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FINAL PERFORMANCE REPORT

FEDERAL AID GRANT NO. T-44-P-1

DEVELOPMENT OF THE OKLAHOMA STATE AQUATIC NUISANCE SPECIES MANAGEMENT PLAN AS AUTHORIZED BY THE OKLAHOMA COMPREHENSIVE WILDLIFE CONSERVATION STRATEGY

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION

December 18, 2006 through June 30, 2009

FINAL PERFORMANCE REPORT

State: Oklahoma **Grant Number:** T-44-P-1

Grant Program: State Wildlife Grants Program

Grant Title: Development of the Oklahoma State Aquatic Nuisance Species Management Plan as authorized by the Oklahoma Comprehensive Wildlife Conservation Strategy

Grant Period: 18 December, 2006 – 30 June 2009

Report Period: 18 December, 2006 – 30 June 2009

Project Leader: Bill Wentroth, Jeff Boxrucker, Gene Gilliland

Objective: To develop by June 2008 an action plan to further protect species in peril in Oklahoma by preventing the immigration or establishment of invasive exotic species, and to develop a rapid response mechanism to address containment and eradication of invasive species that enter the state.

Note: A one-year extension was granted to complete plan development.

The Oklahoma Department of Wildlife Conservation submitted the State Aquatic Nuisance Species Plan to the federal Aquatic Nuisance Species Task Force for approval and funding in November 2008. The plan was subsequently approved and partial funding for the State program was received from the U.S. Fish and Wildlife Service. The approved plan, complete with 2009 update of activities, and results of a boater awareness service are submitted to fulfill reporting requirements of this grant.

Date: September 1, 2009

Approved by:

Jeff Boxrucker

Fisheries Division Administration
Oklahoma Department of Wildlife Conservation

John D. Stafford

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Federal Aid Coordinator
Oklahoma Department of Wildlife Conservation

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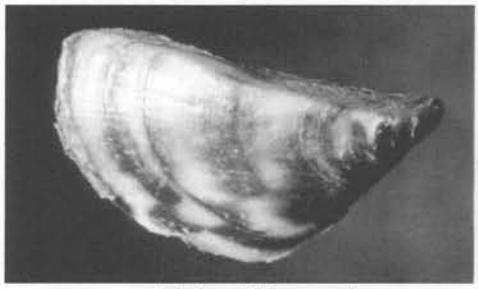
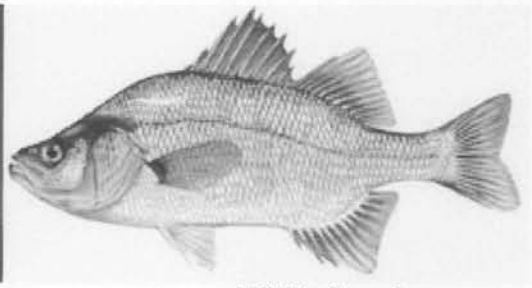
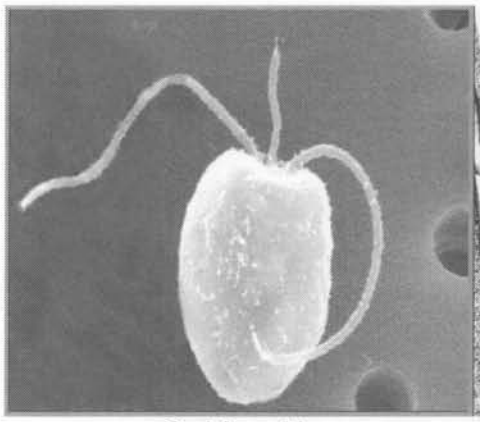
OKLAHOMA
AQUATIC NUISANCE SPECIES
MANAGEMENT PLAN



Zebra Mussels



White Perch



Golden Alga

Hydrilla

OKLAHOMA
AQUATIC NUISANCE SPECIES
MANAGEMENT PLAN

Produced by:
Ashley Foster, Jeff Boxrucker, Gene Gilliland, Bill Wentroth

Updated by Curtis Tackett
September 2009

Oklahoma Department of Wildlife Conservation

Honorable Brad Henry, Governor
State of Oklahoma

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A. Executive Summary

Aquatic Nuisance Species (ANS) pose significant ecological and socio-economic threats to aquatic ecosystems in Oklahoma. Zebra mussels, golden alga, white perch, hydrilla, among others, have already become established in Oklahoma aquatic systems. While their initial impacts have been limited and localized, there is little doubt that these and other ANS pose a serious threat to the aquatic resources, and potentially the economy, of the State of Oklahoma.

