed by email which was much higher than all other choices. For “other,” the most frequently written in responses included television, radio, media, and face-to-face (Table 4-3).

The perceived level of trust of an organization by an individual is a good measure of whether or not that organization would be a viable source of information. Boaters and anglers are less likely to receive and process messages that come from untrustworthy sources. Boaters and anglers indicated that their most trusted source was the Florida Fish & Wildlife Conservation Commission, followed by the University of Florida/IFAS Center for Aquatic & Invasive Plants and boating/angling NGOs. The lowest sources included stores, the media, and the lowest trusted source was social media (Table 4-4).

**Boater and Angler Awareness of Aquatic Invasive Species**

Acknowledging the issue of AIS is a first step towards raising awareness and promoting the adoption of preventive behavior. Awareness of specific invasive species varied widely among survey respondents. High or moderate awareness was highest for hydrilla and water
Hyacinth, AIS found throughout Florida (Table 4-5). High to moderate awareness of these three species ranged from 30% of respondents having heard “a large” amount (n=330) or a “moderate amount” (33%, n=370) about hydrilla, 31% (n=332) having heard a “moderate amount” about water hyacinth, and 33% (n=333) having heard a small amount about water lettuce. Boaters and anglers were less familiar with non-plant species. Over half of the respondents (66%, n=678) had heard nothing about apple snails or armored catfish (57%, n=588) and nearly half reported knowing nothing about quagga/zebra mussels (47%, n=487).

The majority of respondents (63%, n=702) indicated that they boated on waters where AIS were present (Table 4-6). Others did not boat on AIS infested waters (14%, n=158) or did not know if they did (22.5%, n=250). Those that did boat on waters where AIS were present were asked to select (all that apply) how they knew that the waters were infested. The majority of the “yes” respondents indicated that they could identify AIS and observed it personally in the water (80%, n=546), 40% reported that they had seen a sign at the boat launch (n=270), and 25.5% had heard that there was AIS present from a friend or family member (n=174). On the other hand, very few respondents had heard about AIS in waterbodies they frequent from other sources (such as the media or educational materials). It is not known how the majority of respondents knew how to identify specific invasive species and how accurately they could do so. Although a relatively high amount of respondents had seen a sign at the boat launch, many more had not (60%, n=412).

Closely linked to awareness of AIS are control methods used to manage them (Table 4-7). This awareness can vary widely depending on the level of public outreach conducted by management agencies and partners. Respondents were asked how much they knew about the four most commonly used control methods (chemical, mechanical, biological, and physical). Boaters
and anglers reported that they knew more about chemical and mechanical control, followed by physical and biological control methods. Biological control was expected to have a lower awareness rate given the academic and scientific nature of this practice, which precludes a large body of knowledge possessed by the public. See Table 4-7 for a breakdown of plant management awareness.

In order to promote awareness of AIS issues, prevention, and management, it is necessary to determine where stakeholders seek and/or find information. Magazines and newsletters, signs at boat launches, and newspapers were reported to be the most prevalent sources of information for AIS (Table 4-8). Although the use of social media has grown exponentially in the last decade, it does not appear that it is a popular source of information for these survey participants, since only 2% (n=23) indicated that it was a source where they had heard about AIS. Social media is clearly not the best avenue for information dissemination since this is an older demographic group (average age is 59). Another interesting result of this question was the relatively high percentages of respondents indicating that they received information about AIS in fishing, boating or waterfowl hunting regulations (45%, n=487) and boat registration materials (27%, n=289).

Of the sources of information listed, respondents were asked to rank the sources they believe to be most effective at getting out AIS-related information. Weighted scores generated for each respondent assigned higher scores to choices selected for “most effective.” The most effective sources were found to be: 1) signs or information provided at a marina or boat launch, 2) television news or programs, 3) fishing, boating, or waterfowl hunting regulations pamphlets, 4) magazine and newsletter articles, and 5) newspapers (Table 4-9).
Normative influences or subjective norms in many cases are thought to influence behavior. Respondents were asked whether they had heard or seen other boaters or anglers they knew taking AIS preventive action and also if they thought that the majority of boaters and anglers took action. Of the 1106 who responded, 54% (n=602) indicated that they knew of others who took preventive steps. When asked if they believe that the majority of boaters and anglers take preventive action, 68% of respondents indicated that they did not think so (n=731).

**Boater and Angler Attitudes towards Aquatic Invasive Species**

Measures of boater and angler attitudes towards AIS ranged from overall perception of the issue to more specific questions regarding AIS impacts and the need for management and prevention. Respondents were also asked preference questions about fishing, control methods, and vegetation coverage of waterbodies (Table 4-10).

The majority of respondents indicated that AIS were a very serious problem (47%, n=515) or a somewhat serious problem (35%, n=388). These responses were followed by “don’t know,” which indicates a lack of awareness about the issue in general (9%, n=102), “neutral” (6%, n=63), not very serious (2.5%, n=28), and not serious at all (0.5%, n=5), which suggests that the majority of these stakeholders view the issue to be one of significance.

The level of agreement with AIS issues by the respondents was measured by asking if: AIS pose threats to the environment; AIS pose threats to local, state, and regional economies; AIS threaten the health and abundance of native fish and wildlife; there are preventive steps I can take to prevent the spread of AIS; if left unmanaged, invasive plants can take over Florida waters; and if left unmanaged, native aquatic plants can take over Florida waterways (Table 4-10). Respondents reported the highest levels of agreement with the statements regarding the environment, economies, and native fish and wildlife. Interestingly, responses for “neither agree
“nor disagree” and “don’t know” were higher than for disagree statements. Again, this suggests a general lack of awareness or personal experience.

Of the 1096 who answered the question, those respondents who had experienced AIS-related problems (40%, n=443) were slightly lower than those who indicated that they had not had problems (46%, n=508). However, there was an additional 13% who reported that they “did not know” if they had problems with AIS (n=145). See qualitative section (Table 4-22) for a description of specific AIS-related problems reported by respondents.

Of the 83% (n=924) respondents that fished in Florida freshwater in the past year, most preferred fishing in native emergent plant habitats (83%, n=729) and fish attractors, such as piers and gravel beds (85%, n=734), were also reported as “desirable” or “very desirable” for fishing habitat (Table 4-11). Invasive hydrilla beds and open water were reported to be the least desirable fishing habitat. There were also several “don’t know” responses for all categories, which once again suggests the conclusion that many lack knowledge of plant species or fishing expertise (n=718 for all six categories).

Respondents were asked their specific preference for plant coverage in a given waterbody. Most boaters and anglers prefer between 11-40 percent plant coverage in lakes and rivers (54%, n=567), while others prefer 0-10 percent (37%, n=390), 41-70 percent (8%, n=81), or 71-100 percent (1%, n=13).

Related to boater and angler preference of plant coverage is preference for AIS control methods. Respondents indicated that they had the most knowledge about mechanical and chemical control methods (see Table 4-7 in previous section), but report the strongest preferences for mechanical and physical control (Table 4-12). When “strongly favor” and “somewhat favor” are combined, mechanical control is preferred by 73% (n=798) of respondents.
and physical by 63% (n=686). On the lower end, 46% (n=498) of respondents indicated that the strongly or somewhat favored physical control, and 43% (n=467) strongly or somewhat favored chemical control. Again, there are a fair amount of “don’t know” responses, suggesting boaters and anglers are not exposed to information or have no desire to learn about AIS control methods.

Responsibility is a key concept in prevention. Respondents were asked what three methods would best help them prevent the spread of AIS: signs at ramps; educational materials in boat registration and fishing regulations; new boater training; Radio/TV; boat cleaning equipment; boat inspection stations; and rules and regulations (Table 4-13). Additional choices were “other” or “boaters/anglers are not responsible for preventing the spread of AIS.”

Signs at boat launches, education regulations in registration materials, and new boater training were the most potentially helpful measures in regard to increasing boater/angler adoption of AIS preventive practices (Table 4-13). A very small percentage of respondents (3.5%, n=39) indicated that they did not think boaters and anglers were responsible for preventing AIS spread. This suggests that although there are various perceptions of what measures would be the most effective, the group overall believes that something should be done (by stakeholders) to prevent the spread of AIS.

The follow up question one assesses respondent opinions of potential consequences for those who elect not to take action in the prevention of AIS (Table 4-14). The language explicitly asks about consequences for a boater/angler who is aware that AIS are present but does not take preventive steps. The highest percentage of respondents indicated that training would be the best recourse (32.5%, n=346), but it was closely followed by “no consequences—rely on self-regulation.” However, “fines” had almost as much advocacy (30%, n=323) as did “restrictions” (27%, n=287). This suggests that while this population seems to believe that AIS present a
serious threat, they do not agree on the best way to solve the problem. Restrictions, fines, no consequences, and boater training were within five percentage points of each other.

Personality factors, as well as information sources, can potentially serve as motivators for boater/angler adoption of AIS preventive measures (Table 4-15). A scaled question on motivators included both personality factors and information sources. Those that indicated they had already taken action indicated that they did so out of a “sense of personal responsibility” (31%, n=334), a “desire to keep AIS out of lakes and rivers” (29%, n=317), and a “desire to prevent damage to equipment” (24%, n=262). Others who already took action did so because of “talking with friends and acquaintances” (16%, n=169), or, on the informational source side, because they saw a sign at a boat launch (15%. n=165). Signs at boat launches were the highest response in measures that “would be very effective” (66%, n=716), similar to educational materials (60%, n=655), and educational materials in boating/fishing regulation pamphlets (60%, n=639).

Respondents were asked to rank the sources and personality factors listed in Table 4-16 to determine which would be most effective at encouraging boaters and anglers to adopt preventive BMPs. Weighted scores generated for each respondent for higher scores assigned to choices selected for “most important” demonstrated boater and angler preference for sources of information/motivation thought to be most effective. The five most effective sources or measures were: 1) signs at marinas or boat launches, 2) brochures, species ID cards, fact sheets, or other materials, 3) a sense of personal responsibility, 4) fishing or boating regulation pamphlets, and 5) a desire to keep AIS out of our lakes and rivers (see Table 4-16).

**Boater and Angler Aquatic Invasive Species-Related Behavior**

Boaters who regularly travel with their boats are the primary vector in the secondary spread of AIS, particularly boaters who do not take appropriate precautions to stop their spread.
Of the 936 freshwater boaters and anglers who provided a response to the question, 25% (n=237) reported that they only use a single waterbody. The vast majority of Florida registered boaters and non-resident freshwater anglers (75%, n=699) use their boats in multiple waterbodies and present a higher risk of spreading AIS.

Several factors were assessed to determine the level of risk (of spreading AIS), which included: length of time the boat is in the water, length of time boat is left out of the water, and the frequency and distance of travel between waterbodies. Those boats that remain in a waterbody for a long period of time (e.g. more than five days) present a higher risk of becoming a vector for AIS, particularly in the case of Dreissenid mussels or other species that can attach or live in damp areas of boats or equipment. Of the respondents who used a boat in 2011 and responded to the question (n=771), 64% (n=493) had their boat in the water for one day or less, presenting a lower risk than those who remained in the water for 2-4 days (10%, n=78), 5-14 days (12%, n=91), 15=30 days (7%, n=56), or more than 30 days (10.5%, n=81).

Boats that remain out of the water (for more than five days) present a lower risk due to the drying effect. However, five days is not sufficient time to kill some AIS through drying and is thus recommended among other BMPs such as inspect boat and remove plants and animals. The risk of transporting AIS is reduced the longer a boat is out of the water before being transported to a different waterbody. Twenty percent of the 747 respondents (n=149) reported that their boat was out of the water for more than 30 days. Others reported that they commonly kept their boat out of the water for less time; 24% (n=177) 15-30 days out of water, 37% (n=275) 5-14 days of water, 12% (n=90) 2-4 days out of water, and 13.5% (n=101) out of the water just one day or less.
AIS are likely to be transported to nearby waterways first, but boaters that travel with their boats long distances also pose a high risk of moving AIS from one part of the country to another. A majority (52.5%) reported moving between 11-50 miles between waterbodies (n=398). Posing a slightly lesser risk, 28% reported moving less than 10 miles (n=210). Longer distances travelled include 51-150 miles (24%, n=183), 151-500 miles (5.5%, n=42), or more than 500 miles (2%, n=15).

Similarly, boaters who travel long distances tend to cross state lines. Of 784 respondents, 22% (n=172) reported transporting their boat to states outside of where it was registered. Those who transported their boat outside of the state where it was registered most frequently visited Florida (n=101), Georgia (n=35), Alabama (n=25), South Carolina (n=13), and Indiana (n=8). Respondents listed 30 states and two Canadian provinces for places that they had transported their boat(s).

Anglers who competed in fishing competitions are known to travel long distances and present a high risk if BMPs are not practiced. Of the 1104 people that responded to the question, 14% competed in fishing competitions (n=153). The majority of anglers that compete do so within 50 miles of home (71%, n=107), although others travel 51-100 miles (36%, n=54), 101-300 miles (20%, n=30), 301-500 (9%, n=14), or even more than 500 miles (9%, n=13). Given the time, money, and other resources needed to pull a boat long distance, it is not surprising that fewer boaters travel more than 50 miles, but it only takes one boat with AIS “hitchhikers” to produce a new introduction.

Of the 1118 freshwater boater and anglers’ who responded to the survey, 998 completed the question asking if they took steps to prevent the spread of AIS. Those who did not use a boat in 2011 were asked to skip questions regarding taking preventive steps after boat use (skip logic),
which accounts for the decline in respondents. Most respondents reported that they did take steps (69%, n=689) while 31% (n=309) reported that they did not. A follow up question regarding reasons why they did not take action was asked of those that did not take preventive steps (Table 4-17). Of the 309 that did not take action, 285 reported reasons for not taking AIS preventive precautions. The primary reason for not taking action was that boaters “did not know what they were supposed to do” (51%, n=146), followed by “other” (29.5%) and “boat washing equipment was not available” (27%, n=77). Responses for “other” included “because it is not mandatory,” “didn’t think about it,” etc.

The subsequent question asked respondents whether they engage in specific behaviors and if so, how often. Many of those that indicated that they did not take AIS preventive steps actually reported doing some of these behaviors, but perhaps not for the specific reason of stopping the spread of AIS (e.g. prevent damage to boat and equipment). See Table 4-18 for a breakdown of boater/angler AIS BMP adoption and frequency of practicing. The majority of boaters reported “always” draining standing water (73%, n=730) from their boat, removing plants and animals from boat and equipment (70%, n=695), and conducting a visual inspection of the boat (61%, n=6140) after removing it from the water. Washing with hot or high pressure water, wiping the hull of the boat, and allowing everything to dry for at least five days were the BMPs with the lowest level of adoption by boaters and anglers.

Commitment and/or behavioral intent are often measured by willingness-to-pay (WTP) studies, especially in the case of public good utilization such as water resources or public parks. Respondents in this study indicated a higher level of commitment towards signs and information at boat launches and control than AIS outreach or boat cleaning equipment (see Table 4-19).
Finally, one of the best measures of whether or not an individual decides to take action is thought to be intention to act. Boaters and anglers were asked about their likeliness of taking steps to prevent the spread of AIS in the future (regardless if they perceive that they already do or not). An overwhelming majority of the 1099 boaters who answered this question indicated that they would be “very likely” to take preventive steps in the future (75.5%, n=830). This was followed by 18.5% (n=203) being “somewhat likely” to take future action, 2.2% (n=24) “not very likely,” and just 0.5% (n=5) indicating that they were “not at all likely.” In addition 3.4% (n=37) indicated that they do not boat on infested waters and thus do not have a need to take action in the future.

Predicting Boater and Angler Adoption of BMPs

The REB variables thought to predict Responsible Environmental Behavior, in this case, boater and angler adoption of AIS BMPs, were tested through linear regression in the statistical software SAS. With the exception of one variable that was not measured in the questionnaire (action skills), all were tested on the strength of their relationship to behavior (adoption of BMPs). The variables tested included: personality factors (attitudes, self-efficacy, and personal responsibility), knowledge of issue, knowledge of action strategies, intention to act, situational factors, as well as an additional variable (subjective norms) included by the researcher.

After the indices were created for multiple item questions (BMP adoption, knowledge of issues, willingness-to-pay, and attitudes), as discussed in Chapter 3, two-way relationships were tested by generating Pearson Correlation Coefficients for each independent variable (see Table 4-20). Variables constructed with multiple items are denoted by the descriptor “index” in the heading; all others are single measure items. Items with significance values of 0.05 or less (based on 95% confidence level) for most of the two-way relationships included: intention, norms, personal responsibility, self-efficacy, attitudes, knowledge of specific species, and knowledge of
issue. It was apparent from this initial analysis that monetary values (WTP for AIS-related services) and laws and fines, while having some relationship with other independent variables, did not bear a strong relationship to the dependent variable, behavior (BMP Index).

The full REB model was tested using linear regression, providing significance levels for each independent variable’s influence on the dependent variable, BMP adoption (Table 4-21). All variables with a significance level of 0.4 or higher were removed from the model and then the model run again. In the first regression, self-efficacy, laws and fines, and “no boat washing equipment available” (both measures of situational factors) were removed from the model. In the subsequent regression, knowledge index, personal responsibility, and willingness-to-pay (a measure of intention) were removed. In the final regression, issue was removed (a measure of knowledge). Through these tests, it was determined that self-efficacy, personal responsibility, knowledge index, issue, willingness-to-pay, laws and fines, and no equipment were all poor predictors of whether or not a boater/angler takes action (adopts BMPs).

The strongest predictors of boater and angler adoption of BMPs (responsible environmental behavior) per the REB were: intention to act, norms, knowledge of action strategies (or lack thereof), and attitudes. The data was also checked for interaction between norms and attitudes, which proved to be non-significant (data not shown). This information led to the development of a reduced REB model for predicting boater/angler adoption of AIS preventive practices (see Table 4-21).

Table 4-22 provides the means and standard deviation for each variable tested in the REB for this research. Since many of them have different scales (minimum/maximum value), the means are not comparable to each other, but provided for informational purposes only.
Descriptive Analysis of Open-Ended Questions

Comments provided by respondents were diverse and not always focused on AIS issues, but provide insight into the thoughts and perceptions of Florida freshwater boaters and anglers. They were coded using the constant comparative method.

Table 4-23 provides a breakdown of the categories that were found in responses to the open-ended “comments and recommendations” text box (question 36 in survey). These categories include: control, appreciation, education, taxes/fees/regulations, other water issues, responsibility, general issue comments, government, fishing/hunting, boat cleaning/inspections, specific place or issue, community action, introductions, lack of awareness, and other solutions. It is important to note that a single comment may have multiple themes so can be counted in different groupings and categories as necessary.

The categories with the most comments from respondents were taxes/fees/regulations, education, and control. Since respondents were encouraged to write about any AIS issue or topic that they were concerned about, the most numerous subject of comments are significant since they suggest that these issues are meaningful or important to respondents.

Comments regarding general control tended to express broad statements or sentiments about control such as “Do the proper research before taking action,” or “Keep working to control plants in all waterways.” Some had more of an emotional response such as “Let’s get aquatic invasive plants under control so we can enjoy our lakes better.”

For chemical control, comments were mixed between favor and opposition towards herbicides. Proponent comments ranged from “Spray it!” to “Develop ways to attack one species at a time, not harming other plants.” Others made more moderate comments about the frequency or kind of chemical treatments that they had experienced or heard about, such as “There is way too much spraying on the Florida waters I fish,” or “After the state eradication, fishing always
drops off.” Opponents of chemical control made comments like “I think spraying does more harm than good and I am not alone in this opinion.” Comments about mechanical control were mostly favorable, “Use mechanical methods if at all possible,” which reflects the finding in objective three that respondents tended to prefer mechanical control over chemical control. Many of the comments expressed preference for mechanical and also mentioned opinions of other control methods. “Harvester is the only healthy way to control weeds. If you spray you kill more than weeds.” Biological control received mostly unfavorable comments, and was reflected in objective three as well. Most of these comments made the connection between controlling an invasive species with another non-native species. “Control of AIS should be controlled using non-bio methods—these potentially cause more problems than they solve.” Physical control was reflected in comments mostly in the form of draw-downs and water manipulation. Comments were mixed, but mostly favorable, expressing sentiment such as “I think a drawdown and removal of hydrilla would help.”

Some respondents expressed appreciation and gratitude for receiving information that raised their awareness about the issue or being involved in the issue, “Keep tending to it,” “You have covered it pretty good,” or “Thank you for keeping us involved.” Others were appreciative that the study’s goal was to better protect Florida’s freshwater resources or the environment in general, “Thank you for caring about Florida waters.” “Thank you for doing this research. I’m glad someone cares enough about the environment to take steps to protect it.”

Education was the most numerous category of comments and recommendations. There was a large amount of general comments about the importance of education for solving this issue. All comments were favorable. Many comments expressed the need for public education about AIS prevention, “Increase efforts to educate boaters,” “Much more public education needed,” “Needs
more advertising—not well known among common folk.” A lot of other comments emphasized the preference for education over regulations, as well as general personality characteristics of boaters. “Education is key, not rules and fines. We have enough of that stuff already” and “Education/awareness work better than regulations and enforcement. Boaters and fishermen generally want to do the right thing. Fines tend to be more about money than solving problems.”

There were also numerous comments made about putting informational signs at boat ramps and/or marinas. All comments were positive. “You need to have updated and current info at boat ramps, including cleaning procedures and pictures.” Many of these comments stressed the tangible nature of signs in appropriate places and the prompts they can provide.

“Signs at ramps is an excellent way to inform the public about the problem…you are right there at the waters location and about to go boating. That would be great! It’s our last reminder in and out of the water.”

Many suggestions were made about generating various educational materials other than signs at ramps. These included television shows, brochures and other printed materials, billboards, pictures, email/web notifications, fishing magazines, PSAs/media, and bait shops and tackle stores. Many of the comments emphasized the need for pictures for identification purposes in educational materials.

Numerous suggestions were made about putting AIS information in boater registration mailings and fishing regulations. This tactic guarantees that the desired audience is being targeted. “Registration is a good time to put an informational sheet because every boat needs registration tags. Your market is guaranteed.”

Others thought at least using the registered boater list to send additional information would be a good idea. “I think it would be great if you got our email addresses so upon renewal of our license we could get notifications and links.” Others wondered why, if this is a serious issue, information is not already included in existing materials targeting boaters and anglers (about
AIS). “If this issue has importance, why is there so little explanation in the 2011 Florida freshwater fishing regulations??”

Taxes, fees, and regulations received many comments. This category was split between support and opposition, with more supporting than opposing the idea of regulation. Comments included “Institute strong regulations and enforcement” and:

I think there should be an inspection station at all major highways entering the state of Florida for boaters to stop and have their boats inspected by FWC—mandatory. Many comments were qualified with a sentiment about not preferring regulations but feeling that this was a serious issue that may require them or needing to know that funding was going to the cause. “Unfortunately, fines and inspections are probably the only way people will be compelled to care.” “Only fines if money goes 100 percent directly to help eliminate AIS that our fishing licenses should already be assisting with but I don’t think that it does.”

Many respondents made a distinction between those who were unaware and those who had knowledge or had been warned but refused to comply, advocating for “Severe consequences for those who intentionally violate the rules.” Many respondents advocated for education or warnings first, but then moving to regulatory process for violators.

There was also some strong opposition to taxes, fees, and regulations. “Spend more time educating and less time trying to take our freedom.” Many comments mentioned using tax dollars more resourcefully. “Stop making more laws and learn to spend tax money more efficiently.” While others just did not seem to like the idea of regulations, some even mentioned self-regulation. “Taxing and citations do not solve problems.”

Many respondents used the survey as an opportunity to comment about other water issues, mostly in the form of water quality and quantity issues. However, comments regarding building more wetlands, removing manatees, mercury levels, ethanol fuel in marine engines, water
bottling companies, and noisy airboats were also received. Comments having to do with water quantity issues included concerns over drainage and abundance, “Before long, there won’t be a river for fish, plants, or humans to enjoy.” Comments concerning water quality mentioned muck, “Spraying kills weeds which fall to the bottom and create muck. Now you have another problem.” Water quality comments also involved runoff from lawns, septic tanks, and the use of fertilizers by shoreline homeowners, such as “Prevent surface drainage from local land areas.”

Most respondents who made comments about responsibility alluded to boaters and anglers caring a lot about water resources and their equipment, such as “Fishermen are very conscientious” and “Ask for our help!”

Maintaining your boat goes hand-in-hand with preventing the spread of AIS. Responsible boaters who care about their investments don’t want junk on their boat and are less likely to spread AIS.

Others thought that the issue would not only benefit from but require a larger commitment from boaters and anglers than anything else. “You can law things to death, but people make the difference in their personal commitment to make things better.”

Bring about cultural change through behavior-based reinforcement/awareness increase…reward correct behaviors and exclude punitive forms of enforcement. Build personal responsibility through a rewards program.

Others were skeptical that boaters had a responsibility and thought that other sources or vectors were just as responsible (e.g. wildlife) or that it was a shared responsibility to provide equipment and education. “You can’t punish people who don’t know any better.”

Remarks were coded into two groupings for general comments about the AIS issue, those that suggested the issue was unmanageable (or didn’t think that it was a serious issue), and those that were genuinely concerned. Those that thought the issue was unmanageable made comments like “Fighting an unbeatable fight” or “Pandora’s Box has been opened.”
The planet is evolving, human activity is part of evolution, including the dispersal of species. Concepts of ‘native’ and ‘invasive’ are hubris. No matter what we do, the lakes will never be the same.

Those who were concerned about the issue tended to make comments like “Something needs to be done.” Others alluded to the nature of tourism in the state making AIS even a bigger issue. “Since Florida is such a transient state, the concern over the transfer of species should be at a high level.”

Many respondents made comments about the importance of protecting the resources, such as “Action should be taken to protect freshwater resources and the fisheries.” “The spread of harmful invasive species needs to be stopped no matter what the cost.”

There were many comments made about government, both positive and negative. While some were very critical of public agencies and agendas, “Get the politics out of it,” others were concerned about herbicide spraying techniques and/or training of personnel. Some made a distinction between national and local government, “Please keep the federal government out. Let local government deal with local issues.” A portion of comments made about the government were very supportive.

Keep funding WMDs and other government agencies. Unfortunately, it seems negative to be pro-environment in this state. If the WMDs and other agencies wouldn’t control invasive species, I don’t think anyone would!

Others commented on the role of agencies with comments like “Get public agencies more involved in prevention.”

Many comments were made about fishing and hunting. While the majority made comments about fishing as it relates to AIS issues, “Some vegetation desirable for the fishery,” others were concerned about fish health, habitat, or abundance. “Total eradication kills a lake. Have never seen fish kill by too much hydrilla, but chemicals to control hydrilla will kill a lake
it’s fish.” Some referred to the importance of balance in the management of natural resources (natural areas, waters, etc.).

   There needs to be a balance on maintaining a healthy fishery and removal of invasive aquatic vegetation. When you have a healthy fishery, it also benefits the local economy.

In addition, some anglers thought that management agencies in Florida needed to do a better job protecting fisheries.

   Florida is a magnificent bass fishing resource. Florida does not take advantage of this great economic resource, nor does it promote and protect it adequately.

Although much less numerous than fishing, some respondents made comments about hunting. These comments mostly focused on waterfowl, although alligators and invasive snakes were occasionally mentioned. Most comments of this nature consisted of “Strongly wish that involved agencies would be attentive to the needs of duck hunters!” or “Don’t spray during waterfowl hunting season.” A few comments acknowledged the potential user conflicts. “Less veg=fishermen are happy. More veg=duck hunters are happy. Love to see tons of vegetation, but not the non-native invasives.”

   Perhaps related to the frequency the topic was mentioned in the survey, many respondents made comments about boat cleaning, inspection stations, and/or boat check points. These comments were divided into support or opposition. Many more boaters and anglers made supportive comments than unsupportive ones. “Provide facilities at ramps for cleaning boats.” Many respondents alluded to the importance of placement, since boat ramps can get congested and crowded. “Provide out-of-the-way (loading/unloading) location for veg removal at busy public ramps.” Some thought that this practice (of cleaning and/or getting inspected needed to be mandatory.
People should be made aware of the problem and clean their boats and trailers at boat ramps. Although I don’t like more regulations, it may be necessary in order to make people clean their equipment.

Oppositional comments were far less numerous. They mostly alluded to ramps being overcrowded already.

A lot of respondents made comments about a specific issue, species, or place. These were divided into three categories: 1) anecdotal—AIS-related personal stories or experiences, 2) specific species, or 3) a particular lake or location. Many of these comments combine elements of each grouping. For instance, “I like the hydrilla on Toho. It slows down the high-powered (ridiculous) bass boats and makes it safer.” “I knew all the native and invasive plants in my native Indiana. No effort was made to educate me when I registered my boat in Florida.”

Most anecdotes focused on an opinion or experience. “Mostly saltwater fish now. Many freshwater areas I fished no longer attract me due to aquatic weeds.”

We spent 3/4 months in Florida now and see that time increasing. I would favor additional fees for license provided these funds be directed to signage, info, or cleaning stations. I fish IL, WS, MN, Ontario and Manitoba. Now adding FL.

Other comments focused on a specific species, which was most often hydrilla or water hyacinth, although tilapia, armored catfish, and apple snails were also mentioned.

I believe hydrilla was introduced to the lake I live on during wildfires in 2008 by helicopter fire fighting ops.

While still other comments focused on a specific place or location. For example, “The SJRWMD used to spray the inlets from the river…appeared to work good,” “Your spraying of the Rainbow River is terrible,” or “vegetation is a major problem in Lake Okeechobee.”

Comments on community action mentioned on teaching kids, creating jobs locally, involving scout troops or 4H groups, community cleanup events, public meetings, or using inmates to help clean or inspect boats/ramps.
Jobs could be created to remove these species which helps our environment and economy. All it will take is time and training.

Quite a few comments were made about the source of invasive species introductions. All alluded to the need or preference for “laws prohibiting import of invasive species,” “stopping all sales and import of invasives,” or “limiting plants coming into the country.” Some pointed to bass tournaments as sources and others focused on the broader invasive species issue. “Exotic pet trading must be eliminated!”

A few respondents made comments or apologies about not knowing more about the issue, “Sorry I do not know much about this problem,” or “I know very little because the problem is so poorly advertised.”

Finally, some respondents offered solutions that did not fall into any of the previous categories. These included: closing infested areas, implementing and AIS sticker (“like a Sun Pass for boaters”), incorporating AIS prevention in boater safety courses, putting a filter on locks to catch weeds, providing tax credits for AIS prevention donations, forming committees of local stakeholders, and providing incentives for homeowners to control their own shorelines.

Of the 1096 who answered the question, 40% of respondents reported that they had experienced AIS-related problems (n=443). These respondents were prompted to write in a description of the problem, which 417 did comment. Categories for problems described include: 1) navigation, 2) recreation, which was further broken down into boat/equipment, and fishing groups, and 3) other, which was further broken down into a group who explicitly cited chemicals.

There were 178 comments that mentioned navigational issues specifically. Such as “Hard to travel in infested waters” or “You can’t get the boat in the water or, when you do, all you pull up are plants.” “Plant species taking over water makes it un-navigable and/or unfishable.”
Problems related to boats and equipment were nearly as numerous as navigation issues with 173 comments. Most of these comments mentioned AIS clogging intakes or jet drives, wrapping around propeller, causing the motor to overheat, or “hangs up trolling motor.”

“Propeller getting entangled, blocks water inlet, and engine runs hot.”

Others alluded to mechanical issues such as “mechanical problems for outboards” or “burnt motor up.” Another 85 comments described problems relating to fishing or fish habitat, health or abundance, such as “fish dying off,” or “eliminates fish spawning habitat.” Many described problems with fishing or access issues. Such as “Can’t get lure through vegetation,” “Caught up in lures/reels,” or “Hard to get into areas where fish are located.” Some boaters made more general comments about the problem, “Hydrilla makes boating and fishing more work than play.”

Some respondents simply described the AIS-related problem as general “recreation” (36 comments), “Trouble with water skiing and other recreational activities” or “Hydrilla so thick I cannot paddle my kayak.” Others mentioned swimming specifically. “Invasives had destroyed our ability to swim in the lake.”

An “other problems” category was created that included those 69 comments referencing a specific lake, species, issue or a general problem such as “taking up too much water” or “Lake becoming shallower-too dense.” Species mentioned included hydrilla, zebra mussels, catfish, tilapia, cattails, algae, and snails. Several respondents alluded to a chemical issue such as “Only the over-spraying. It’s killing fish and birds.” “After spraying, the dead/dying hydrilla seemed to de-oxygenate the water. I would do very well on a lake only to find it do poorly after spraying.”
Table 4-1. Boater and Angler Demographics

<table>
<thead>
<tr>
<th>Measure</th>
<th>Percent</th>
<th>Frequency</th>
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</thead>
<tbody>
<tr>
<td>Both (n=1395)</td>
<td>68.1%</td>
<td>950</td>
</tr>
<tr>
<td>Boat only (n=1395)</td>
<td>10.7%</td>
<td>149</td>
</tr>
<tr>
<td>Fish only (n=1395)</td>
<td>9.9%</td>
<td>138</td>
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<tr>
<td>None (n=1395)</td>
<td>11.0%</td>
<td>158</td>
</tr>
<tr>
<td>Saltwater-only (n=1237)</td>
<td>8.5%</td>
<td>119</td>
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</table>

Table 4-2. Boater and Angler Radio Station Preference

<table>
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<tr>
<th>Radio Station Genre</th>
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<th>No</th>
</tr>
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<tbody>
<tr>
<td>Country (n=1083)</td>
<td>63.1% (n=683)</td>
<td>36.9% (n=400)</td>
</tr>
<tr>
<td>Oldies/Classic rock (n=1083)</td>
<td>52.4% (n=568)</td>
<td>47.6% (n=515)</td>
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<td>Talk radio (n=1083)</td>
<td>36.0% (n=390)</td>
<td>64.0% (n=693)</td>
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<td>Public radio (n=1083)</td>
<td>21.7% (n=235)</td>
<td>78.3% (n=848)</td>
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<tr>
<td>Other (n=1083)</td>
<td>18.3% (n=198)</td>
<td>81.7% (n=885)</td>
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<td>New age/Alternative (n=1083)</td>
<td>14.2% (n=154)</td>
<td>85.8% (n=929)</td>
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<tr>
<td>Classical (n=1081)</td>
<td>10.6% (n=115)</td>
<td>89.4% (n=966)</td>
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Table 4-3. Boater and Angler Radio Communication Method Preference

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<tr>
<th>Communication Method (n=1082)</th>
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<th>No</th>
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<tbody>
<tr>
<td>Mail</td>
<td>78.1% (n=845)</td>
<td>21.9% (n=237)</td>
</tr>
<tr>
<td>Email</td>
<td>41.6% (n=450)</td>
<td>58.4% (n=632)</td>
</tr>
<tr>
<td>Smart Phone App</td>
<td>6.7% (n=72)</td>
<td>93.3% (n=1010)</td>
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<tr>
<td>Public meetings</td>
<td>6.5% (n=70)</td>
<td>93.5% (n=1012)</td>
</tr>
<tr>
<td>Other (TV, radio, face-to-face)</td>
<td>4.9% (n=53)</td>
<td>95.1% (n=1029)</td>
</tr>
<tr>
<td>Social Media</td>
<td>3.3% (n=36)</td>
<td>96.7% (n=1046)</td>
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Table 4-4. Trustworthiness of Organizations

<table>
<thead>
<tr>
<th>Agency</th>
<th>Very trustworthy</th>
<th>Somewhat trustworthy</th>
<th>Slightly trustworthy</th>
<th>Not trustworthy</th>
<th>No experience</th>
<th>Undecided</th>
<th>M</th>
<th>SD</th>
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</thead>
<tbody>
<tr>
<td>FWC (n=1072)</td>
<td>57.4% (n=615)</td>
<td>25.1% (n=269)</td>
<td>5.9% (n=63)</td>
<td>2.1% (n=23)</td>
<td>6.3% (n=67)</td>
<td>3.3% (n=35)</td>
<td>1.85</td>
<td>1.335</td>
</tr>
<tr>
<td>EPA (n=1068)</td>
<td>25.4% (n=271)</td>
<td>27.9% (n=298)</td>
<td>15.0% (n=160)</td>
<td>16.7% (n=178)</td>
<td>10.2% (n=109)</td>
<td>4.9% (n=52)</td>
<td>2.73</td>
<td>1.495</td>
</tr>
<tr>
<td>UF/IFAS CAIP (n=1067)</td>
<td>52.3% (n=558)</td>
<td>22.1% (n=236)</td>
<td>4.7% (n=50)</td>
<td>0.6% (n=6)</td>
<td>15.9% (n=170)</td>
<td>4.4% (n=47)</td>
<td>2.19</td>
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<td>WMD (n=1065)</td>
<td>20.8% (n=222)</td>
<td>35.0% (n=373)</td>
<td>17.6% (n=187)</td>
<td>9.3% (n=99)</td>
<td>12.5% (n=133)</td>
<td>4.8% (n=51)</td>
<td>2.72</td>
<td>1.460</td>
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<td>Stores (n=1061)</td>
<td>10.1% (n=107)</td>
<td>39.3% (n=417)</td>
<td>28.9% (n=307)</td>
<td>6.8% (n=72)</td>
<td>8.3% (n=88)</td>
<td>6.6% (n=70)</td>
<td>2.84</td>
<td>1.328</td>
</tr>
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<td>Tackle shops (n=1067)</td>
<td>18.7% (n=199)</td>
<td>46.3% (n=494)</td>
<td>20.8% (n=222)</td>
<td>3.2% (n=34)</td>
<td>6.6% (n=70)</td>
<td>4.5% (n=48)</td>
<td>2.46</td>
<td>1.273</td>
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<tr>
<td>Boating &amp; angling NGOs</td>
<td>32.0% (n=341)</td>
<td>36.3% (n=387)</td>
<td>13.2% (n=141)</td>
<td>1.6% (n=17)</td>
<td>11.4% (n=122)</td>
<td>5.5% (n=59)</td>
<td>2.41</td>
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<td>Env. NGOs (n=1070)</td>
<td>17.1% (n=183)</td>
<td>26.4% (n=283)</td>
<td>18.9% (n=202)</td>
<td>15.8% (n=169)</td>
<td>15.2% (n=163)</td>
<td>6.5% (n=70)</td>
<td>3.05</td>
<td>1.518</td>
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<td>Extension (n=1055)</td>
<td>23.6% (n=249)</td>
<td>31.7% (n=334)</td>
<td>15.1% (n=159)</td>
<td>3.8% (n=40)</td>
<td>17.6% (n=186)</td>
<td>8.2% (n=87)</td>
<td>2.85</td>
<td>1.651</td>
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<tr>
<td>Friends/family (n=1068)</td>
<td>27.9% (n=298)</td>
<td>39.3% (n=420)</td>
<td>18.2% (n=194)</td>
<td>3.8% (n=41)</td>
<td>4.6% (n=49)</td>
<td>6.2% (n=66)</td>
<td>2.36</td>
<td>1.373</td>
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<td>Media (n=1063)</td>
<td>8.6% (n=91)</td>
<td>39.0% (n=415)</td>
<td>30.8% (n=327)</td>
<td>10.3% (n=110)</td>
<td>5.4% (n=57)</td>
<td>5.9% (n=63)</td>
<td>2.83</td>
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<td>Social media (n=1067)</td>
<td>2.2% (n=24)</td>
<td>13.8% (n=147)</td>
<td>27.1% (n=289)</td>
<td>17.5% (n=187)</td>
<td>22.9% (n=244)</td>
<td>16.5% (n=176)</td>
<td>3.94</td>
<td>1.383</td>
</tr>
</tbody>
</table>

Note on coding: 1=very trustworthy, 2=Somewhat trustworthy, 3=Slightly trustworthy, 4=not trustworthy, 5=no experience w/organization, and 5=undecided
Table 4-5. Boater and Angler Awareness of Specific Species