The importance of the State's aquatic resources requires a coherent and integrated response to the threat posed by ANS. Using guidance from the National ANS Task Force and other accepted state agency plans such as Kansas, Illinois, Iowa and Oregon, this management plan was developed to establish management actions to address the prevention, control, and effects of non-indigenous aquatic nuisance species that have invaded or may invade Oklahoma waters. The Oklahoma Aquatic Nuisance Species Management Plan serves as the initial step in establishing a program to specifically address ANS issues in Oklahoma.

The development of a state ANS management plan, as called for in Section 1204 of the Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) of 1990, provides an opportunity for federal cost-share support for implementation of the plan. NANPCA, reauthorized in 1996 as the National Invasive Species Act (NISA), specifies that state plans identify feasible, cost-effective management practices and measures that can be implemented by the state to prevent and control ANS infestations in an environmentally sound manner. The goal of the Oklahoma ANS Management Plan is to: *Minimize the harmful ecological, economic, and social impact of ANS through prevention and management of introduction, population growth, and dispersal of ANS into, within, and from Oklahoma.*

The goal will be met by implementing a set of objectives as follows:

1. Coordinate and implement a comprehensive management plan.
2. Prevent the introduction of new ANS into Oklahoma.
3. Detect, monitor, and eradicate ANS.
4. Control and eradicate established ANS that have significant impacts.
5. Educate resource user groups about the risks and impacts of ANS and how to reduce the harmful impacts.
6. Conduct/support research to determine risks associated with pathways of introduction/spread, environmental conditions favorable for establishment of ANS, interactions with native species, and cost-effective and environmentally safe control/eradication measures.

Included in this plan are discussions of existing problems, a summary of federal, regional, and state policy; a list of non-indigenous species known to exist in Oklahoma; identification of existing priority ANS, and a discussion of regional ANS that pose a threat to Oklahoma's aquatic ecosystems.

To ensure that the goals of this plan are being effectively addressed a procedure for monitoring and evaluating the implementation of strategies and tasks will be initiated. This evaluation will focus on the feasibility and cost-effectiveness of management activities. The plan is a working document and will be periodically updated and expanded based upon the experience gained from implementation, scientific research, and new tools as they become available.

The effort to develop a state ANS management plan was led by the Oklahoma Department of Wildlife Conservation in conjunction with personnel from other government agencies and private organizations (Appendix B). Public comments were solicited from local governments, regional entities, public and private organizations, and resource user groups that have expertise and interest in the control of ANS. Comments were considered, and revisions have been made to the plan.

B. Introduction

Non-native invasive species, or for the purpose of this document, aquatic nuisance species (ANS), threaten the ecological integrity of aquatic systems worldwide. These invaders displace native species, disrupt ecological processes, upset the stability of ecosystems, and can irreversibly change natural landscapes. In addition to the ecological damage caused by ANS, the burden to local, state, and federal economies can be staggering. State and local governments spend hundreds of millions of dollars annually to control ANS. It is estimated that ANS cost the U.S. economy $137 billion annually (Pimentel et al. 2000).

Recognizing the ecological and economic threats posed by ANS, the federal government passed the Non-indigenous Aquatic Nuisance Prevention and Control Act (NANPCA) in 1990. This legislation provided a funding mechanism for states to address ANS issues. This legislation was expanded with passage of the National Invasive Species Act (NISA) in 1996. NISA specifies that state plans identify feasible, cost-effective management strategies to prevent introductions of and control the spread of ANS in an environmentally sound manner. For Oklahoma to be eligible for federal cost-share funds to combat ANS, a state-wide ANS management plan must be approved by the Federal ANS Task Force established under NISA.

Oklahoma's State Wildlife Action Plan (SWAP; State Wildlife Grant T-2-P-1) identifies exotic and invasive species as one of five priority issues that threaten the conservation of Oklahoma's wildlife resources. Specific issues within SWAP that identify ANS as threats include:

- water diversion projects, particularly inter-basin transfers, that can serve as pathways for the spread of ANS;
- nutrient runoff from fertilizers and confined animal feeding operations degrade water quality and destabilize aquatic systems which increases the potential for establishment of non-native species;
- establishment of ANS destabilizes aquatic systems often resulting in decreased biodiversity and threatening populations of "species of greatest conservation need";
- movement of species outside their native range by the public, i.e., bait bucket releases, were likely the cause of establishment of the Red river shiner *Notropis bairdi* becoming established in the Cimarron River and the Red river pupfish *Cyprinodon rubrofluviatilis* becoming established in the Canadian River;
- zebra mussels *Dreissena polymorpha* and Asian carp are potential threats to native mussel populations.