<table>
<thead>
<tr>
<th>Species</th>
<th>A lot of knowledge</th>
<th>Some knowledge</th>
<th>A little knowledge</th>
<th>No knowledge</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrilla (n=1092)</td>
<td>30.2%</td>
<td>33.9%</td>
<td>22.4%</td>
<td>13.5%</td>
<td>1.81</td>
<td>1.015</td>
</tr>
<tr>
<td>Water hyacinth (n=1064)</td>
<td>18.0%</td>
<td>31.2%</td>
<td>26.9%</td>
<td>24.0%</td>
<td>1.43</td>
<td>1.041</td>
</tr>
<tr>
<td>Water lettuce (n=1013)</td>
<td>7.3%</td>
<td>16.0%</td>
<td>32.9%</td>
<td>56.2%</td>
<td>.87</td>
<td>.935</td>
</tr>
<tr>
<td>Armored catfish (n=1030)</td>
<td>5.0%</td>
<td>11.7%</td>
<td>26.1%</td>
<td>57.1%</td>
<td>.65</td>
<td>.876</td>
</tr>
<tr>
<td>Island Apple snail (n=1022)</td>
<td>3.4%</td>
<td>8.0%</td>
<td>22.2%</td>
<td>66.3%</td>
<td>.49</td>
<td>.785</td>
</tr>
<tr>
<td>Quagga/zebra mussel (n=1033)</td>
<td>8.8%</td>
<td>16.6%</td>
<td>27.5%</td>
<td>47.1%</td>
<td>.87</td>
<td>.987</td>
</tr>
</tbody>
</table>

Table 4-6. Boater and Angler Awareness of AIS in Visited Waterbodies

<table>
<thead>
<tr>
<th>Source of awareness</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Able to identify &amp; observed (n=682)</td>
<td>80.1% (n=546)</td>
<td>19.9% (n=136)</td>
</tr>
<tr>
<td>Sign at boat launch (n=682)</td>
<td>39.6% (n=270)</td>
<td>60.4% (n=412)</td>
</tr>
<tr>
<td>Friend or family member (n=690)</td>
<td>25.5% (n=174)</td>
<td>74.5% (n=508)</td>
</tr>
<tr>
<td>Media (n=682)</td>
<td>10.9% (n=74)</td>
<td>89.1% (n=608)</td>
</tr>
<tr>
<td>Regulation pamphlet (n=682)</td>
<td>10.7% (n=73)</td>
<td>89.3% (n=609)</td>
</tr>
<tr>
<td>Educational brochure (n=690)</td>
<td>5.4% (n=37)</td>
<td>94.6% (n=645)</td>
</tr>
<tr>
<td>Website (n=690)</td>
<td>3.1% (n=21)</td>
<td>96.9% (n=661)</td>
</tr>
<tr>
<td>Boat inspector (n=690)</td>
<td>1.2% (n=8)</td>
<td>98.8% (n=674)</td>
</tr>
</tbody>
</table>

Table 4-7. Boater and Angler Awareness of AIS Control Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>A lot of knowledge</th>
<th>Some knowledge</th>
<th>A little knowledge</th>
<th>No knowledge</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical (n=1099)</td>
<td>10.0%</td>
<td>41.9%</td>
<td>29.0%</td>
<td>19.0%</td>
<td>2.57</td>
<td>.909</td>
</tr>
<tr>
<td>Mechanical (n=1100)</td>
<td>9.7%</td>
<td>42.4%</td>
<td>26.6%</td>
<td>21.3%</td>
<td>2.59</td>
<td>.928</td>
</tr>
<tr>
<td>Biological (n=1099)</td>
<td>4.5%</td>
<td>27.6%</td>
<td>34.6%</td>
<td>33.4%</td>
<td>2.97</td>
<td>.888</td>
</tr>
<tr>
<td>Physical (n=1094)</td>
<td>9.2%</td>
<td>37.3%</td>
<td>28.2%</td>
<td>25.3%</td>
<td>2.70</td>
<td>.951</td>
</tr>
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</table>
Table 4-8. Boater and Angler Sources for AIS Awareness

<table>
<thead>
<tr>
<th>Source of information</th>
<th>Yes</th>
<th>No</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Magazine/newsletter (n=1080)</td>
<td>58.8% (n=635)</td>
<td>35.6% (n=384)</td>
<td>5.6% (n=61)</td>
</tr>
<tr>
<td>Sign at boat launch (n=1079)</td>
<td>56.6% (n=610)</td>
<td>35.3% (n=381)</td>
<td>8.2% (n=88)</td>
</tr>
<tr>
<td>Newspapers (n=1081)</td>
<td>47.7% (n=516)</td>
<td>45.0% (n=486)</td>
<td>7.4% (n=79)</td>
</tr>
<tr>
<td>Fishing/boating/hunting regulations (n=1076)</td>
<td>45.3% (n=487)</td>
<td>44.3% (n=477)</td>
<td>10.4% (n=112)</td>
</tr>
<tr>
<td>Information at bait/tackle shop (n=1062)</td>
<td>38.1% (n=405)</td>
<td>52.7% (n=560)</td>
<td>9.1% (n=97)</td>
</tr>
<tr>
<td>TV news or programs (n=1060)</td>
<td>35.9% (n=381)</td>
<td>55.5% (n=588)</td>
<td>8.6% (n=91)</td>
</tr>
<tr>
<td>Boat registration materials (n=1070)</td>
<td>27.0% (n=289)</td>
<td>60.4% (n=646)</td>
<td>12.6% (n=135)</td>
</tr>
<tr>
<td>Educational materials (n=1053)</td>
<td>24.7% (n=260)</td>
<td>67.5% (n=659)</td>
<td>11.4% (n=134)</td>
</tr>
<tr>
<td>Websites (n=1066)</td>
<td>22.9% (n=244)</td>
<td>68.0% (n=725)</td>
<td>9.1% (n=97)</td>
</tr>
<tr>
<td>Booth at sport/fishing show (n=1064)</td>
<td>21.7% (n=231)</td>
<td>68.1% (n=725)</td>
<td>10.3% (n=108)</td>
</tr>
<tr>
<td>Sport/environmental organization (n=1064)</td>
<td>21.1% (n=225)</td>
<td>67.5% (n=718)</td>
<td>11.4% (n=121)</td>
</tr>
<tr>
<td>Fishing surveys or boat inspections (n=1065)</td>
<td>17.3% (n=184)</td>
<td>73.3% (n=781)</td>
<td>9.4% (n=100)</td>
</tr>
<tr>
<td>Billboards (n=1068)</td>
<td>12.7% (n=136)</td>
<td>78.0% (n=833)</td>
<td>9.3% (n=99)</td>
</tr>
<tr>
<td>Conferences, presentations, meetings (n=1064)</td>
<td>12.7% (n=135)</td>
<td>86.5% (n=824)</td>
<td>11.3% (n=105)</td>
</tr>
<tr>
<td>Radio (n=1068)</td>
<td>12.5% (n=134)</td>
<td>76.9% (n=821)</td>
<td>10.6% (n=113)</td>
</tr>
<tr>
<td>Contests, derbies, or regattas (n=1065)</td>
<td>12.5% (n=133)</td>
<td>76.6% (n=816)</td>
<td>10.9% (n=116)</td>
</tr>
<tr>
<td>Educational videos (n=1013)</td>
<td>5.8% (n=59)</td>
<td>81.3% (n=824)</td>
<td>12.8% (n=130)</td>
</tr>
<tr>
<td>Social media (n=1048)</td>
<td>2.2% (n=23)</td>
<td>86.5% (n=907)</td>
<td>11.3% (n=118)</td>
</tr>
<tr>
<td>Other-specified (n=43)</td>
<td>14.0% (n=6)</td>
<td>76.7% (n=33)</td>
<td>9.3% (n=4)</td>
</tr>
<tr>
<td>Measure/source</td>
<td>Frequency</td>
<td>Total Points</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-----------</td>
<td>--------------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Most important (n=896)</td>
<td>2\textsuperscript{nd} most important (n=872)</td>
<td>3\textsuperscript{rd} most important (n=837)</td>
</tr>
<tr>
<td>Signs at marinas or launches</td>
<td>252</td>
<td>125</td>
<td>117</td>
</tr>
<tr>
<td>Television news or programs</td>
<td>129</td>
<td>72</td>
<td>59</td>
</tr>
<tr>
<td>Fishing, boating, or waterfowl hunting regulation pamphlets</td>
<td>95</td>
<td>104</td>
<td>90</td>
</tr>
<tr>
<td>Magazine/newsletter articles</td>
<td>82</td>
<td>101</td>
<td>70</td>
</tr>
<tr>
<td>Newspapers</td>
<td>83</td>
<td>46</td>
<td>54</td>
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</table>
### Table 4-10. Boater and Angler Attitudes about AIS Impacts

<table>
<thead>
<tr>
<th>Impact</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Don’t Know</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental (n=1111)</td>
<td>42.4%</td>
<td>39.0%</td>
<td>8.3%</td>
<td>1.7%</td>
<td>0.5%</td>
<td>8.2%</td>
<td>2.03</td>
<td>1.388</td>
</tr>
<tr>
<td>(n=471)</td>
<td></td>
<td>(n=433)</td>
<td>(n=92)</td>
<td>(n=19)</td>
<td>(n=5)</td>
<td>(n=91)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Economic (n=1110)</td>
<td>32.6%</td>
<td>43.1%</td>
<td>12.3%</td>
<td>2.5%</td>
<td>0.4%</td>
<td>9.2%</td>
<td>2.23</td>
<td>1.415</td>
</tr>
<tr>
<td>(n=362)</td>
<td></td>
<td>(n=478)</td>
<td>(n=136)</td>
<td>(n=28)</td>
<td>(n=4)</td>
<td>(n=102)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native Fish/Wildlife (n=1108)</td>
<td>41.7%</td>
<td>36.6%</td>
<td>10.3%</td>
<td>2.5%</td>
<td>0.5%</td>
<td>8.4%</td>
<td>2.09</td>
<td>1.414</td>
</tr>
<tr>
<td>(n=462)</td>
<td></td>
<td>(n=406)</td>
<td>(n=114)</td>
<td>(n=28)</td>
<td>(n=5)</td>
<td>(n=93)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I can take preventive steps (n=1103)</td>
<td>22.4%</td>
<td>36.9%</td>
<td>7.4%</td>
<td>0.8%</td>
<td>0.1%</td>
<td>14.6%</td>
<td>2.42</td>
<td>1.609</td>
</tr>
<tr>
<td>(n=312)</td>
<td></td>
<td>(n=515)</td>
<td>(n=103)</td>
<td>(n=11)</td>
<td>(n=1)</td>
<td>(n=161)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Invasive plants can take over (n=1111)</td>
<td>39.2%</td>
<td>29.4%</td>
<td>4.8%</td>
<td>1.1%</td>
<td>0.3%</td>
<td>6.1%</td>
<td>1.85</td>
<td>1.262</td>
</tr>
<tr>
<td>(n=547)</td>
<td></td>
<td>(n=410)</td>
<td>(n=67)</td>
<td>(n=16)</td>
<td>(n=3)</td>
<td>(n=68)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native Plants can take over (n=1109)</td>
<td>27.0%</td>
<td>31.7%</td>
<td>17.5%</td>
<td>9.4%</td>
<td>2.9%</td>
<td>11.6%</td>
<td>2.64</td>
<td>1.590</td>
</tr>
<tr>
<td>(n=299)</td>
<td></td>
<td>(n=351)</td>
<td>(n=194)</td>
<td>(n=104)</td>
<td>(n=32)</td>
<td>(n=129)</td>
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<td></td>
</tr>
</tbody>
</table>

### Table 4-11. Angler Preference for Fishing Habitat

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Very desirable</th>
<th>Desirable</th>
<th>Undesirable</th>
<th>Very undesirable</th>
<th>Don’t know</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native emergent plants (n=881)</td>
<td>39.4%</td>
<td>43.4%</td>
<td>3.4%</td>
<td>1.5%</td>
<td>12.4%</td>
<td>2.04</td>
<td>1.265</td>
</tr>
<tr>
<td>(n=347)</td>
<td></td>
<td>(n=382)</td>
<td>(n=30)</td>
<td>(n=13)</td>
<td>(n=109)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Native submerged plants (n=881)</td>
<td>28.7%</td>
<td>43.6%</td>
<td>8.9%</td>
<td>2.4%</td>
<td>16.5%</td>
<td>2.34</td>
<td>1.355</td>
</tr>
<tr>
<td>(n=253)</td>
<td></td>
<td>(n=384)</td>
<td>(n=78)</td>
<td>(n=21)</td>
<td>(n=145)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Floating plants (n=872)</td>
<td>11.8%</td>
<td>33.3%</td>
<td>27.9%</td>
<td>13.0%</td>
<td>14.1%</td>
<td>2.84</td>
<td>1.215</td>
</tr>
<tr>
<td>(n=103)</td>
<td></td>
<td>(n=290)</td>
<td>(n=243)</td>
<td>(n=113)</td>
<td>(n=123)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrilla (n=871)</td>
<td>8.0%</td>
<td>19.1%</td>
<td>27.7%</td>
<td>29.7%</td>
<td>15.5%</td>
<td>3.26</td>
<td>1.169</td>
</tr>
<tr>
<td>(n=70)</td>
<td></td>
<td>(n=166)</td>
<td>(n=241)</td>
<td>(n=259)</td>
<td>(n=135)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Open water (n=867)</td>
<td>11.2%</td>
<td>36.6%</td>
<td>24.9%</td>
<td>13.3%</td>
<td>14.1%</td>
<td>2.82</td>
<td>1.216</td>
</tr>
<tr>
<td>(n=97)</td>
<td></td>
<td>(n=317)</td>
<td>(n=216)</td>
<td>(n=115)</td>
<td>(n=122)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other structure (n=867)</td>
<td>36.6%</td>
<td>48.1%</td>
<td>4.3%</td>
<td>1.4%</td>
<td>9.7%</td>
<td>2.00</td>
<td>1.156</td>
</tr>
<tr>
<td>(n=317)</td>
<td></td>
<td>(n=417)</td>
<td>(n=37)</td>
<td>(n=12)</td>
<td>(n=84)</td>
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</table>
Table 4-12. Boater and Angler Preference of AIS Control Methods

<table>
<thead>
<tr>
<th>Method</th>
<th>Strongly favor</th>
<th>Somewhat favor</th>
<th>Neither</th>
<th>Somewhat oppose</th>
<th>Strongly oppose</th>
<th>Don’t know</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>15.1%</td>
<td>27.6%</td>
<td>13.2%</td>
<td>16.4%</td>
<td>18.2%</td>
<td>9.6%</td>
<td>3.24</td>
<td>1.606</td>
</tr>
<tr>
<td>(n=1094)</td>
<td>(n=165)</td>
<td>(n=302)</td>
<td>(n=144)</td>
<td>(n=179)</td>
<td>(n=199)</td>
<td>(n=105)</td>
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<td></td>
</tr>
<tr>
<td>Mechanical</td>
<td>36.2%</td>
<td>36.7%</td>
<td>13.6%</td>
<td>2.9%</td>
<td>1.8%</td>
<td>8.7%</td>
<td>2.23</td>
<td>1.455</td>
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<tr>
<td>(n=1094)</td>
<td>(n=396)</td>
<td>(n=402)</td>
<td>(n=149)</td>
<td>(n=32)</td>
<td>(n=20)</td>
<td>(n=95)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Biological</td>
<td>19.3%</td>
<td>26.7%</td>
<td>15.2%</td>
<td>13.0%</td>
<td>12.6%</td>
<td>13.2%</td>
<td>3.12</td>
<td>1.687</td>
</tr>
<tr>
<td>(n=1083)</td>
<td>(n=209)</td>
<td>(n=289)</td>
<td>(n=165)</td>
<td>(n=141)</td>
<td>(n=136)</td>
<td>(n=143)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>25.8%</td>
<td>37.4%</td>
<td>17.9%</td>
<td>5.1%</td>
<td>3.1%</td>
<td>10.8%</td>
<td>2.55</td>
<td>1.532</td>
</tr>
<tr>
<td>(n=1087)</td>
<td>(n=280)</td>
<td>(n=406)</td>
<td>(n=195)</td>
<td>(n=55)</td>
<td>(n=34)</td>
<td>(n=117)</td>
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<td></td>
</tr>
</tbody>
</table>

Table 4-13. Perception of Effective Methods to Help Boater/Anglers Prevent the Spread

<table>
<thead>
<tr>
<th>Measure</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs at boat launch</td>
<td>84.0% (n=930)</td>
<td>16.0% (n=177)</td>
</tr>
<tr>
<td>Educational materials</td>
<td>63.3% (n=701)</td>
<td>36.7% (n=406)</td>
</tr>
<tr>
<td>Boater training courses</td>
<td>34.0% (n=376)</td>
<td>66.0% (n=731)</td>
</tr>
<tr>
<td>Radio/TV</td>
<td>30.0% (n=332)</td>
<td>70.0% (n=775)</td>
</tr>
<tr>
<td>Boat cleaning equipment</td>
<td>28.2% (n=312)</td>
<td>71.8% (n=795)</td>
</tr>
<tr>
<td>Rules and regulations</td>
<td>20.3% (n=225)</td>
<td>79.9% (n=882)</td>
</tr>
<tr>
<td>Boat inspections</td>
<td>11.0% (n=122)</td>
<td>89.0% (n=985)</td>
</tr>
<tr>
<td>Other (specified)</td>
<td>7.2% (n=80)</td>
<td>92.8% (n=1027)</td>
</tr>
<tr>
<td>Boaters/anglers not responsible</td>
<td>3.5% (n=39)</td>
<td>96.5% (n=1068)</td>
</tr>
</tbody>
</table>

Table 4-14. Perception of Effective Consequences for Violators

<table>
<thead>
<tr>
<th>Measure</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boater training</td>
<td>32.5% (n=346)</td>
<td>67.5% (n=718)</td>
</tr>
<tr>
<td>No consequences</td>
<td>31.3% (n=333)</td>
<td>68.7% (n=731)</td>
</tr>
<tr>
<td>Fines</td>
<td>30.4% (n=323)</td>
<td>69.6% (n=741)</td>
</tr>
<tr>
<td>Restrictions</td>
<td>27.0% (n=287)</td>
<td>73.0% (n=777)</td>
</tr>
<tr>
<td>Other (specified)</td>
<td>10.2% (n=109)</td>
<td>89.8% (n=955)</td>
</tr>
</tbody>
</table>
Table 4-15. Motivators for AIS BMP Adoption

<table>
<thead>
<tr>
<th>Measure/source</th>
<th>Already led me to take action</th>
<th>Would be very effective</th>
<th>Would be somewhat effective</th>
<th>Would NOT be effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>Friends and acquaintances (n=1074)</td>
<td>15.7% (n=169)</td>
<td>37.2% (n=399)</td>
<td>38.7% (n=416)</td>
<td>8.4% (n=90)</td>
</tr>
<tr>
<td>Sense of personal responsibility (n=1081)</td>
<td>30.9% (n=334)</td>
<td>50.2% (n=543)</td>
<td>16.5% (n=178)</td>
<td>2.4% (n=26)</td>
</tr>
<tr>
<td>Desire to keep AIS out of lakes/ rivers (n=1080)</td>
<td>29.4% (n=317)</td>
<td>54.5% (n=589)</td>
<td>13.6% (n=147)</td>
<td>2.5% (n=27)</td>
</tr>
<tr>
<td>Desire to prevent damage to equipment (n=1094)</td>
<td>24.2% (n=262)</td>
<td>55.3% (n=599)</td>
<td>16.4% (n=178)</td>
<td>4.2% (n=45)</td>
</tr>
<tr>
<td>Desire to reduce cost of controlling AIS (n=1075)</td>
<td>12.4% (n=133)</td>
<td>50.0% (n=537)</td>
<td>26.0% (n=279)</td>
<td>11.7% (n=126)</td>
</tr>
<tr>
<td>Laws &amp; regulations (n=1088)</td>
<td>7.4% (n=81)</td>
<td>54.7% (n=595)</td>
<td>26.2% (n=285)</td>
<td>11.7% (n=127)</td>
</tr>
<tr>
<td>Enforcement checks (n=1075)</td>
<td>5.6% (n=60)</td>
<td>50.7% (n=545)</td>
<td>29.7% (n=319)</td>
<td>14.0% (n=151)</td>
</tr>
<tr>
<td>Fines to be paid by violators (n=1078)</td>
<td>3.7% (n=40)</td>
<td>45.3% (n=487)</td>
<td>30.2% (n=443)</td>
<td>20.9% (n=83)</td>
</tr>
<tr>
<td>Media (n=1079)</td>
<td>5.0% (n=54)</td>
<td>46.2% (n=499)</td>
<td>41.1% (n=443)</td>
<td>7.7% (n=83)</td>
</tr>
<tr>
<td>TV/Radio (n=1086)</td>
<td>5.1% (n=55)</td>
<td>45.3% (n=492)</td>
<td>39.5% (n=429)</td>
<td>10.1% (n=110)</td>
</tr>
<tr>
<td>Billboards (n=1071)</td>
<td>3.3% (n=35)</td>
<td>38.7% (n=415)</td>
<td>43.7% (n=468)</td>
<td>14.3% (n=153)</td>
</tr>
<tr>
<td>Mag/newsletter (n=1081)</td>
<td>5.2% (n=56)</td>
<td>41.5% (n=449)</td>
<td>43.9% (n=475)</td>
<td>9.3% (n=101)</td>
</tr>
<tr>
<td>Website (n=1068)</td>
<td>3.5% (n=37)</td>
<td>34.9% (n=373)</td>
<td>42.9% (n=458)</td>
<td>18.7% (n=200)</td>
</tr>
<tr>
<td>Social Media (n=1068)</td>
<td>1.7% (n=18)</td>
<td>28.1% (n=300)</td>
<td>38.8% (n=414)</td>
<td>31.5% (n=336)</td>
</tr>
<tr>
<td>Educational materials (n=1088)</td>
<td>7.7% (n=84)</td>
<td>60.2% (n=655)</td>
<td>28.1% (n=306)</td>
<td>4.0% (n=43)</td>
</tr>
<tr>
<td>Fishing/boating regulation pamphlets (n=1072)</td>
<td>5.5% (n=59)</td>
<td>59.6% (n=639)</td>
<td>31.3% (n=336)</td>
<td>3.5% (n=38)</td>
</tr>
<tr>
<td>Signs at boat launches (n=1080)</td>
<td>15.3% (n=165)</td>
<td>66.3% (n=716)</td>
<td>16.8% (n=181)</td>
<td>1.7% (n=18)</td>
</tr>
<tr>
<td>Boat inspections (n=1064)</td>
<td>3.4% (n=36)</td>
<td>47.2% (n=502)</td>
<td>31.8% (n=338)</td>
<td>17.7% (n=188)</td>
</tr>
<tr>
<td>Videos/presentations (n=1073)</td>
<td>2.1% (n=23)</td>
<td>40.4% (n=433)</td>
<td>45.0% (n=483)</td>
<td>12.5% (n=134)</td>
</tr>
<tr>
<td>Radio broadcasts along roads (n=1070)</td>
<td>1.3% (n=14)</td>
<td>24.9% (n=266)</td>
<td>42.1% (n=451)</td>
<td>31.7% (n=339)</td>
</tr>
<tr>
<td>New boater training courses (n=1086)</td>
<td>2.9% (n=32)</td>
<td>55.1% (n=598)</td>
<td>32.0% (n=348)</td>
<td>9.9% (n=108)</td>
</tr>
</tbody>
</table>
Table 4-16. Sources/steps Most Effective for Getting Boaters/Anglers to Adopt BMPs

<table>
<thead>
<tr>
<th>Measure/source</th>
<th>Most important (n=896)</th>
<th>2nd most important (n=872)</th>
<th>3rd most important (n=837)</th>
<th>Total Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Signs at marinas or boat launches</td>
<td>150</td>
<td>140</td>
<td>113</td>
<td>843</td>
</tr>
<tr>
<td>Brochures, ID cards, fact sheets or other materials</td>
<td>114</td>
<td>88</td>
<td>81</td>
<td>599</td>
</tr>
<tr>
<td>Sense of personal responsibility</td>
<td>126</td>
<td>42</td>
<td>35</td>
<td>497</td>
</tr>
<tr>
<td>Fishing or boating regulations</td>
<td>47</td>
<td>92</td>
<td>68</td>
<td>393</td>
</tr>
<tr>
<td>A desire to keep AIS out of our lakes and rivers</td>
<td>67</td>
<td>69</td>
<td>46</td>
<td>385</td>
</tr>
</tbody>
</table>

Note: Points assigned to each respondent based on 3 for “most important,” 2 for “2nd most important, and 1 for “3rd most important.”

Table 4-17. Respondents Reasons for Not Taking Action

<table>
<thead>
<tr>
<th>Reason for not taking action (n=285)</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Don’t know what to do</td>
<td>51.2% (n=146)</td>
<td>48.8% (n=139)</td>
</tr>
<tr>
<td>Other (specified)</td>
<td>29.5% (n=84)</td>
<td>70.5% (n=201)</td>
</tr>
<tr>
<td>Boat washing equipment not available</td>
<td>27.0% (n=77)</td>
<td>73.0% (n=208)</td>
</tr>
<tr>
<td>Didn’t boat on infested waters</td>
<td>13.7% (n=39)</td>
<td>86.3% (n=246)</td>
</tr>
<tr>
<td>Don’t believe AIS are a problem</td>
<td>3.5% (n=10)</td>
<td>96.5% (n=275)</td>
</tr>
<tr>
<td>Don’t believe steps will prevent AIS</td>
<td>3.5% (n=10)</td>
<td>96.5% (n=275)</td>
</tr>
<tr>
<td>Not convenient</td>
<td>2.1% (n=6)</td>
<td>97.9% (n=279)</td>
</tr>
</tbody>
</table>
Table 4-18. Adoption and Frequency of Boater AIS Preventive BMPs

<table>
<thead>
<tr>
<th>BMP</th>
<th>Always</th>
<th>Usually</th>
<th>Sometimes</th>
<th>Never</th>
<th>Does not apply</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Visual inspection (n=1002)</td>
<td>61.3%</td>
<td>22.9%</td>
<td>7.3%</td>
<td>6.0%</td>
<td>2.6%</td>
<td>2.46</td>
<td>1.044</td>
</tr>
<tr>
<td>(n=614)</td>
<td>(n=229)</td>
<td>(n=73)</td>
<td>(n=60)</td>
<td>(n=26)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drain water (n=999)</td>
<td>73.1%</td>
<td>16.0%</td>
<td>4.2%</td>
<td>2.3%</td>
<td>4.4%</td>
<td>2.63</td>
<td>.961</td>
</tr>
<tr>
<td>(n=730)</td>
<td>(n=160)</td>
<td>(n=42)</td>
<td>(n=23)</td>
<td>(n=44)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dispose of live bait properly (n=982)</td>
<td>53.8%</td>
<td>15.6%</td>
<td>7.3%</td>
<td>10.6%</td>
<td>12.7%</td>
<td>2.66</td>
<td>1.417</td>
</tr>
<tr>
<td>(n=528)</td>
<td>(n=153)</td>
<td>(n=72)</td>
<td>(n=104)</td>
<td>(n=125)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Remove plants and animals (n=995)</td>
<td>69.8%</td>
<td>16.5%</td>
<td>4.4%</td>
<td>3.7%</td>
<td>5.5%</td>
<td>2.57</td>
<td>1.052</td>
</tr>
<tr>
<td>(n=695)</td>
<td>(n=164)</td>
<td>(n=44)</td>
<td>(n=37)</td>
<td>(n=55)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wash (n=988)</td>
<td>40.1%</td>
<td>22.3%</td>
<td>23.9%</td>
<td>10.5%</td>
<td>3.2%</td>
<td>1.99</td>
<td>1.232</td>
</tr>
<tr>
<td>(n=396)</td>
<td>(n=220)</td>
<td>(n=236)</td>
<td>(n=104)</td>
<td>(n=32)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wash with hot or high pressure (n=987)</td>
<td>13.1%</td>
<td>9.7%</td>
<td>25.4%</td>
<td>46.8%</td>
<td>5.0%</td>
<td>1.01</td>
<td>1.325</td>
</tr>
<tr>
<td>(n=129)</td>
<td>(n=96)</td>
<td>(n=251)</td>
<td>(n=462)</td>
<td>(n=49)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flush cooling system (n=977)</td>
<td>26.3%</td>
<td>13.4%</td>
<td>23.7%</td>
<td>26.7%</td>
<td>9.8%</td>
<td>1.43</td>
<td>1.404</td>
</tr>
<tr>
<td>(n=257)</td>
<td>(n=131)</td>
<td>(n=232)</td>
<td>(n=261)</td>
<td>(n=96)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry (n=987)</td>
<td>23.0%</td>
<td>29.7%</td>
<td>24.7%</td>
<td>17.4%</td>
<td>5.2%</td>
<td>1.64</td>
<td>1.247</td>
</tr>
<tr>
<td>(n=227)</td>
<td>(n=293)</td>
<td>(n=244)</td>
<td>(n=172)</td>
<td>(n=51)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wipe hull (n=99)</td>
<td>14.8%</td>
<td>15.6%</td>
<td>31.0%</td>
<td>33.8%</td>
<td>4.7%</td>
<td>1.20</td>
<td>1.274</td>
</tr>
<tr>
<td>(n=147)</td>
<td>(n=155)</td>
<td>(n=308)</td>
<td>(n=335)</td>
<td>(n=47)</td>
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<td></td>
</tr>
</tbody>
</table>

Table 4-19. Boater and Angler Willingness to Pay for AIS-Related Services

<table>
<thead>
<tr>
<th>Service</th>
<th>None</th>
<th>$1</th>
<th>$2</th>
<th>$5</th>
<th>$10</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boat cleaning stations (n=1054)</td>
<td>38.8%</td>
<td>21.9%</td>
<td>17.0%</td>
<td>16.8%</td>
<td>5.5%</td>
<td>2.12</td>
<td>2.639</td>
</tr>
<tr>
<td>(n=409)</td>
<td>(n=231)</td>
<td>(n=179)</td>
<td>(n=177)</td>
<td>(n=58)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Signs and materials at boat ramps (n=1056)</td>
<td>30.6%</td>
<td>34.3%</td>
<td>19.8%</td>
<td>12.3%</td>
<td>3.0%</td>
<td>1.86</td>
<td>2.190</td>
</tr>
<tr>
<td>(n=323)</td>
<td>(n=362)</td>
<td>(n=209)</td>
<td>(n=130)</td>
<td>(n=32)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication &amp; outreach (n=1035)</td>
<td>43.4%</td>
<td>29.5%</td>
<td>16.5%</td>
<td>8.2%</td>
<td>2.4%</td>
<td>1.44</td>
<td>2.043</td>
</tr>
<tr>
<td>(n=449)</td>
<td>(n=305)</td>
<td>(n=171)</td>
<td>(n=85)</td>
<td>(n=25)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management &amp; control of AIS (n=1066)</td>
<td>27.6%</td>
<td>25.0%</td>
<td>18.7%</td>
<td>19.8%</td>
<td>8.9%</td>
<td>2.69</td>
<td>2.925</td>
</tr>
<tr>
<td>(n=294)</td>
<td>(n=267)</td>
<td>(n=199)</td>
<td>(n=211)</td>
<td>(n=95)</td>
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</table>

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Table 4-20. Correlations Between Boater/Angler BMP Adoption and Personality Factors, Knowledge of Issues, Knowledge of Action Strategies, Norms and Intention

<table>
<thead>
<tr>
<th></th>
<th>BMP index</th>
<th>Know. index</th>
<th>Issue</th>
<th>Efficacy</th>
<th>BMP likely</th>
<th>WTP index</th>
<th>Norms</th>
<th>Pers. Res.</th>
<th>Laws/fines</th>
<th>Attitudes</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP index</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Know. index</td>
<td>.110*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Issue</td>
<td>.097*</td>
<td>.248*</td>
<td>1.00</td>
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<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficacy</td>
<td>.162*</td>
<td>.225*</td>
<td>.388*</td>
<td>1.00</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>BMP likely</td>
<td>.360*</td>
<td>.034</td>
<td>.139*</td>
<td>.234*</td>
<td>1.00</td>
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<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WTP index</td>
<td>.052</td>
<td>.056</td>
<td>.185*</td>
<td>.087*</td>
<td>.108*</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Norms</td>
<td>.318*</td>
<td>.204*</td>
<td>.179*</td>
<td>.304*</td>
<td>.308*</td>
<td>.056</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pers. Res.</td>
<td>.172*</td>
<td>.206*</td>
<td>.263*</td>
<td>.392*</td>
<td>.245*</td>
<td>.139*</td>
<td>.483*</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Laws/fines</td>
<td>.039</td>
<td>-.009</td>
<td>.149*</td>
<td>.136*</td>
<td>.085*</td>
<td>.208*</td>
<td>.079*</td>
<td>.159*</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Attitudes</td>
<td>.144*</td>
<td>.168*</td>
<td>.629*</td>
<td>.402*</td>
<td>.202*</td>
<td>.213*</td>
<td>.173*</td>
<td>.275*</td>
<td>.261*</td>
<td>1.00</td>
</tr>
</tbody>
</table>

*indicates a significance of 0.05 or less
Table 4-21. Linear Regression: Full REB Model vs. Reduced REB Model

<table>
<thead>
<tr>
<th>Predictive Variable</th>
<th>Full REB Model&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Reduced REB Model&lt;sup&gt;b&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>B</td>
<td>Std. Error</td>
</tr>
<tr>
<td>Attitude</td>
<td>3.663</td>
<td>1.381</td>
</tr>
<tr>
<td>Efficacy</td>
<td>-8.00</td>
<td>1.035</td>
</tr>
<tr>
<td>Per. Res.</td>
<td>-1.848</td>
<td>1.081</td>
</tr>
<tr>
<td>Knowledge Index</td>
<td>.038</td>
<td>.034</td>
</tr>
<tr>
<td>Issue</td>
<td>-1.576</td>
<td>.911</td>
</tr>
<tr>
<td>Norms</td>
<td>3.255</td>
<td>.640</td>
</tr>
<tr>
<td>BMP Likely</td>
<td>11.377</td>
<td>1.479</td>
</tr>
<tr>
<td>Likely Spend</td>
<td>.409</td>
<td>.329</td>
</tr>
<tr>
<td>Laws/Fines</td>
<td>.285</td>
<td>1.038</td>
</tr>
<tr>
<td>No Equip.</td>
<td>.938</td>
<td>4.447</td>
</tr>
</tbody>
</table>


<sup>a</sup> R squared= .223 (Adjusted R squared= .210)
<sup>b</sup> R squared= .209 (Adjusted R squared= .205)
Table 4-22. Variable Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>Min/Max Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMP Index (dep.)</td>
<td>1008</td>
<td>59.80</td>
<td>21.70</td>
<td>0-100</td>
</tr>
<tr>
<td>Knowledge Index</td>
<td>1092</td>
<td>32.60</td>
<td>20.70</td>
<td>0-100</td>
</tr>
<tr>
<td>Issue</td>
<td>1101</td>
<td>3.16</td>
<td>1.01</td>
<td>0-4</td>
</tr>
<tr>
<td>Efficacy</td>
<td>1103</td>
<td>3.02</td>
<td>7.55</td>
<td>0-4</td>
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<tr>
<td>1. Control</td>
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<tr>
<td>a. General</td>
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<td>b. Chemical</td>
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<td>c. Mechanical</td>
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<tr>
<td>d. Biological</td>
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<tr>
<td>e. Physical</td>
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<tr>
<td>2. Appreciation</td>
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<td>3. Education</td>
<td>151</td>
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<tr>
<td>a. Signs at boat ramps</td>
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<td>b. Educational materials</td>
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<td>c. Boating registration/fishing regulations</td>
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<td>4. Taxes/fees/regulations</td>
<td>103</td>
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<tr>
<td>a. Favor</td>
<td>64</td>
<td></td>
<td></td>
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<tr>
<td>b. Oppose</td>
<td>39</td>
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<tr>
<td>5. Other water issue</td>
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<tr>
<td>a. Quality</td>
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<tr>
<td>b. Quantity</td>
<td>12</td>
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<tr>
<td>6. Responsibility</td>
<td>59</td>
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<td>7. General issue comment/recommendation</td>
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<tr>
<td>a. Unmanageable/not an issue</td>
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<tr>
<td>b. Concerned</td>
<td>46</td>
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<tr>
<td>8. Government</td>
<td>41</td>
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<tr>
<td>9. Fishing/hunting</td>
<td>39</td>
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<td>10. Boat cleaning/inspections</td>
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<td></td>
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<tr>
<td>a. Favor</td>
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<tr>
<td>b. Oppose</td>
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<tr>
<td>11. Specific place or issue</td>
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<tr>
<td>a. Anecdotal</td>
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<td>b. Species</td>
<td>32</td>
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<tr>
<td>c. Location</td>
<td>38</td>
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<td>12. Community involvement/action</td>
<td>11</td>
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<td>13. Introductions of AIS</td>
<td>14</td>
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<td>14. Don’t know about issue</td>
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<tr>
<td>15. Other solutions</td>
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CHAPTER 5
DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

Invasive species are a global problem and are considered to be one of the biggest environmental threats of the 21\textsuperscript{st} Century (Coblentz, 1990; U.S. General Accountability Office, 2002). With increased trade, transport, and travel, natural barriers that used to deter species movement are disappearing. Aquatic invasive species (AIS) pose serious threats to freshwater resources by diminishing biological diversity as invasive plants and animal species move in and take over native species (Carlton & Geller, 1993; Vitousek, 1994). These invasives can also threaten public safety, local economies, livelihoods, recreation, water supply, water quality, and property values (Rockwell, 2003).

Recreational water activities (e.g. boating and fishing) are the leading sources of the secondary spread of AIS (Johnson & Padilla, 1996; Johnson et al., 2001; Murry et al., 2011). Florida leads the nation in number of registered boats and an estimated 300,000 visitors who come to boat and/or fish annually (FDHSMV, 2010). As such, this study provides a baseline assessment of Florida boater and angler awareness, attitudes and behavior in regard to AIS issues and prevention.

Florida registered boaters who boat primarily on freshwater in Florida are major stakeholders in the AIS issue; assessing their knowledge, attitudes, and behavior in regard to AIS can provide critical information to management agencies on how best to develop and disseminate an educational campaign targeting the biggest user group in the state.

The study focused on boater and angler behavior in regards to the spread of AIS, but explored other constructs such as awareness and attitudes. While several theories are used in environmental behavior studies, this research model draws specifically from Responsible Environmental Behavior (REB) and the Theory of Planned Behavior (TPB). The two models
share the constructs of intention to act and attitude. In both models, attitudes are assumed to have a direct influence on an individuals’ intention to act. In addition to possessing the intention to act, the REB asserts that two additional broad factors are necessary: cognitive (issue, action strategy, and skill knowledge) and affective (attitudes, personal responsibility, and locus of control) components. The principle is that if cognitive and affective factors can be changed, behavioral intentions can be influenced, which can ultimately result in environmentally desirable behaviors (Hwang, Kim, & Jeng, 2000).

For the purpose of this research, the REB was modified to include a variable present in the TPB, subjective norms. Research on boaters and anglers suggested that norms were a significant factor that could have a great influence on behavior. Understanding what factors facilitate boater and angler responsible environmental behavior can provide important guidelines for designing and implementing an educational campaign capable of increasing boater and angler adoption and practice of AIS preventive measures. Effective AIS outreach can motivate boaters to act (Jensen, 2010). In order to adequately address the multitude of impacts associated with AIS, effective educational campaigns should be developed and implemented. Behavioral theory and models are helpful tools in understanding why people chose to take action (or not) and the best ways in which to engage stakeholders with messages that are relevant, targeted, and adept at influencing behavior.