Action plans identified in SWAP to deal with these threats include:

- develop an invasive species management plan;
- survey aquatic systems to determine distribution of ANS;
- remove non-native plants from wetlands and restore native plant communities;
- develop cost-share or incentive programs for private landowners to encourage control of ANS on private property;

- educate the public on ANS issues and roles that the public plays in preventing introductions and controlling the spread of ANS.

Development of this plan is partially funded through a SWAP grant (T-44-P-1) to the Oklahoma Department of Wildlife Conservation (ODWC).

The northeast quadrant of Oklahoma is the region of the state currently most impacted by ANS (Figure 1). Zebra mussels have moved up the McClellen-Kerr Arkansas River Navigation system, most likely via barge traffic from the Mississippi River and are progressing down the Arkansas River via natural movement from El Dorado Reservoir in Kansas. Bighead carp *Hypophthalmichthys nobilis* have been found in Grand Lake and in the Neosho River above Grand Lake. Bighead carp have also been verified from the Red River below Lake Texoma and from the Kiamichi River below Hugo Lake. White perch *Morone americana* have moved downstream from Cheney Reservoir in Kansas and are currently found in Kaw and Keystone Reservoirs. They will likely continue to move downstream throughout the Arkansas River system. Golden alga *Prymnesium parvum* has caused fish kills in Lake Texoma and Altus City Lake. Hydrilla *Hydrilla verticillata* has recently been found in Arbuckle, Murray, and Sooner Reservoirs, likely as a result of movements via recreational boaters. The exotic zooplankton *Daphnia lumholzi* has been found in 18 Oklahoma reservoirs. Strategies to contain these and other ANS species infesting Oklahoma waters, as well as strategies to prevent the introduction of ANS not currently found in Oklahoma will be addressed in this plan.

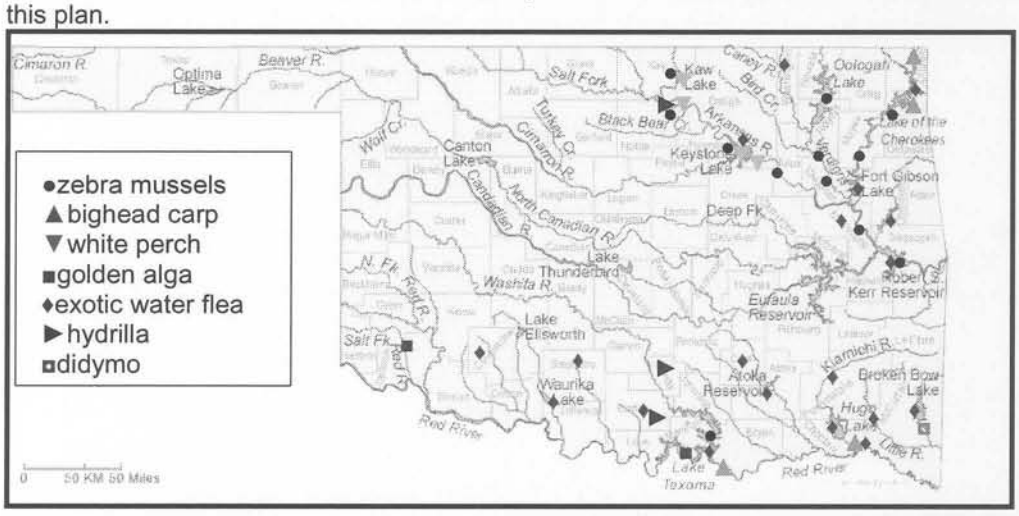

Figure 1. Current known distribution of selected ANS in Oklahoma as of August 2009

To prevent the spread of ANS into, or out of Oklahoma, strategies that are cohesive with those of neighboring states are vital. The Arkansas River runs through both Kansas and Oklahoma and has served as a pathway for the introduction of ANS. Lake Texoma is shared by Oklahoma and Texas and has experienced fish kills due to golden alga. Zebra mussels were first reported in Lake Texoma in 2009. This is the first case of zebra mussels in Texas and is a concern regarding water transfer from Lake Texoma to Lake Lavon, TX. Grand Lake in the northeastern corner of Oklahoma is a popular fishing destination connected to Missouri via the Elk River. Kansas has an approved state ANS management plan and Missouri and Texas both have plans drafted. Texas has also produced a state plan for the management of golden alga in public waters. The strategies in these documents were considered and incorporated where relevant in this management plan. A common goal of Oklahoma and its bordering states is to establish working partnerships with ANS management programs in regional states to facilitate the sharing of data and coordination of management activities. Oklahoma, Texas and Kansas all support the 100th Meridian Initiative, and participate in the Western and Mississippi River Basin Panels of the Aquatic Nuisance Species Task Force. Participation in these forums will help to facilitate development of a coordinated network among state agencies to document, evaluate, and monitor effects of invasive species on the economy, the environment, and human health.