**Summary and Discussion of Results**

A mail survey was sent to 4500 Florida freshwater boaters and non-resident anglers requesting participation in this study regarding AIS. A total of 1395 surveys were returned, yielding a response rate of 33.87%. Of these, 1118 (27.14%) were completed surveys returned by freshwater boaters (70%, n=787) and anglers (30%, n=333). The remaining 277 surveys were
returned by boaters/anglers who either had not boated/fished in some time or boated/fished in saltwater-only. All 1395 returned surveys were respondents, 1118 were considered valid.

**Socio-Demographic Information**

Demographic information can provide insight into who the target audience is and how best to target them. Of the eligible respondents (n=1118), an overwhelming majority (68%) reported that they both boated and fished in 2011. Most of the respondents were male (91%) and the average age was found to be 59, which is significantly higher than a five-state comparison of boater awareness, where the mean age was 45 (Jensen, 2010). Most of the respondents used a small powerboat under 20 feet, fished in freshwater in the past year for pleasure or sport for mostly largemouth bass, crappie or bluegill. This is an older (retired-age) population that prefers to listen to country or oldies/classic rock on the radio and receive information by mail or email. Respondents also indicated that they found the Florida Fish & Wildlife Commission (FWC) to be a “very trustworthy” source, along with the University of Florida IFAS Center for Aquatic & Invasive Plants. It is possible that because these organizations were associated with the survey, it presented some bias in the question. However, it does suggest that these organizations would be logical entities to design and implement an AIS educational campaign for boaters. Also, it should be noted that respondents also regarded friends and family with a high degree of trust, with 67% (n=718) rating them as very or somewhat trustworthy. This supports the notion of incorporating a strong social, normative component to an AIS prevention campaign.

**Species and Management Awareness**

Awareness of specific invasive species varied widely among boaters and anglers. High or moderate awareness was greatest for hydrilla, water hyacinth, and water lettuce, which are widespread in Florida. Awareness of other species listed was much lower, particularly that of quagga and zebra mussels, which was found to be the species of highest awareness in Jensen’s
(2010) five-state comparison. Quagga and zebra mussels has served as an AIS “poster child” in the Great Lakes Region, and more recently the northwest, though there are also national campaigns focused on them as well, such as the *Stop Aquatic Hitchhikers* campaign. Florida, and likely the entire southeast region, which was not evaluated in Jensen’s (2010) five-state comparison, has much lower levels of awareness about mussels. This could be attributed to a low perception of risk on the part of managers. However, as suggested elsewhere, mussels do present a risk to Florida, and are currently found in parts of Louisiana, Mississippi, and Alabama. Jensen (2010) found that public awareness was highest for species that had been made a priority and promoted in boater outreach efforts for extended periods of time, suggesting that AIS awareness of Florida boaters and non-resident anglers could increase greatly if all species of concern were made more of a priority. Also, Jensen (2010) recommended that states with hydrilla or other aquatic plant infestations focus on making boater outreach a priority, since these plants are known to be carriers of other AIS.

Boaters and anglers reported that they knew more about chemical and mechanical control method than physical and biological control methods. This data likely reflects the prevalence and observable nature of these practices (AIS treatment by chemical and mechanical means). If management agencies would like boaters and anglers (and other stakeholders) to be more aware of management efforts and tools, this could be incorporated into an AIS educational campaign along with preventive measures. However, since attitudes about these control methods (chemical control in particular) varied from strong opposition to support, a campaign focusing on management would have to be carefully designed and tested before implementation in order to be successful.
Sources of AIS information. Most respondents who boated on AIS-infested waters knew that AIS were present because they could identify the species and personally observed them. Although a relatively high amount of respondents reported that they had seen a sign at the boat launch, most had not, indicating that this may be a valuable missed educational opportunity where signs are not present. This data suggests that ensuring all public waterways have signs notifying users of AIS presence and specifying preventive BMPs would be an important part of an educational campaign.

“Friends and family” were also listed as fairly common reason that boaters/anglers knew a waterbody was infested with AIS, which points to a strong normative association for this issue among boaters, similar to the results of the five-state comparison of boaters and manatee conservation study (Jensen, 2010; Aipanjiguly et al., 2003). As suggested in the TBP, an individual’s perceived social pressure by people who matter to them is referred to as a “social norm” which will influence whether or not the individual decides to engage in the behavior or not.

Knowledge of where boaters/anglers receive information can assist management agencies by recognizing the most likely effective allocation of resources for specific mediums. Magazines and newsletters, signs at boat launches, newspapers, and fishing regulations were reported to be the most prevalent sources of information for AIS coverage among respondents. An additional 27% of respondents indicated that they had received information about AIS in boat registration materials. Management agencies in Florida have included very limited information about AIS in fishing regulations, but not to boat owners with registration materials (Bob Wattendorf, personal communication May 10, 2012). For those who reside or hunt/fish outside of the state, it is possible that they have received AIS materials with hunting regulations or boat registration
materials, but not much for those who reside inside of Florida. Since all registered boaters receive registration materials and all anglers receive fishing regulations, the data suggests that these would be effective and inexpensive sources to disseminate AIS information and messages in an educational campaign.

**Boater and Angler Attitudes towards AIS Issues, Spread and Management**

Attitudes are an important mediating factor relating to an individual’s intention in the TPB and the REB. A vast majority of respondents indicated that AIS were a “very serious” or “somewhat serious” problem, which seems to reflect an outlook supportive of prevention and conservation. Many of the comments made in the open-ended questions also alluded to boaters and anglers being responsible, conscientious, and caring about the resource. Most respondents indicated that they “strongly agreed” or “agreed” that AIS pose threats to the environment, regional and local economies, native fish and wildlife, and could take over Florida waterways if unmanaged. Most boaters and anglers also “strongly agreed” or “agreed” that there are steps they can take to prevent the spread, alluding to their level of self-efficacy. However, this finding was followed by a relatively large amount of respondents reporting that they “did not know” any specific steps they could take. This indicates a gap between caring about an issue or thinking it’s important, but not understanding what can be done to address the issue. This presents an opportunity for education on not only the AIS issue and associated impacts, but also for providing clear action strategies that empower boaters and anglers to better protect the resources that they enjoy.

The number of respondents who had personally experienced issues or problems with AIS was similar to those who indicated they had not experienced problems. In the open-ended questions, many respondents provided anecdotal information about their personal experiences and attitudes.
Many personal experiences seem to dictate or play a role in attitudes about AIS as an issue or some aspect of it such as control. Anglers indicated that native emergent plants and other underwater structure were more desirable fishing habitat than invasive submersed hydrilla or floating plants. This suggests that while some anglers may prefer more vegetation in general, they do care if it is invasive. Over half of the respondents indicated that 11-40 percent plant coverage of a lake was most desirable, which may help inform plant management goals. The survey respondents reported a strong preference for mechanical and physical control compared to chemical and biological control. This is significant since respondents also indicated that they had more knowledge of chemical and mechanical control. This finding suggests, probably to no surprise to those who manage AIS, that stakeholders (such as boaters and anglers) have reservations about chemical and biological control. In the open-ended comments, many respondents reported concern, fear, or disapproval of chemical methods and alluded to negative impacts to fish, wildlife, and native plants, as well as appropriate training of applicators. Comments made about biological control all emphasized the danger in releasing another exotic species to deal with an invasive one. Because there was a substantial majority of boaters and anglers who viewed AIS as a serious issue and demonstrated strong support for taking action on this issue, it is significant that so many made negative comments or indicated discomfort with chemical control, which is the most commonly used form of control in Florida and many other states.

**Motivators and sources of influence.** Florida freshwater boaters and anglers indicated that signs at boat launches, AIS educational materials in boat registration mailings and fishing regulations, and incorporating AIS prevention into boater training courses (for new boaters) would be the best methods of helping them prevent the spread. This question gets at the heart of
the responsibility issue. If boaters and anglers do not think that they have a responsibility to help curb the secondary spread of invasives, they are not likely to take action. However, only 3.5% of respondents (n=1107) indicated that they did not think boaters and anglers were responsible, which suggests that a strong majority do believe that they play a pivotal role in prevention. The subsequent question asking about consequences for violators was nearly equal for three solutions: boater training, no consequences, and fines. This suggests that there is a dichotomy between those who think the issue needs to be handled by education alone or education coupled with regulations.

A third of respondents indicated that they already took preventive steps (e.g. adopted BMPs) out of a “sense of personal responsibility,” which is directly correlated to personality factors in the REB. This was closely matched by those who reported that they took action out of a “desire to keep AIS out of lakes and rivers,” and a “desire to prevent damage to equipment.” Though seemingly opposite, these latter two motivators are related to the AIS issue. Most of the BMPs recommended for AIS prevention go “hand-in-hand,” as one respondent eloquently wrote, with thorough maintenance of boats and equipment. Though the motivation may be different than wanting to protect the resource, the two should not be mutually exclusive. These concepts could be carefully crafted into an educational campaign incorporating a “two birds with one stone” kind of message.

Similarly, respondents were asked what motivators or sources would be “most effective” for getting them to take action. Signs at boat launches, educational materials (brochures, species ID, fact sheets, etc.), and educational materials in boat registration and fishing regulations were reported as the perceived most effective means of increasing boater action.
Boater and Angler AIS-Related Behavior

Three-quarters of respondents (75%, n=699) indicated that they frequent multiple waterbodies, which presents a high risk of the secondary spread of AIS, especially given the number of waterbodies in Florida infested with invasive species. Many of these respondents are coming from geographic locations which present a significant risk to Florida’s freshwater resources. High risk areas include eastern Canada and the Great Lakes region, among others.

Several factors play a role in assessing the level of risk of spreading AIS. Generally speaking, they include the length of time the boat was in the water, the length of time the boat was out of the water, and the frequency and distance of moves. The longer a boat is in the water, the higher the chance that it will be carrying plant fragments, hull-fouling species, or other organisms either on the boat or equipment or in standing water. Most respondents had their boat in the water for one day or less. Boats that are out of the water for more than five days after being in a waterbody present a lower risk (due to the drying effect). However, in damp or humid climates, some species may still be viable after five days. Most boaters surveyed indicated that are out of the water 5-14 days, which was closely followed by those who regularly kept their boat(s) out the water for even longer periods of time.

Nearly a quarter of respondents indicated that they move their boat outside of the state in which it is registered, and 14% traveled to compete in fishing derbies. In this case, boaters listed 30 states and two Canadian provinces that they had traveled with their boats in the past year. As it only takes one boat to introduce a new species, assessing risk of boaters by evaluating travel patterns, while useful, does not provide a silver bullet solution to prevention.

Different types of watercraft pose different kinds of risk in terms of spreading AIS. For example, those with large powerboats and sailboats are not as likely to move 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 it to be colonized by hull-fouling species such as *Dreissenid* mussels. Therefore, these kinds of watercraft still pose a high risk if moved to another waterbody, even if they don’t move as frequently as smaller watercraft. Small watercraft (20’ and less) 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 (Jensen, 2010). Much like risk assessments, vessel size can be helpful in identifying higher risk pathways, but all traveling vessels pose a risk.

Most respondents reported that they take steps to prevent AIS. The primary reason provided by those who did not was that they “did not know exactly what to do.” In order to adopt AIS preventive BMPs, boaters must be empowered with knowledge of action strategies in order to take any kind of action. This is a gap where education can play a major role. The easier and more common boater practices were reported by the majority of respondents (draining water, removing plants/animals, visual inspection), but other suggested BMPs were not adopted or practiced as often. While these other BMPs may be more time consuming, only a couple of them involve any kind of specialized equipment (flush cooling system, wash with hot/high pressure water), which suggests that boaters could easily adopt more BMPs if they knew what to do. Regardless if they took action in the past, the majority of respondents indicated that they “very likely” or “somewhat likely” to take future action, which indicates a strong intention to act.

Respondents were also asked if they would be willing to pay more for a license or registration if the money went to specific AIS-related services, which can reflect an individual’s commitment or behavioral intention. Freshwater boaters and anglers were more willing to pay more if the funds went towards management and control or boat cleaning stations, suggesting that a multifaceted management approach would be supported by these stakeholders.
Predicting Boater and Angler Responsible Environmental Behavior

Predictive variables tested in the modified REB model included personality factors (attitudes, self-efficacy, and personal responsibility), knowledge of issue, knowledge of action strategies, subjective norms, situational factors (equipment available, presence or lack of laws/fines/regulations), and intention to act. It is important to note that these variables measured respondent’s levels of each variable specifically relating to whether or not they took action (adopted AIS BMPs). Of these, intention was found to be the strongest predictor of responsible environmental behavior (adoption of BMPs), as the model predicted. As Hines et al., (1986/87) assert, those individuals who make a verbal commitment or “an expressed intention to act in a certain manner,” are much more likely to engage in responsible environmental behavior (p.5). Although the authors use the term “verbal commitment,” they measured all cases by the use of a written instrument, as was the case in this study. Intention was a mediating variable for both attitudes and knowledge of action strategies occurring between the predictors and the outcome (responsible environmental behavior).

Intention was followed by norms and knowledge of action strategies. Norms were added to the modified REB, making a hybrid between the TPB and the REB, and turned out to be a strong predictor of behavior surpassed only by intention. The power of norms in influencing intentions (and thus adoption of AIS BMPs) is one of the most significant findings in this research. It suggests that boaters and anglers are more likely to take action if they perceive that it is a subjective norm (e.g. others they know take action). The greater the perceived social pressure to adopt and regularly practice AIS BMPs, the higher the likelihood that boaters will engage in preventive behaviors. As Ajzen (2002) asserts, these social norms are heavily influenced by the judgment and opinions of significant others in their life, such as spouses, friends, family, members of an organization, or those held in high regard. If the AIS preventive BMPs are
adopted by opinion leaders and members of specific groups with whom an individual aligns himself, it is expected that the individual will also adopt that specific behavior (Ajzen, 2002).

Only one of these predictive variables lends itself directly to educational solution—knowledge of action strategies. This represents an important variable in whether or not individuals take action that can actually be addressed through education (knowledge of what action is required to help prevent the problem). The other predictors, however, are more complex and require a carefully developed communication campaign that emphasizes BMP adoption as a norm in boater/angler culture.

Attitudes (about AIS as a serious issue) had a strong relationship with intention, but less directly with behavior, as Hines et al. (1986/87) similarly reported. Attitudes that are supportive of taking action to prevent the spread of AIS or favor doing something about the AIS issue appear to play a role in individual action via intentions (and other factors).

The remaining variables turned out to be poor predictors of behavior. Whether or not there was equipment available (presumably at launches) turned out to have very little bearing on whether or not boaters were likely to take action. This was also found with willingness-to-pay measures. Whether or not boaters and anglers were willing to pay for signs at launches, other outreach, boat cleaning stations, or control of AIS did not play a role in determining if they took action or not. Self-efficacy also did not have a strong, net relationship with behavior. This data suggests that providing AIS-related information alone (knowledge of issues), a traditional approach to public good and environmental problems, may not be successful in increasing boater adoption of AIS BMPs either, since knowledge did not have a strong relationship with responsible environmental behavior.
Although boaters and anglers need to know about the issue in order to care about it, the model suggests that knowledge of action strategies, a supportive attitude, and the intention to act are very important. This will require a multifaceted approach that emphasizes and incorporates influencing attitudes, providing clear information about action strategies and changing the culture to incorporate this behavior as a social norm.

**Limitations of Study**

Every study, no matter how well it is conducted, is going to have some limitations. Limitations can include any parts of the population that were excluded, the generalizability of the study to the entire population, etc. In this study, limitations included:

- The data request to FWC for non-resident freshwater anglers included only those anglers with a current fishing license. This means that those who had purchased a short term license (three or seven day options) before the data request was granted are not represented in the population. Also, those who purchased a long-term freshwater license after the date the request was granted are also not represented in the population. This could have resulted in a coverage error for non-resident freshwater anglers.

- Approximately 300 anglers were removed from the sample after the first mailing. The advance letter sent to these anglers was returned with a postal sticker saying “return to sender: temporarily away.” Since there were cash incentives involved, and we did not know what would happen to the mail of those “temporarily away” anglers, they were removed. In hindsight, the issue was a) a population with a high proportion of people who leave their primary residence in the winter, b) a stamp on the envelopes “please return to sender” that caused the mail not to be forwarded to the temporary address, and c) a larger percentage of these long-term license holders due to limitations in the FWC database request. This also could have led to some degree of coverage error.

- Boats over 20 feet were excluded in order to minimize sending surveys to saltwater-only registered Florida boaters since this research was specific to freshwater aquatic invasive species. Provided the unique nature of Florida’s water resources (an abundance of freshwater lakes, rivers, and streams as well as brackish water and saltwater), there are a plethora of both freshwater and saltwater boaters. One way to target freshwater boaters was to remove the larger vessels from the population of boaters, assuming that larger boats are used only in saltwater. This could remove some larger boats that are used in freshwater (such as larger bass boats, pontoon boats and houseboats). Consultation with FWC personnel and boat dealerships indicates that freshwater boats are sold up to 20 feet. It was deemed necessary to target freshwater boaters and anglers (instead of the entire state population of boaters) which may contribute to some coverage error since there are no doubt some freshwater boats over 20 feet in length.
• Vessels exempt from registration are not included in the population since there is no access to that information. These vessels include: non-motor powered vessel less than 16 feet in length, and any non-powered canoe, kayak, racing shell, or rowing scull, regardless of length; vessels used exclusively on private lakes and ponds; vessels owned by the United States Government; vessels used exclusively as a ship’s lifeboat; and vessels covered by numbers in full force and effect which have been awarded pursuant to federal law or a federally approved numbering system provided that such vessels are not operated in state waters in excess of 90 consecutive days (Florida Department of Highway Safety & Motor Vehicles, 2010). Users of non-motorized boats such as kayaks and canoes are a population that can be greatly impacted by aquatic invasive species, but there is no way in which to obtain contact information for this population since there are vessels not registered.

• This research was based on an existing survey instrument. Therefore, little effort was made to develop questions specifically measuring Responsible Environmental Behavior variables, and as such, pose limitations in what could be measured. For example, there were no suitable questions analyzed that assessed whether or not skill associated with action strategies was a significant predictor variable. While some variables had strong measures (e.g. multiple items or questions) relating to AIS BMPs, others did not and single items or questions were used.

• Descriptive survey methods do have weaknesses. A large number of the selected sample must reply in order to be representative. It may be difficult for participants to recall information and survey research is difficult in addressing context (Colorado State University, 2010). Particularly, questions that require participants to recall dates of frequencies are expected to have a lower response rate, which was also found to be true in this survey.

• Adult learners, including boaters and anglers, generally reflect on and relate to issues to which they have been exposed or experienced directly. If individuals in the sample did not have exposure or personal experience with AIS issues, the survey questions may have been difficult to answer.

• Boater survey results only represent awareness, knowledge, attitudes, values, motivations, and behaviors for the Florida boating population and non-resident freshwater anglers surveyed during the study period (2011-2012).

Assumptions of Study

Assumptions are those things that can be taken for granted in research, usually in the case of statements made about certain elements of the research that are believed to be true. In this case, there were assumptions made about the sample population. These included:

• The registered boat owner or angler who purchased non-resident freshwater fishing license in Florida was the person to actually complete the survey.
Each individual in the population had a registered boat or has purchased a non-resident freshwater fishing license in the past year per the FDMVHS and the FWC’ records.

AIS issues will be relevant and matter to boaters and anglers once they are aware, see the significance, and understand what they can do to help.

People are rational beings and make choices based on a sound decision-making process based on available information, values, attitudes and past experiences.

**Recommendations for Increasing Responsible Environmental Behavior**

The data collected for this study provide support and implications for action on the part of AIS management agencies and advocacy groups. Most recommendations focus on developing a salient and well-targeted educational campaign, utilizing the most effective communication outlets, emphasizing cultural and social norms, and considering the placement of boat cleaning stations and inspection stations. While these recommendations are specific to this research on Florida boaters and anglers, they also may hold promise for other environmental issues that rely on human behavior.

**Develop a Well-Targeted Educational Campaign**

Boaters and anglers responding to this baseline assessment indicated that they care about the issue and support action to prevent the secondary spread of AIS. The most important predictors of whether or not boaters and anglers adopt preventive BMPs were intention, social norms, knowledge of action strategies, and attitudes. This suggests that an AIS educational campaign must move beyond traditional information dissemination to focus on the factors that really matter to this population to have the best chance of successfully increasing stakeholder adoption of BMPs. It is recommended that strategies and guidelines suggested in social marketing and Community-Based Social Marketing theory are adopted to take advantage of these factors.
The idea of using marketing strategies for social issues emerged in the 1950s and has gained traction over the years. Social marketing is the use of marketing logic for non-business purposes. Social marketing is defined by Kotler & Zaltman (1971, p.5) as the “design, implementation, and control of programs calculated to influence the acceptability of social ideas and involving considerations of product planning, pricing, communication, distribution, and marketing research.”

Though there are fundamental differences between products and social causes, through marketing a commonality is found: both are based on an exchange relationship (Kotler & Zaltman, 1971). In the case of social issues, money/services are not exchanged, but an exchange relationship between “client” and “exchange agent” very much exists (Kotler & Zaltman, 1971, p.4). Examples of social causes utilizing social marketing principles include Smokey Bear, the “Keep America Beautiful” campaign, and “Join the Peace Corps.”

Wiebe (1951-52) suggests that there five factors that determine whether or not a social marketing campaign will be effective. Successful campaigns must possess 1) force (intensity of an individual’s motivation toward the goal/behavior which is a combination of predisposition and stimulation of the message), 2) direction (knowledge of how an individual might follow through on message), 3) mechanism (a person must be enabled to act which may include providing resources or materials), 4) adequacy and compatibility (of the agency/message), and 5) distance (the individual’s estimate of the cost and effort required to carry out the desired behavior).

Traditional marketing practices focus on the “4 P’s” of product, promotion, place, and price. Social marketing also should consider these concepts in promoting social causes (McCarthy, 1968). Kotler & Zaltman (1971) stress the importance of agencies developing
campaigns based on social marketing principles instead of more superficial social advertising principles. Successful social marketing requires research on the target audience and “product” perceptions, a well-developed campaign that uses appropriate communication channels and influential groups to spread the message (Kotler & Zaltman, 1971). Without knowing up front where the audience gets information (channels) and who they listen to (influential groups), the message could be lost entirely.

Community-Based Social Marketing (CBSM) has emerged more recently and advocates a multifaceted approach to environmental issues that starts with behavior and works backward to select tactics most suitable for promoting that behavior. This approach acknowledges that while knowledge and attitudes may be part of the solution, their relationship to actual behavior is commonly quite weak. Changing behavior is difficult. For this reason, traditional marketing strategies will likely fall short since they involve altering existing behavior (e.g. preference of one brand over another) not actually changing behavior. CBSM advocates a pragmatic approach to environmental issues that involves: identifying barriers and benefits to behavior, designing a strategy that utilizes behavior change tools (e.g. gaining commitment, building cultural norms, addressing barriers, emphasizing benefits), piloting the strategy, and evaluating the impact (McKenzie-Mohr, 2008). This research provides the first step in the CBSM process—identifying barriers and benefits of adopting AIS BMPs.

It is recommended that an AIS educational campaign be developed that utilizes CBSM strategies. These strategies include: identifying barriers and emphasizing benefits of the desired behavior; building commitment, intention and social norms among the target audience; developing a campaign based on research of the stakeholders; piloting and testing the campaign; making changes as necessary; and utilizing communication outlets most effective to reach the
boaters and anglers. In addition, campaigns should be evaluated regularly to ensure the campaign is continuing to reach and impact the target audience.

Test before Launch

Also, it is recommended that an educational campaign be tested before dissemination by using focus groups or other qualitative analysis methods to ensure messages and materials are salient, appropriate, and possess enough “stickiness” to be remembered by members of the target audience. An educational campaign should be consistent with its messages. As part of a campaign, it is important to develop a logo, name, and possibly even a tag line. For example the Stop Aquatic Hitchhikers campaign always uses the same logo for educational materials and the Texas Plant and Pest Council’s (2011) invasive species educational campaign adopted a consistent and recognizable message that features a “hello, goodbye” message on Public Service Announcements (PSAs) and printed materials. Although this requires a bit more cost up front, ensuring a pertinent message in a campaign is usually found to be well worth the investment.

Social Norms Pack a Punch

It is important that the social norms be a component of each part of the AIS prevention campaign, given its power in predicting whether an individual will take action or not. Emphasizing an “everyone is doing it” theme towards AIS holds great promise for increasing adoption of the desired behaviors. The social aspect can be emphasized in the campaign by featuring photos and broadcast media pieces that reflect the boater/angler group as conservationists who work together to protect the resources they depend upon. Ajzen (2002) recommends utilizing opinion leaders and influential groups to help spread the message. In this case it could be boating and angler groups and FWC conservation officers who frequently demonstrate the desired behaviors, which could become a very observable norm for boaters and
anglers. Additionally, strategically-placed boat cleaning and inspection stations could provide impetus for greater awareness and prevention of AIS spread.

Increasing boater and angler adoption of responsible environmental behavior in regard to AIS will likely require a change in culture, or the way things are done in a specific organization or group (Burke, 2008). These are the “human forces that either facilitate or prevent transformation” and concerns deeply held beliefs, attitudes, and values (Duck, 2001; Burke, 2008). Burke (2008) advocates focusing on the desired behaviors to gradually change the attitudes and values of the culture over time.

**Boat Cleaning/Inspection Stations Provide Equipment and Social Norms**

Respondents indicated the desire to clean their boats and help maintain their investment. Many were even willing to pay more for a license if they money went towards these services. Although there were concerns about congestion and overcrowding at launches, there was also a fair amount of interest in the idea. Many states have adopted prevention programs that provide facilities on highways to intercept those who travel with their boats. This avoids the congestion at boat ramps, targets those engaging in the most risky behavior, and is less costly than putting equipment and inspectors at launches. However, inspection stations on highways do not offer the same kind of demonstrated social norm that cleaning stations at public boat ramps do. They are harder for the public to see and understand and can involve a regulatory approach, which can undermine choice and cultural norms. One approach might be to provide equipment at busy launches on a trial basis to see if they are utilized and if they contribute to an increase in a cultural norm to take preventive steps after leaving a waterbody to prevent the spread of AIS.

**Carrot First, Stick Later**

While many respondents advocated for an education-only or education-first approach to solving this issue, there are others who believe that regulations also have a role to play. It may be
necessary to implement an educational program first to better inform boaters and anglers about the issue and the preventive action strategies, but in time it may also be necessary to follow or supplement an educational campaign with regulations on transporting invasive species or stopping for mandatory boat inspections. When asked about what would be most effective at getting boaters and anglers to take action, at least half of respondents thought that laws and regulations, enforcement checks, and fines for violators would be effective, suggesting a significant level of support. CBSM guidelines, while they do not emphasize regulations, recognize that they can be successful (auto emissions or seat belts for example). This theory asserts that our ability to regulate is “contingent upon people’s willingness to be regulated” (McKenzie-Mohr, 2008, p.8). As demonstrated here, though not a consensus, many boaters and anglers supported some kind of regulation. The most common form of regulation mentioned in comments was mandatory boat inspections to prevent transport of AIS.

Control Methods are Contentious

While boaters and anglers indicated that they believed AIS to pose “very serious” or “somewhat serious” threats to the environment, economies, and native fish and wildlife, they also demonstrated apprehension or opposition to both chemical and biological control methods. It is possible that this stems from a general lack of exposure to AIS control methods, but respondents indicated that they had the most information about chemical and mechanical control and still preferred mechanical and physical control. If management agencies want to increase public awareness or support for specific control methods, it will be necessary to address the concerns that accompany them. While control is definitely related to prevention, they are also very different. It may be possible to build an educational campaign that encompasses both prevention and control at some point, but caution is advised. If the two concepts were combined into one campaign, it also runs the risk of negatively influencing those who have strong feelings
about control methods but are supportive of preventive measures. If the management agencies are interested in pursuing a campaign with both messages, it may be necessary to start with prevention and add management strategies at a later point.

**Signs at Boat Launches as Reminders**

Information posted at launches where boaters can immediately take action might be effective “prompts” or reminders of action strategies per CBSM guidelines. Informational signs at boat launches was one of the most frequently cited recommendation in the open-ended comment question at the end of the survey as well as numerous other survey questions. Many respondents requested signs posted at launches that feature pictures (for species identification), have current information about the specific AIS issue, and most importantly, provide an explanation of action strategies to prevent the spread. This is an important venue for prompts reminding boaters and anglers about the issue and action strategies since it targets them while they are engaging in the potentially harmful behavior (e.g. not taking action).

**Send AIS Information via Boat Registration and Fishing Regulations**

Since these methods target boaters and anglers specifically, including more information about AIS with boat registration and fishing regulation materials is strongly recommended. Boaters and anglers sampled demonstrated strong support for this tactic and some even wondered why it was not commonly practiced already. In fact, the lack of language about specific action strategies and AIS-related issues in these materials has the danger of sending a message that it is not that important. Since it is guaranteed that the target audience will receive this information, this would also be a good communication method in which to provide AIS prevention materials.
Traditional Media Outlets

This population reported that traditional media sources are an effective means of providing information about AIS. Due to the power of social norms demonstrated in this research, it is recommended that AIS-related information be published in boating and fishing organization’s newsletters and magazines since this can also provide a social pressure among the group. This social pressure has the power to influence all variables found to be important to behavior, including intention, building of norms, knowledge of action strategies, and attitudes about AIS.

Internet Isn’t Overly Popular with this Crowd

Given the popularity of the internet and social media, these sources are especially interesting to scientists and management agencies. However, these were minor sources of information for Florida boaters and non-resident anglers. Social media in particular was very low. Many respondents indicated that the internet (particularly social media) was not a preferred mode of communication. However, among younger boaters, social media should not be completely discounted. If this communication outlet is utilized, it is recommended it be paired with something like AIS preventive strategy training at boater safety courses intended for new or young boaters. Social media and apps could be advertised or adoption encouraged at these courses. Also, the FWC website, at the very least, should include more detailed information about the issue and advocate specific preventive action strategies. Currently, most of the information on the site related to AIS is on control methods and is not located in the boating section of the website. Although this population did not choose the internet or websites as “very effective,” it is a useful tool for searching for more information once curiosity is piqued or awareness is raised and stakeholders desire more information.
They are listening; Utilize Broadcast Media

In terms of targeting these boaters and anglers, radio seemed to be relatively popular among the population, while not many of them indicated that something they heard on the radio had motivated them to take action, a strong majority thought that it would be a “very effective” way to get AIS information out. These Florida boaters and anglers are most likely to listen to country and oldies/classic rock stations. In addition, television and videos were recommended by stakeholders as a “very effective” tool for disseminating AIS information. Several respondents brought up reality TV shows and Animal Planet-type shows for communication modes conducive to providing information about AIS issues and control methods (think Burmese python hunting). Also, with the increasing popularity of YouTube, it is recommended that AIS-related videos be created and frequently posted. For example, the Texas Parks and Wildlife have partnered with other agencies and advocacy organizations to create a popular invasive species educational campaign. This clever “hello, goodbye” campaign features TV and radio spots that target anglers and boaters specifically and can be adapted for specific species as well as other educational materials such as posters, fliers and brochures (Texas Parks & Wildlife, 2010; Texas Invasive Plant & Pest Council, 2011).

Recommendations for Further Inquiry

While prevention of new invasions is the most desirable management action, it is still critical to limit the further spread of invasive species once they have been introduced. Any efforts that slow the spread are helpful in providing time to assess impacts and develop control strategies (Johnson et al., 2001).

Knowledge of what aspects of the programs work and which can be enhanced is crucial in a time of government deficits and reduced public spending. States working on policy and management changes to create AIS preventive programs will also benefit from the knowledge
gained by determining the most cost effective educational programs that create behavioral changes and lend to the adoption of boating practices that curb the spread of AIS. This information would have broad application for many agencies and organizations worldwide.

The entire discipline would benefit from further research on assessing stakeholder awareness, attitudes and behavior while evaluating existing invasive species educational programs. A comparison of existing invasive species educational campaigns across states, regions, or even countries would be valuable. Also, the focus of this research is on stakeholders and vectors (e.g. boaters and anglers), but what is often overlooked is the role of managers in this issue. Whether or not managers adhere to the precautionary principle and value prevention over reaction is a major factor in whether or not successful educational campaigns are implemented. Finally, research addressing solutions to the introduction issue would be beneficial. Perrings (2001) makes a case for a solution based on economics, but very little research exists in this particular area.

Assessments and Comparisons of AIS Education/Prevention Campaigns

The AIS field would benefit from more baseline assessments of current boater and angler awareness, attitudes and behaviors in order to best target them for preventive action. For state’s that already have educational campaigns, they would benefit from regular evaluations to ensure that the message is still accomplishing its goals. These assessments and evaluations could maximize resources by focusing on communication methods and outlets that work best to target boaters and anglers. Currently, there is very little data supporting the most effective means of targeting stakeholders and increasing participation and BMP adoption.

There is currently no study with the exception of Jensen’s (2010) five-state assessment of boater awareness that provides a comparison of different invasive species educational campaigns. Research that explicitly compares and contrasts different current educational
campaigns would provide valuable information to those with an interest in developing or improving prevention programs. This would also be the best utilization of resources—to know what works best.

**Importance of Prevention in Management**

Ecologists generally differentiate between two types of managerial interventions in regard to invasive species: prevention and control (Finoff, Shogren, Leung & Lodge, 2007). Preventive measures are those that seek to obstruct the arrival of a nuisance species to non-infested ecosystems. Control measures are aimed at curbing population growth or reducing the population of an invasive species after it has already arrived (Davis & Moeltner, 2010). Currently, there are a handful of theoretical economic contributions that address how scarce agency resources should be divided between these two strategies (Leung et al., 2002, Finoff et al., 2007).

Finoff et al. (2007) demonstrates how increased aversion to risk by managers can lead to less prevention and more control, particularly in the case of *Dreissenid* mussels, “which increases the probability of invasions and realized abundance of invaders, which lowers overall social welfare in comparison to a less risk averse decision maker” (p.217). This counterintuitive data is the result of risk-averse managers valuing a dollar spent on control (with assured benefits now) more highly than a dollar spent on prevention (with uncertain benefits). Preventive tactics are more uncertain because managers do not know if she/he really kept the species out or whether it simply would never have arrived or may die out on its own. The opportunity costs of investments in prevention drive the manager to lean toward control at the expense of prevention (Finoff et al., 2007). This demonstrates that the higher the aversion to risk, the less prevention is emphasized. Applying excessive caution in management strategies in this case is counterproductive when it leads to more control rather than preventive attitudes and measures.
Finnoff et al. (2007) found that there are social consequences of this choice that lead to a greater probability of future invasions by AIS and associated lower social welfare.

Though it is commonly argued that environmental and health issues caused by pollution would be reduced more cost effectively by greater investments in prevention, the bulk of private and public resources are invested primarily for control (Finnoff et al., 2007). This is especially true for the spread of AIS, a biological form of pollution (U.S. General Accounting Office, 2002). Concepts such as the precautionary principle (Sandin, 1999; Foster, Vecchia & Repacholi, 2000) suggest that a cautious manager would use more preventive techniques relative to control strategies because prevention would keep more invaders out over time. But this is not the case. Instead, it is more common for managers to wait until the invaders have arrived before scrambling to limit damages to communities, natural resources, and native species (Leung et al., 2002).

**Sources of Introductions**

Perrings (2001) maintains that invasive species introductions, an anthropogenic environmental change, are a consequence of economic activity. Invasive species invasions impose real costs on society, and as such, a precautionary approach that involves an economic solution is necessary to curb future introductions of non-native species. Since the control of invasive species is dependent on human behavior, a key element in control, according to Perrings (2001), must be the regulation of human behavior. Perrings recommends utilizing penalties for violators as well as incentives promoting the desired behaviors. Environmental assurance bonds on the part of those who import non-native species would be an example. Importers of new species (considered to be undertaking high risk) would be required to post a bond equal to the estimated damage if the species was to become established and cause problems (Perrings, 2001).
Very little research exists on these concepts of better regulating sources of AIS introductions through policy. For this reason, the AIS field would benefit from further research in this area.

**Recommendations for Theory**

The REB theory proved to be a valuable model in this particular issue. It would be interesting to test the REB in other social and/or environmental issues to assess whether variables that did not turn out to be good predictors in this case would be when other types of environmental behavior are being assessed. There may be translatability to other environmental behaviors that are as observable and visible as AIS prevention. Certain kinds of environmental behavior that have no social consequences (e.g. not as public, others don’t see individuals taking action) may have considerable different outcomes regarding REB variables.

Particularly in regard to norms, since AIS preventive behavior is very visible, norms seem to be very powerful, but other less visible environmental behaviors such as composting organic waste or properly disposing of hazardous household wastes might logically not be so dependent upon social norms.

One concept that is not directly incorporated into the REB but could play a significant role in whether or not individuals decide to take action or adopt behavior are perceptions of risk. In this case, the perception of risk may relate to natural resources (e.g. protecting balanced ecosystems, preventing catastrophic changes, providing productive resources for future generations, etc.) or personal property (e.g. preventing damage to boats and equipment or decreases in shoreline property). Following the TPB, it is reasonable to assume that risk perceptions would influence attitudes, so perhaps that is where it would fit within the REB. Further study on whether or not perceptions of risk are a significant factor in whether or not boaters and anglers take AIS preventive action would be beneficial and could build upon existing behavioral theory.
Additionally, social marketing and CBSM as research tools have not been fully utilized or assessed in the development of an AIS campaign. Research on the effectiveness of social marketing techniques, particularly through a pre/post evaluation, would be highly valuable in the development of theory into practice.
APPENDIX B
INSTITUTIONAL REVIEW BOARD DOCUMENTATION

UF
Institutional Review Board
UNIVERSITY of FLORIDA

PO Box 112250
Gainesville, FL 32611-2250
352-392-0433 (Phone)
352-392-9234 (Fax)
irb2@ufl.edu

DATE: October 20, 2011
TO: William T. Haller, PhD
PO Box 110610
Campus

FROM: Ira S. Fischler, PhD, Chair
University of Florida
Institutional Review Board 02

SUBJECT: Approval of Protocol #2011-U-0965

TITLE: Boater and Anglers Views of Aquatic Invasive Species – A Survey

SPONSOR: Florida Fish & Wildlife Conservation Commission (FWC)

I am pleased to advise you that the University of Florida Institutional Review Board has recommended approval of this protocol. Based on its review, the UFIRB determined that this research presents no more than minimal risk to participants, and based on 45 CFR 46.117(c). An IRB may waive the requirement for the investigator to obtain a signed consent form for some or all subjects if it finds either: (1) That the only record linking the subject and the research would be the consent document and the principal risk would be potential harm resulting from a breach of confidentiality. Each subject will be asked whether the subject wants documentation linking the subject with the research, and the subject’s wishes will govern; or (2) That the research presents no more than minimal risk of harm to subjects and involves no procedures for which written consent is normally required outside of the research context.

The IRB authorizes you to administer the informed consent process as specified in the protocol. If you wish to make any changes to this protocol, including the need to increase the number of participants authorized, you must disclose your plans before you implement them so that the Board can assess their impact on your protocol. In addition, you must report to the Board any unexpected complications that affect your participants.

This approval is valid through September 22, 2012. If you have not completed the study by this date, please telephone our office (392-0433), and we will discuss the renewal process with you. It is important that you keep your Department Chair informed about the status of this research protocol.