As per Rendall (1997), ANS management plans need to consider the following points when developing strategies to control invasive species:

- many pathways exist for the introduction and spread of ANS, most of which are related to human activity; new species are continually introduced via these pathways;
- introductions have many associated costs, i.e., control and management costs, long-term ecosystem changes, loss of recreational opportunities;
- once ANS become established, few, if any, acceptable control measures are available; control measures are very expensive and eradication unlikely;
- prevention is the best course of action with comprehensive management plans, education programs, and regulations offering the best chances of containment.

These points have provided guidance in drafting the strategies aimed at prevention and control of ANS in Oklahoma's aquatic ecosystems.

The intended outcomes of this plan include:

- identifying species of greatest concern, whether currently present in Oklahoma waters or likely to invade in the future;
- create sufficient funding and personnel to support the plan;
- identify gaps in distribution data to focus survey efforts to best determine current distribution patterns;
- identify pathways for spread of invasives outward from current locations;
- identify shortcomings in current statutes aimed at preventing introductions of ANS not currently in Oklahoma and movement of ANS to uninfested systems;
- recommend language to lawmakers on how to strengthen said regulations;

- develop public outreach strategies to raise public awareness of ANS issues and the role of aquatic resource users in preventing their introduction and spread;

- create a framework for coordination of ANS activities among federal, state and local government, private industry, non-governmental organizations, and the public.

The ODWC was the lead agency in drafting this plan. Members of the Zebra Mussel Task Force (ZMTF), an interagency coordination group established shortly after zebra mussels were found in Oklahoma (1993) and the ANS Plant Task Force (PTF) reviewed drafts of the plan. Staffs from the office of the State Secretary of the Interior, representatives from state agencies with regulatory authority over ANS issues and academics from state universities with expertise in ANS were involved in the review process. A complete list of individuals and their respective agencies are included in Appendix B. Public comments were solicited from local governments, private industry, public and private organizations, and resource user groups. All comments were considered and incorporated where appropriate. A summary of these comments is included in Appendix E. The draft plan was approved by the ANS Task Force in October, 2008. Funding from the U.S. Fish and Wildlife Service ($34,677) was received in May, 2009 to be used toward implementation of the plan.

To effectively manage ANS, a definition must first be established to help focus resources aimed at control and management of individual species. Oklahoma will use the definition for invasive species, or for the purpose of this report, ANS, outlined in Executive Order 13112 on Invasive Species, signed by President Clinton on February 3, 1999. The Order states that an "invasive species" is one that is non-native to the affected ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. As per this definition, not all non-native species are considered ANS. ODWC uses non-native species, such as striped bass *Morone saxatilis* and walleye *Sander vitreum* and their hybrids in its management programs. These species have created economically valuable fisheries with no measurable negative affects on reservoir ecosystems.

C. Problem Definition

Non-indigenous Aquatic Animals

A draft list of non-indigenous aquatic animals in Oklahoma is included in Appendix A and is based on existing data. As such, the list is likely incomplete as information on such animals in Oklahoma is limited. A discussion of ANS species considered of special concern in Oklahoma follows.

Asian Carp: The life history traits of Asian carps (e.g., reproductive capability, population densities, feeding habits, broad climate tolerance, mobility, and longevity) indicate that they have a high probability of causing ecological and economic effects where populations become established (Mandrak and Cudmore 2004; Kolar et al. 2005; Nico et al. 2005). In some locations of the Mississippi River Basin, such effects have occurred. Natural resources managers are concerned that the four species of Asian carp have the potential to cause extensive and irreversible changes to the aquatic

environment, thereby jeopardizing the long-term sustainability of native aquatic species, particularly to imperiled, threatened, and endangered species. Confounding this situation is the fact that the bighead carp has been cultured and sold as a live food fish product since the early 1980s, grass carp *Ctenopharyngodon idella* have been stocked nationally by public and private entities since the late 1960s as a biological control for aquatic weeds (grass carp are also cultured and sold as a live food fish product), and the black carp *Mylopharyngodon piceus* has been used since the early 1980s as a biological control for pest snails in commercial aquaculture production ponds.