ISF:dj
# UFIRB 02 – Social & Behavioral Research

## Protocol Submission Form

**Title of Protocol:** Boater and Anglers Views of Aquatic Invasive Species—a survey

<table>
<thead>
<tr>
<th>Principal Investigator:</th>
<th>Dr. William T. Haller</th>
<th>UFID #: 3957-4290</th>
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<tbody>
<tr>
<td>Degree / Title:</td>
<td>Director, UF/IFAS Center for Aquatic &amp; Invasive Plants</td>
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<td>Mailing Address: (if on campus include PO Box address):</td>
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<td>Email:</td>
<td><a href="mailto:whaller@ufl.edu">whaller@ufl.edu</a></td>
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<tr>
<td>Department:</td>
<td>UF/IFAS Agronomy–Center for Aquatic &amp; Invasive Plants</td>
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<tr>
<td>P.O. Box 110810</td>
<td>Gainesville, FL 32611</td>
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<tr>
<td>Telephone #:</td>
<td>(352) 392-9615</td>
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<tr>
<td>Co-Investigator(s):</td>
<td>Kathryn L. Wilson</td>
<td>UFID#: 6412-4639</td>
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<tr>
<td>Email:</td>
<td><a href="mailto:kathrynlwilson@ufl.edu">kathrynlwilson@ufl.edu</a></td>
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<td>Supervisor (If PI is student):</td>
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<td>Department:</td>
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<td>Date of Proposed Research:</td>
<td>October 2011-March 2012</td>
<td></td>
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<tr>
<td>Source of Funding (A copy of the grant proposal must be submitted with this protocol if funding is involved):</td>
<td>Florida Fish &amp; Wildlife Conservation Commission (FWC)</td>
<td></td>
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<tr>
<td>Scientific Purpose of the Study:</td>
<td>Conduct a baseline assessment of both Florida registered boaters' and non-resident freshwater anglers' knowledge, perceptions, and experiences with aquatic invasive species in Florida lakes and rivers. This study will inform FWC of current levels of knowledge and perceptions of aquatic invasive plants and/or animals issues, spread, and management which will ultimately assist in the development of a communication campaign targeting boaters and anglers.</td>
<td></td>
</tr>
<tr>
<td>Describe the Research Methodology in Non-Technical Language:</td>
<td>(Explain what will be done with or to the research participant.) Participants will be randomly selected from 1) boat registration contact information or 2) non-resident freshwater fishing license data and be asked to voluntarily participate in filling out and mailing back a mail questionnaire on their experiences with aquatic invasive species in Florida waterbodies.</td>
<td></td>
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</table>

Revised August, 2009
Describe Potential Benefits: Though there are no direct benefits to survey participants, the information will be valuable in protecting Florida waterbodies from further aquatic invasive species introductions once a communication campaign is implemented and targeted at the highest user groups (boaters and anglers).

Describe Potential Risks: (If risk of physical, psychological or economic harm may be involved, describe the steps taken to protect participant.) There are no risks to for participants responding to the survey.

Describe How Participant(s) Will Be Recruited: Randomly selected from a Florida DMV list of contacts (boaters) or randomly selected from FWC license data list of contacts (non-resident anglers).

<table>
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<tr>
<th>Maximum Number of Participants (to be approached with consent)</th>
<th>6000</th>
<th>Age Range of Participants:</th>
<th>18-80</th>
<th>Amount of Compensation/ course credit:</th>
<th>Some respondents will be provided a cash incentive with the survey</th>
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</table>

Describe the Informed Consent Process. (Attach a Copy of the Informed Consent Document. See http://irb.ufl.edu/irb92/samples.html for examples of consent.) The survey will include four points of contact (all of which are included in this package): 1) the pre-letter communicating that a survey will be forthcoming; 2) the actual survey with the informed consent language in the cover letter; 3) a reminder post card; and 4) a second cover letter with a second survey for those who have yet to respond.

(SIGNATURE SECTION)

Principal Investigator(s) Signature: _______________________________ Date: 9/2/11

Co-Investigator(s) Signature(s): _______________________________ Date: 9/2/11

Supervisor’s Signature (if PI is a student): _______________________________ Date: 

Department Chair Signature: _______________________________ Date: 9/2/11

Revised August, 2009
Weeds in the Water: Boating & Fishing in Florida Lakes and Rivers

Understanding freshwater boater and angler opinions and awareness of aquatic invasive species in Florida waters.

UF/IFAS Center for Aquatic & Invasive Plants
P.O. Box 110610
Gainesville, FL 32611
plants.ifas.ufl.edu
(352) 392-6841
FRESHWATER BOATER & ANGLER VIEWS ON FLORIDA AQUATIC INVASIVE SPECIES

1. Do you fish, boat, or both in freshwaters of Florida? (Please select one)
   - ○ YES, boat in Florida
   - ○ YES, fish in Florida
   - ○ YES, both

   If you boat or fish in saltwater only, please mark the circle below and either send the survey back in the enclosed self-addressed and pre-paid envelope or call (352) 392-6841 to let us know you are a saltwater-only boater/angler. If you boat in both fresh and saltwater, please proceed.

   Thanks!
   - ○ Boat, Fish, or Both in SALTWATER ONLY

   ○ NO

   If you do NOT boat or fish in Florida, please stop survey now and send back in self-addressed pre-paid envelope or call (352) 392-6841. Thanks!

2. AQUATIC INVASIVE SPECIES are plants or animals that enter places where they have NOT always lived and create problems. Invasive species cause significant issues or risks to the environment (fish, wildlife, native plants), the economy (water use or supply, recreation), or human health. How much information have you heard or read about each of the AQUATIC INVASIVE SPECIES listed below? (Please mark one for each item)

<table>
<thead>
<tr>
<th>AQUATIC INVASIVE SPECIES</th>
<th>A Large Amount</th>
<th>A Moderate Amount</th>
<th>A Small Amount</th>
<th>None</th>
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<td>b. Water hyacinth</td>
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<td>c. Water lettuce</td>
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<td>d. Armored catfish</td>
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<td>e. Island apple snail</td>
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<td>f. Quagga or zebra mussels</td>
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</tr>
</tbody>
</table>
3. During 2011, did you boat on waters where you knew aquatic invasive species were present?

- **YES**
  - (IF YES) How did you know that the waters you boated on were infested with an aquatic invasive species? *(Mark all that apply)*
    - Sign or poster at boat launch or marina
    - Able to identify, and observed it personally
    - Fishing, boating, or waterfowl regulation pamphlet
    - Internet website
    - Watercraft educator/inspector
    - Media sources (newspaper, radio, TV)
    - Brochure, fact sheet, or flyer
    - Heard about it from a friend or relative
    - Other *(please specify)*

- **DON'T KNOW**

- **NO**

4. How serious of an issue do you think aquatic invasive species are? *(Please mark one)*

<table>
<thead>
<tr>
<th>Very serious</th>
<th>Somewhat serious</th>
<th>Neutral</th>
<th>Not very serious</th>
<th>Not serious at all</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

5. Do you agree or disagree with the following statements about aquatic species management? *(Mark one answer for each item)*

<table>
<thead>
<tr>
<th>MANAGEMENT STATEMENT</th>
<th>Strongly Agree</th>
<th>Agree</th>
<th>Neither Agree nor Disagree</th>
<th>Disagree</th>
<th>Strongly Disagree</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Aquatic invasive species pose threats to the environment.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Aquatic invasive species pose threats to local, state, and regional economies.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Aquatic invasive species threaten the health and abundance of native fish and wildlife.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. There are steps I can take to prevent the spread of aquatic invasive species.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. If left unmanaged, aquatic invasive plants can take over Florida waters.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. If left unmanaged, native aquatic plants can take over Florida waterways.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
6. In your opinion, which three methods would best help boaters and anglers prevent the spread of aquatic invasive species? *(Please mark your top three choices)*

- Signs at ramps
- Educational materials in boat registration and fishing regulations
- Aquatic invasive species education and prevention in new boater training courses
- Radio/TV spots
- Boat cleaning equipment
- Boat inspection stations
- Rules and regulations
- Boaters/anglers are not responsible for preventing the spread of aquatic invasive species
- Other *(please specify)*

7. If a boater/angler does not take steps to prevent the spread of aquatic invasive species but knows that they are present where they boat and can be prevented, what kind of consequence should exist? *(Mark all that apply)*

- Fines/penalties
- Mandatory training
- Restriction of privileges
- No consequences and rely on self-regulation
- Other *(please specify)*

8. How effective would each of the following be in getting YOU to take steps to prevent the spread of aquatic invasive species? *(Mark one for each item.)*

<table>
<thead>
<tr>
<th>HOW EFFECTIVE WOULD THIS BE IN GETTING YOU TO TAKE ACTION . . .</th>
<th>Has already led me to take action</th>
<th>Would be very effective</th>
<th>Would be somewhat effective</th>
<th>Would NOT be very effective</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Talking with friends or acquaintances</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. A sense of personal responsibility</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c. A desire to keep aquatic invasive species out of our lakes and rivers</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d. A desire to prevent damage to my boat or equipment</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e. A desire to reduce the cost of controlling aquatic invasive species and use taxes/fees on other fish/wildlife conservation efforts</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f. Laws or regulations to prevent the transport of aquatic invasive species</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g. Enforcement checks to educate users and/or catch violators</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>h. Fines that must be paid by violators</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>i. Media sources (news or opinion pieces)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>j. Television or radio spots</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>k. Billboards</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>l. Magazine or newsletter articles</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>m. Internet websites</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>n. Facebook, Twitter, or other social media</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>HOW EFFECTIVE WOULD THIS BE IN GETTING YOU TO TAKE ACTION...</td>
<td>Has already led me to take action</td>
<td>Would be very effective</td>
<td>Would be somewhat effective</td>
<td>Would NOT be very effective</td>
</tr>
<tr>
<td>--------------------------------------------------------------</td>
<td>----------------------------------</td>
<td>------------------------</td>
<td>---------------------------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>o. Brochures, species identification cards, fact sheets, or other materials</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>p. Fishing or boating regulation pamphlets</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>q. Signs at marinas or boat launches</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>r. Boat inspections on roads or at launches</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>s. Videos or presentations to boating, lake, and sporting associations</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>t. Traveler information on radio broadcasts along roads</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>u. Aquatic invasive species education and prevention in new boater training courses</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

9. If you selected an item that "would be VERY EFFECTIVE" in Question 8, which would be MOST effective in getting you to help prevent the spread of aquatic invasive species? (Please rank below using the letters of your top three preferences)

   ____ Most Important
   ____ 2nd most important
   ____ 3rd most important

**BOATING/FISHING QUESTIONS**

10. Did you use a boat in Florida in the past year?

   ○ YES  (IF YES) What type of boat(s)? (Mark all that apply)
   ○ Small powerboat (less than 20 feet)  ○ Sailboat
   ○ Personal watercraft (jet ski)
   ○ Airboat
   ○ Canoe or kayak
   ○ Large powerboat (20+ feet)
   ○ Other type of boat __________

   Approximately how many days have you boated in Florida in the past year?
   ________

   If you also boat in saltwater or brackish water, approximately how many days (of the figure listed above) did you boat in saltwater in 2011?
   ________

   ○ NO  (IF YOU DID NOT USE A BOAT IN FLORIDA IN 2011, PLEASE SKIP TO QUESTION 18.)

11. Please list five most frequently visited FRESHWATER lakes/rivers/streams (and county) in the space below.

**IF YOU HAVE BOATED ON ONLY ONE WATERBODY IN 2011, PLEASE SKIP TO QUESTION 16.**
12. Considering the boats you used during 2011, for how long was the boat(s) IN the water before being moved to a DIFFERENT waterbody (on average)? Do NOT include time on a boat lift. (Please mark all that apply)

- One day or less
- 2 to 4 days
- 5 to 14 days
- 15 to 30 days
- More than 30 days

** IF YOU HAVE BOATED ON ONLY ONE WATERBODY IN 2011, PLEASE SKIP TO QUESTION 16.**

13. About how long was the boat(s) OUT of the water before you put it in a DIFFERENT waterbody (on average)? Include the amount of time on a trailer, on a boat lift, on a rack, or transported on a road. (Please mark all that apply)

- One day or less
- 2 to 4 days
- 5 to 14 days
- 15 to 30 days
- More than 30 days

14. 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? (Mark all that apply and remember to fill in the number of times during the 2011 boating season for each distance category.)

- I never moved ANY boat(s) to a different waterbody
- Ten miles or less ______ times
- 11 to 50 miles ______ times
- 51 to 150 miles ______ times
- 151 to 500 miles ______ times
- More than 500 miles ______ times

Remember to write in the number of times you moved your boat to another waterbody.

15. During the 2011 boating season, did you TRANSPORT (by truck, trailer, car top, etc.) and use any boat(s) to waters OUTSIDE the state where the boat is registered?

- YES
  - If you transported your boat(s) outside of the state:
    - What state is your boat(s) registered in? ________________
    - How many different times did you transport boat(s) to another state or province in the past year? ______ times
    - Please list each state/province that you transported boat(s) to: ____________________________

- NO

16. Upon leaving a waterbody, do you take any steps to prevent the transport of aquatic invasive species?

- YES
  - I don’t believe it will prevent the eventual spread of AIS.
  - It’s inconvenient.
  - I don’t know exactly what I’m supposed to do.
  - I didn’t boat on infested waters.
  - I don’t believe aquatic invasive species are a problem.
  - Boat washing equipment is not available.
  - Other (please specify) ____________________________

- NO
17. After removing your boat(s) from the water, how often do you do the following? *(Choose one for each)*

<table>
<thead>
<tr>
<th>STEPS TAKEN:</th>
<th>Always</th>
<th>Usually</th>
<th>Sometimes</th>
<th>Never</th>
<th>Does Not Apply</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Conduct visual inspection of boats and equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>for aquatic plants, animals and mud</td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>b. Drain water from boats, including motor, live wells, bilge, and bait</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>buckets</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. Dispose of unwanted bait, worms and fish parts in the trash.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. Remove aquatic plants and animals from boats and equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>e. Wash or rinse boat, trailer and equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>f. Wash or rinse boat, trailer and equipment with high pressure and/or hot</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>g. Flush motor’ s cooling system with tap water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>h. Dry everything for at least five days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>i. Wipe down hull and other equipment with a towel</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>j. Other <em>(please specify)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

18. Have you seen or heard of other boaters or anglers you know taking steps to stop the spread of aquatic invasive species?

- **YES**
- **NO**

19. Do you think the majority of boaters and anglers take steps to stop the spread of aquatic invasive species?

- **YES**
- **NO**

20. If you boat on waters with aquatic invasive species, how likely is it that you will take steps to prevent the spread of aquatic invasive species in the FUTURE *(IE: checking/cleaning gear after boating/fishing)*?

<table>
<thead>
<tr>
<th></th>
<th>Very likely</th>
<th>Somewhat likely</th>
<th>Not very likely</th>
<th>Not at all likely</th>
<th>I don’t boat on infested waters</th>
</tr>
</thead>
</table>
21. Did you fish in Florida lakes, rivers, or streams in the past year?

○ YES

(IF YES) Approximately how many times have you fished in the past year? ________

Approximately how many different waterbodies have you fished? ________

Do you fish for: (Mark all that apply)
○ pleasure/sport ○ work/economics ○ Food source

What do you fish for? (Mark all that apply)
○ Largemouth bass ○ Bluegill/shellcrackers/other bream
○ Crappie/speckled perch ○ Catfish/bullheads
○ Stripers/sunshine bass ○ No preference
○ Other (please specify) ________

Please rate the desirability of the following fish habitats:

<table>
<thead>
<tr>
<th>HABITAT</th>
<th>Very desirable</th>
<th>Desirable</th>
<th>Undesirable</th>
<th>Very undesirable</th>
<th>Don't know</th>
</tr>
</thead>
<tbody>
<tr>
<td>Native emergent plants (bulrush,grasses)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Native submersed plants (eelgrass, coontail)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Floating plants (water hyacinth, water lettuce)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Invasive submersed beds of hydrilla</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Open, non-vegetated water</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Other structure fish attractors (piers, gravel beds)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

22. Have you participated in fishing competitions?

○ YES

If YES, how far have you traveled to compete in a fishing competition? (Please mark all that apply and write how many times you have participated)
○ Less than 50 miles (local competitions) ______ times
○ 51-100 miles (regional competitions) ______ times
○ 101-300 miles ______ times
○ 301- 500 miles ______ times
○ More than 500 miles ______ times

○ NO
23. Have aquatic invasive species caused problems for you?

- YES
- NO
- DON'T KNOW

If YES, please describe any problems you have experienced (recreation, navigation, commercial fishing, aesthetically, etc.):

24. 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 invasive species and to reduce their harmful effects?

(Mark one for each item below)

<table>
<thead>
<tr>
<th>ACTIVITY:</th>
<th>NONE</th>
<th>$1</th>
<th>$2</th>
<th>$5</th>
<th>$10</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Boat cleaning stations</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>b. Signs &amp; materials at boat ramps</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>c. Communication &amp; outreach campaign</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>d. Management and control of aquatic invasive species</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**PLANT MANAGEMENT QUESTIONS**

25. Do you favor or oppose use of the following aquatic plant management control methods? (Select one for each)

<table>
<thead>
<tr>
<th>CONTROL METHOD</th>
<th>Strongly Favor</th>
<th>Somewhat Favor</th>
<th>Neither Favor or Oppose</th>
<th>Somewhat Oppose</th>
<th>Strongly Oppose</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Herbicide control methods (use of chemical substances)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>b. Mechanical harvesting methods (use of machines to control plants)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>c. Biological control methods (use of insects, fish, diseases, and other biological agents)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>d. Physical control methods (hand removal, water level manipulations)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

26. How much do you know about the following control methods? (Please select one for each)

<table>
<thead>
<tr>
<th>CONTROL METHOD</th>
<th>A lot of knowledge</th>
<th>Some knowledge</th>
<th>A little knowledge</th>
<th>No knowledge</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Herbicide control methods</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>b. Mechanical harvesting methods</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>c. Biological control methods</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>d. Physical control methods</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
27. What is your preferred coverage of aquatic plants in a given lake or river (0% being none, and 100% being completely covered)?

<table>
<thead>
<tr>
<th>PERCENT COVERAGE:</th>
<th>0-10 percent</th>
<th>11-40 percent</th>
<th>41-70 percent</th>
<th>71-100 percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

28. Have you heard of or read about aquatic invasive species from any of the following sources? (Choose one answer for each source)

<table>
<thead>
<tr>
<th>SOURCES</th>
<th>Yes</th>
<th>No</th>
<th>Don't Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Newspapers</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>b. Magazine or newsletter articles</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>c. Television news or programs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>d. Radio news or programs</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>e. Billboards</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>f. Internet websites</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
<tr>
<td>g. Social Media (Facebook, YouTube, Twitter, etc.)</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
</tr>
</tbody>
</table>

EVENTS
h. Conferences, presentations, or meetings | ☐ | ☐ | ☐ |

i. Fishing contests, fishing derbies, or sailboat regattas | ☐ | ☐ | ☐ |

j. Booth at a sport or fishing show | ☐ | ☐ | ☐ |

FISHING OR BOATING SOURCES
k. Fishing, boating or waterfowl hunting regulation pamphlets | ☐ | ☐ | ☐ |

l. Boat registration materials | ☐ | ☐ | ☐ |

m. Fishing surveys or inspections on roads or boat launches | ☐ | ☐ | ☐ |

n. Signs or information provided at a marina or boat launch | ☐ | ☐ | ☐ |

o. Information at a bait or tackle shop | ☐ | ☐ | ☐ |

p. A fishing, boating, sporting, or environmental organization | ☐ | ☐ | ☐ |

OTHER SOURCES
q. Brochures, species ID cards, fact sheets, or other materials | ☐ | ☐ | ☐ |

r. Educational videos | ☐ | ☐ | ☐ |

s. Other (please specify) | ☐ | ☐ | ☐ |

29. Of all the sources of information in Question 28, which three would you consider to be the MOST EFFECTIVE at providing information on aquatic invasive species education and prevention? (Please rank them below by writing the letter of selection from question 28).

____ Most Important
____ 2nd most important
____ 3rd most important
30. Please rate the trustworthiness of the following organizations (for providing information).

<table>
<thead>
<tr>
<th>TRUSTWORTHINESS OF SOURCES</th>
<th>Very Trustworthy</th>
<th>Somewhat Trustworthy</th>
<th>Slightly Trustworthy</th>
<th>Not at all Trustworthy</th>
<th>No experience w/organization</th>
<th>Undecided</th>
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<tr>
<td>Florida Fish &amp; Wildlife Commission</td>
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<tr>
<td>U.S. Environmental Protection Agency</td>
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<td>○</td>
</tr>
<tr>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Water Management Districts</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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</tr>
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<tr>
<td>Local tackle shops or marinas</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Boating, angling, or hunting groups (BASS, American Fisheries Society, Trout Unlimited)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>Environmental groups (Sierra Club, Audubon, Nature Conservancy)</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>County Extension office</td>
<td>○</td>
<td>○</td>
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<td>○</td>
<td>○</td>
<td>○</td>
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<tr>
<td>Friends/family</td>
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<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Media (Newspapers, TV, Internet reporting)</td>
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<td>○</td>
<td>○</td>
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</tr>
<tr>
<td>Social media (Facebook, YouTube, Twitter)</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**DEMOGRAPHIC INFORMATION:**
This information will be used only to compare answers. It will not be used to identify you in any way.

31. Are you male or female?
   ○ 1. Male
   ○ 2. Female

32. In what county and state or province is your primary residence located? ____________________________

33. In what year were you born? 19__

34. What types of radio stations do you usually listen to? *(Mark all that apply)*
   ○ Classical music
   ○ Country music
   ○ Public radio
   ○ New/alternative rock music
   ○ Oldies/classic rock music
   ○ Talk radio
   ○ Other (please specify) ____________________________
35. What is your preferred communication method? (Mark all that apply)

- Mail
- Email notifications
- Social media (Please specify: Facebook, Twitter, etc.)
- 1-phone/Smart Phone Apps
- Public meetings
- Other (please specify)

36. What recommendations or other comments would you like to make about the spread of aquatic invasive species in your state or province waters? (Please write in space below)

37. If you wish to sign up for the UF/IFAS Center for Aquatic & Invasive Plants ListServe to receive information related to aquatic invasive species in Florida, please provide your email address below.

__________________________________________

Thank you for your time and cooperation! Your help is appreciated.

Please fold this questionnaire and return it in the enclosed postage-paid addressed envelope.

For questions, please call or email: (352) 392-6841 or kathrynlwilson@ufl.edu

For more information about the UF/IFAS Center for Aquatic & Invasive Plants, please visit our website: http://plants.ifas.ufl.edu
APPENDIX D
SURVEY CORRESPONDENCE-mailing one: advance letter

Dear Angler:

A few days from now you will receive a request in the mail to fill out a brief questionnaire on aquatic invasive species in Florida. Aquatic invasive species are non-native plants and/or animals that pose a risk or cause problems for the environment, economy, or human health.

The survey is being conducted by the University of Florida’s Center for Aquatic and Invasive Plants to learn about your angling experiences with and opinions about aquatic invasive plants and/or animals. Your responses will provide important information that will help us to develop educational materials specifically for anglers.

We are writing because we have found that many people like to know ahead of time that they will be contacted.

Thank you for your time and consideration. Only with the generous help of people like you can our survey be successful.

Sincerely,

\[
\text{William T. Haller, Director} \\
\text{UF/IFAS Center for Aquatic & Invasive Plants}
\]
January 25, 2012

Dear angler:

A few days from now you will receive a request in the mail to fill out a brief questionnaire on aquatic invasive species in Florida. Aquatic invasive species are non-native plants and/or animals that pose a risk or cause problems for the environment, economy, or human health.

The survey is being conducted by the University of Florida’s Center for Aquatic and Invasive Plants to learn about your angling experiences with and opinions about aquatic invasive plants and/or animals. Your responses will provide important information that will help us to develop educational materials specifically for anglers.

We are writing because we have found that many people like to know ahead of time that they will be contacted.

Thank you for your time and consideration. By taking a little time to share your thoughts about aquatic invasive species, you will be helping us a great deal and a small token of our appreciation is enclosed as a way of saying thank you in advance for your participation in this study. Only with the generous help of people like you can our survey be successful.

Sincerely,

[Signature]

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic and Invasive Plants
Dear Boater:

A few days from now you will receive a request in the mail to fill out a brief questionnaire on aquatic invasive species in Florida. Aquatic invasive species are non-native plants and/or animals that pose a risk or cause problems for the environment, economy, or human health.

The survey is being conducted by the University of Florida’s Center for Aquatic and Invasive Plants to learn about your boating experiences with and opinions about aquatic invasive plants and/or animals. Your responses will provide important information that will help us to develop educational materials specifically for boaters.

We are writing because we have found that many people like to know ahead of time that they will be contacted.

Thank you for your time and consideration. Only with the generous help of people like you can our survey be successful.

Sincerely,

[Signature]

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic & Invasive Plants
Dear boater:

A few days from now you will receive a request in the mail to fill out a brief questionnaire on aquatic invasive species in Florida. Aquatic invasive species are non-native plants and/or animals that pose a risk or cause problems for the environment, economy, or human health.

The survey is being conducted by the University of Florida’s Center for Aquatic and Invasive Plants to learn about your boating experiences with and opinions about aquatic invasive plants and/or animals. Your responses will provide important information that will help us to develop educational materials specifically for boaters.

We are writing because we have found that many people like to know ahead of time that they will be contacted.

Thank you for your time and consideration. By taking a little time to share your thoughts about aquatic invasive species, you will be helping us a great deal and a small token of our appreciation is enclosed as a way of saying thank you in advance for your participation in this study. Only with the generous help of people like you can our survey be successful.

Sincerely,

[Signature]

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic and Invasive Plants
January 31, 2012

<<First_Name>> <<Last_Name>>
<<Street>>
<<City>>, <<State>> <<Zip>>

Dear <<First_Name>> <<Last_Name>>:

The University of Florida’s Center for Aquatic and Invasive Plants is conducting a study on non-resident freshwater angler opinions of aquatic invasive species. Aquatic invasive species are non-native plants and/or animals that cause harm or threats to the environment, the economy, and/or public health. The study will focus on aquatic invasive species issues, spread, and management in Florida lakes and rivers, which can affect the quality of your angling experience.

The best way to learn about anglers’ views about aquatic invasive species is by asking them about their experiences, knowledge and opinions of aquatic invasive species in Florida waterbodies. Your address is one of only a small number that have been randomly selected to help us in this important study.

I am asking you to participate in this study because of your interest in fishing. The survey will take about 15 minutes to complete. The person in the household who has purchased a non-resident freshwater fishing license in Florida should be the one to fill out the survey and return it to us in the enclosed pre-paid envelope.

There are no anticipated risks to you as a participant in this study. There are also no direct benefits or compensation to you for participating in the study. Your responses are voluntary and will be kept confidential. You are free to withdraw your consent to participate and may discontinue your participation at any time without consequence. If you have any questions about the study, please contact us at (352) 392-6841. Questions or concerns about your rights as a research participant may be directed to the IRB02 office, University of Florida, Box 112250, Gainesville, FL 32611; (352) 392-0433.

By taking a little time to share your thoughts about aquatic invasive species, you will be helping us a great deal. Your help is greatly appreciated and we look forward to receiving your responses.

Sincerely

[Signature]

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic & Invasive Plants
January 31, 2012

Dear <<First_Name>> <<Last_Name>>:

The University of Florida’s Center for Aquatic and Invasive Plants is conducting a study on non-resident freshwater angler opinions of aquatic invasive species. Aquatic invasive species are non-native plants and/or animals that cause harm or threats to the environment, the economy, and/or public health. The study will focus on aquatic invasive species issues, spread, and management in Florida lakes and rivers, which can affect the quality of your fishing experience.

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I am asking you to participate in this study because of your interest in fishing. The survey will take about 15 minutes to complete. The person in the household who purchased a freshwater fishing license in Florida should be the one to fill out the survey and return it to us in the enclosed pre-paid envelope.

If you have questions about the study, please contact our office at: (352) 392-6841 or send an email to kathrynlwilson@ufl.edu.

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Sincerely,

[Signature]

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic & Invasive Plants
January 31, 2012

Dear <<First_Name>> <<Last_Name>>,

The University of Florida’s Center for Aquatic and Invasive Plants is conducting a study on Florida boaters’ opinions of aquatic invasive species. Aquatic invasive species are non-native plants and/or animals that cause harm or threats to the environment, the economy, and/or public health. The study will focus on aquatic invasive species issues, spread, and management in Florida lakes and rivers, which can affect the quality of your boating experience.

The best way to learn about boaters’ views about aquatic invasive species is by asking them about their experiences, knowledge, and opinions of aquatic invasive species in Florida waterbodies. Your address is one of only a small number that have been randomly selected to help us in this important study.

I am asking you to participate in this study because of your interest in boating. The survey will take about 15 minutes to complete. The person in the household with a boat registered in Florida should be the one to fill out the survey and return it to us in the enclosed pre-paid envelope.

We are seeking freshwater boaters for this study, so if you boat in saltwater only, please do one of the following: indicate that you are a saltwater boater in question one and return the survey OR call (352) 392-6841 or email kathynwilson@ufl.edu to let us know that you are a saltwater-only boater and we can record the data. If you boat in both freshwater and saltwater, please take the survey.

There are no anticipated risks to you as a participant in this study. There are also no direct benefits or compensation to you for your participation. Your responses are voluntary and will be kept confidential. You are free to discontinue your participation at any time without consequence. Questions or concerns about your rights as a research participant may be directed to the IRB office, University of Florida, Box 112250, Gainesville, FL 32611; (352) 392-0433.

By taking a little time to share your thoughts about aquatic invasive species, you will be helping us a great deal. Your help is greatly appreciated and we look forward to receiving your responses.

Sincerely,

[Signature]

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic & Invasive Plants

An Equal Opportunity/Affirmative Action Employer
January 31, 2012

<<First_Name>> <<Last_Name>>
<<Street>>
<<City>>, FL <<Zip>>

Dear <<First_Name>> <<Last_Name>>:

The University of Florida’s Center for Aquatic and Invasive Plants is conducting a study on Florida boater opinions of aquatic invasive species. Aquatic invasive species are non-native plants and/or animals that cause harm or threats to the environment, the economy, and/or public health. The study will focus on aquatic invasive species issues, spread, and management in Florida lakes and rivers, which can affect the quality of your boating experience.

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By taking a little time to share your thoughts, you will be helping us a great deal and a small token of our appreciation is enclosed as a way of saying thank you in advance for your participation in this study. Your help is greatly appreciated and we look forward to receiving your responses.

Sincerely,

Dr. William T. Haller, Director
UF/IFAS Center for Aquatic & Invasive Plants
APPENDIX F
SURVEY CORRESPONDENCE-mailing three: post card

February 10, 2011

Dear Angler,

A few days ago, I sent you a questionnaire asking about your experience with fishing and aquatic invasive plants in Florida lakes and rivers. If you have completed and returned the questionnaire, please accept my heartfelt thanks.

If you have not yet returned your questionnaire, please do so as soon as possible. Because of the small number of people being asked to participate in this survey, it is very important that each person complete and return the questionnaire. Thank you for your help.

If you have questions about the survey, please call (352) 392-6841.

Sincerely,

William Haller

Dr. William T. Haller, Director
February 10, 2011

Dear Boater,

A few days ago, I sent you a questionnaire asking about your experience with boating and aquatic invasive plants in Florida lakes and rivers. If you have completed and returned the questionnaire, please accept my heartfelt thanks.

If you have not yet returned your questionnaire, please do so as soon as possible. Because of the small number of people being asked to participate in this survey, it is very important that each person complete and return the questionnaire. Thank you for your help.

If you have questions about the survey, please call (352) 392-6841.

Sincerely,

[Signature]

Dr. William T. Haller, Director
February 28, 2012

<<First_Name>> <<Last_Name>>
<<Street>>
<<City>>, <<State>> <<Zip>>

Dear <<First_Name>> <<Last_Name>>:

A couple of weeks ago, I sent you a survey asking about your experience with aquatic invasive species in Florida lakes and rivers. As of today, however, I have not received your completed survey. If you have already responded, thank you for your input and please ignore this letter.

Many people have already responded. They described their fishing experiences, as well as their opinions and thoughts on aquatic invasive species. The results will be very useful to us here at the University of Florida Center for Aquatic & Invasive Plants.

I am writing again due to the importance of your input in order to get accurate results. Although I sent questionnaires to other freshwater anglers who fish in Florida, I need to hear from nearly everyone in the sample to be sure that the results are truly representative of non-resident anglers. The survey will take about 15 minutes to complete. Please ensure that the person in the household who has who has purchased a non-resident freshwater fishing license in Florida is the one to fill out the survey.

We will keep your answers confidential and your name will not be used in any report. We will only use your answers after they have been combined with other respondents’ answers. Please note that the number on the questionnaire will be used only to check your name off of the mailing list when the survey is returned. Your participation is voluntary. You do not have to answer any question that you do not wish to answer. We believe that there are no risks to you as a result of participating in this study. There are also no direct benefits or compensation for participating. If you have questions or concerns about your rights, please contact the UFIRB office, Box 112250, University of Florida, Gainesville, Fl 32611.

Once the survey is completed, please return it in the pre-paid envelope provided. If you have any questions, do not boat in Florida, or boat in saltwater-only, please contact my assistant Kate Wilson at (352) 392-6841 or send an email to kathrynwilson@ufl.edu. Thank you for your help!

Sincerely,

William T. Haller
Director
UF/IFAS Center for Aquatic & Invasive Plants
February 28, 2012

<<First_Name>> <<Last_Name>>
<<Street>>
<<City>>, <<State>> <<Zip>>

Dear <<First_Name>> <<Last_Name>>:

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There are also no direct benefits or compensation for participating. If you have questions or concerns about your rights, please contact the UFIRB office, Box 112250, University of Florida, Gainesville, FL 32611.

Please accept the enclosed token of our appreciation and gratitude for your participation in this study. Once the survey is completed, please return it in the pre-paid envelope provided. If you have any questions, do not boat in Florida, or boat in saltwater-only, please contact my assistant Kate Wilson at (352) 392-6841 or send an email to kathrynlwilson@ufl.edu. Thank you for your help!

Sincerely,

William T. Haller
Director
UF/IFAS Center for Aquatic & Invasive Plants

An Equal Opportunity/Affirmative Action Employer
February 28, 2012

<<First_Name>> <<Last_Name>>
<<Street>>
<<City>>, FL <<Zip>>

Dear <<First_Name>> <<Last_Name>>:

A couple of weeks ago, I sent you a survey asking about your experience with aquatic invasive species in Florida lakes and rivers. As of today, however, I have not received your completed survey. If you have already responded, thank you for your input and please ignore this letter.

Many people have already responded. They described their boating experiences, as well as their opinions and thoughts on aquatic invasive species. The results will be very useful to us here at the University of Florida Center for Aquatic & Invasive Plants.

I am writing again due to the importance of your input in order to get accurate results. Although I sent questionnaires to boaters throughout Florida, I need to hear from nearly everyone in the sample to be sure that the results are truly representative of Florida boaters. The survey will take about 15 minutes to complete. Please ensure that the person in the household who has registered a boat in Florida is the one to fill out the survey.

We will keep your answers confidential and your name will not be used in any report. We will only use your answers after they have been combined with other respondents’ answers. Please note that the number on the questionnaire will be used only to check your name off the mailing list when the survey is returned. Your participation is voluntary. You do not have to answer any question that you do not wish to answer. We believe that there are no risks to you as a result of participating in this study. There are also no direct benefits or compensation for participating. If you have questions or concerns about your rights, please contact the UFRB office, Box 112250, University of Florida, Gainesville, FL 32611.

Once the survey is completed, please return it in the pre-paid envelope provided. If you have any questions, do not boat in Florida, or boat in saltwater-only, please contact my assistant Kate Wilson at (352) 392-6841 or send an email to kathrynlwilson@ufl.edu. Thank you for your help!

Sincerely,

William T. Haller
Director
UF/IFAS Center for Aquatic & Invasive Plants

An Equal Opportunity/Affirmative Action Employer
February 28, 2012

<<First_Name>> <<Last_Name>>
<<Street>>
<<City>>, FL <<Zip>>

Dear <<First_Name>> <<Last_Name>>:

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Many people have already responded. They described their boating experiences, as well as their opinions and thoughts on aquatic invasive species. The results will be very useful to us here at the University of Florida Center for Aquatic & Invasive Plants.

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Sincerely,

William T. Haller, Director
UF/IFAS Center for Aquatic & Invasive Plants

An Equal Opportunity/Affirmative Action Employer
APPENDIX H
RESPONSE RATE BY TREATMENT GROUPS

Treatment Groups for Cash Incentive Experiment

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<th>$5 INCENTIVE</th>
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<td>3</td>
</tr>
<tr>
<td>1/25/12</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
<tr>
<td>SURVEY 1 MAILING</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>2/1/12</td>
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<td>500</td>
<td>500</td>
</tr>
<tr>
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<td>7</td>
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<td>9</td>
</tr>
<tr>
<td>2/28/12</td>
<td>500</td>
<td>500</td>
<td>500</td>
</tr>
</tbody>
</table>

Table H-1. Treatment Groups for Embedded Cash Incentive Experiment

Response Rate by Treatment Group-AB
Combined, Valid-only

- $5 @ Q2: 31.7%
- $2 @ Q2: 24.1%
- $0 @ Q2: 18.3%
- $5 @ Q1: 38.3%
- $2 @ Q1: 29.6%
- $0 @ Q1: 16.8%
- $5 @ Pre: 36.6%
- $2 @ Pre: 27.9%
- $0 @ Pre: 20.6%

Figure H-1. Response Rates per Treatment Group
REFERENCES


BIOGRAPHICAL SKETCH

Kathryn Lorraine Wilson grew up in the tiny town of Northport, Washington. Nestled in the craggy mountains of the Pacific Northwest, Northport is located in eastern Washington and home to right around 500 lucky souls. She holds that growing up in the country is responsible for the best parts of her, that and a fun-lovin’ family! Rural living has a way of cultivating creativity, connectivity, and a deep love for wide-open spaces.

For her undergraduate studies, Kathryn attended Carroll College in Helena, Montana, a small liberal-arts school, where she majored in public relations/journalism and minored in English writing. While completing her degree, Kathryn edited a literary magazine and served on the board of a grassroots environmental organization. She completed an internship for the Helena Festival of the Book and graduated with honors in 2005.

In the five years after graduating from Carroll, Kathryn worked in Sandpoint, Idaho as the executive director for the Pend Oreille Basin Commission, a state-created advisory board on water quality and quantity issues in the Pend Oreille watershed. This work combined science and outreach and provided a rich and diverse experience that included writing grants, managing budgets, planning and facilitating public meetings, assisting with fish and plant surveys, and carrying out Commission-funded projects. In addition, Kathryn worked as a project journalist for Resource Planning Unlimited, authoring a regular column in the River Journal as well as feature stories and articles in regional and national magazines on natural resource issues in the Pacific Northwest.

Always interested in graduate school, these professional experiences provided the insight and motivation to pursue an advanced degree in environmental communication. Insert Dr. Haller and his fantastic recruitment abilities! Dr. Haller was advising the state of Idaho on aquatic invasive species issues and management when he met the likes of Kathryn. Once her interest in
graduate school was out of the bag, Kathryn was off to University of Florida for a visit. Kathryn recognized a great opportunity, even though it involved being whisked away from all of the wild water issues of the west. Little did she realize that Florida would be home to some very interesting water and natural resources as well.

While working in Idaho, Kathryn became an avid spokesperson for the seriousness of aquatic invasive species. Through this she became a boat inspector trainer and prevention advocate, providing workshops, trainings, and seminars throughout the Northwest.

At the University of Florida, Kathryn took many classes on communication theory and practice, but also facilitation, human dimensions of biological conservation, water politics, public policy analysis, and agricultural and natural resource law. Research methods and statistics classes served their role in her research as well. The thesis research turned out to be an excellent topic that fit the niche that Kathryn has come to be most passionate about, preventing the spread of aquatic invasive species. It is her dream to work on environmental outreach and education projects, particularly on water issues. She is also very interested in natural resource conflict resolution, outdoor/environmental writing, and public policy evaluation.