Small silver carp *Hypophthalmichthys molitrix* and bighead carp resemble gizzard shad *Dorosoma cepedianum*. Cast-netting for bait in tailwaters below some major reservoirs in Oklahoma has the potential to introduce Asian carp into some of the premier sport fishing lakes in the state. Anglers routinely cast net for bait below the Dennison Dam at Lake Texoma and use the bait to fish for striped bass or catfish in Lake Texoma. Asian carp can be accidentally introduced into the lake through this practice. Bighead and silver carp have reproductive requirements similar to those of striped bass. There is a real potential to establish a reproducing population of Asian carp in Lake Texoma which could be devastating to the striped bass fishery and paddlefish *Polyodon spathula* recovery efforts. A 13-pound bighead carp, a photo of which was verified by an ODWC fisheries technician, was shot by a bowfisherman in Lake Texoma in 2009.

Grass Carp (*Ctenopharyngodon idella*): Grass carp are native to large rivers in Asia, ranging from the Amur River in China and Siberia south to the West River in China and Thailand. As a food fish, the species has been cultured nearly worldwide. The diploid grass carp has been used for biological control of aquatic plants. Numerous studies have been conducted to evaluate its potential for reproduction, feeding preferences, stocking rates, and impacts on other aquatic resources (Smith and Shireman 1983). However, the potential of the diploid grass carp to naturally reproduce caused considerable controversy over its use as a biological control agent. This eventually led to the production of sterile, triploid grass carp which most states allow to be used for the control of aquatic plants, at least for experimental purposes. Through the use of grass carp to control excessive aquatic vegetation, they have been legally introduced into at least 35 states, including Oklahoma. Diploid grass carp stocking for control of aquatic vegetation in private waters was legalized in Oklahoma in the early 1980's. Currently grass carp are available for purchase for private use through a number of commercial fish producers in the state. The Oklahoma Department of Wildlife Conservation currently uses grass carp on its four fish hatcheries for control of aquatic vegetation in culture ponds. Grass carp orient to flow and will quickly leave ponds when water is flowing over the spillway. Today grass carp can be found in most reservoirs in Oklahoma and reproduction of grass carp has been verified in Lake Texoma by ODWC biologists and the University of Oklahoma (Hargrave and Gido 2004). The ability of grass carp to consume vegetation and reproduce in state waters gives them the potential to significantly impact, if not totally eradicate, beneficial aquatic plants. Without protective and escape cover, small species of fish and young game fish abundances would decline. Their distribution throughout the state makes grass carp a significant threat that warrants attention. Effective 1 January 2010, triploid grass carp only can be stocked in private waters for vegetation control. Possession of diploid grass

carp by licensed commercial aquaculture facilities will be legal for exportation to states allowing diploid grass carp and for the production for the human food market only.

Bighead carp (*Hypophthalmichthys nobilis*): The bighead carp is a large-bodied planktivore endemic to eastern China. In 1973, an aquaculturist introduced bighead carp into Arkansas in an attempt to improve water quality in production ponds (Freeze and Henderson 1982). In 1974, regulations were mandated to restrict bighead carp stocking into public waters of Arkansas to reduce the probability of accidental introductions. Despite these regulations, bighead carp escaped from aquaculture facilities and subsequently dispersed into nineteen states. The bighead carp has been observed in Oklahoma below Hugo dam in the Kiamichi River, below Denison Dam on the Red River, and in the Neosho River in and above Grand Lake (Pigg et al. 1993; Pigg et al. 1997). Five bighead carp were reported from the Neosho River and Grand Lake in spring 2009, all large adults. A single bighead carp was reported by a bowfisherman, verified by an ODWC fisheries technician, from Lake Texoma in 2009. This species is currently not in sufficient numbers to cause harm, but this situation could change as bighead carp become more widespread in Oklahoma and if reproduction in the Neosho River and/or Lake Texoma is verified.

Silver carp (*Hypophthalmichthys molitrix*): Silver carp were imported and stocked for phytoplankton control in eutrophic water bodies and also as a food fish. They were first brought into the United States in 1973 when a private fish farmer imported them into Arkansas. By 1980 the species was discovered in natural waters, probably a result of escapes from fish hatcheries and other types of aquaculture facilities (Freeze and Henderson 1982). In numbers, the silver carp has the potential to cause enormous damage to native species because it feeds on plankton required by larval fish and native mussels. Population densities in the Mississippi River have exploded and native fish species have been displaced. Presently, silver carp have been recorded in 12 states including Oklahoma (Benson et al. 2001). Although they have been found in Oklahoma, silver carp do not appear to be causing any severe problems at this point. This situation could change as silver carp become more widespread. Monitoring of this species will be needed.

Black carp (*Mylopharyngodon piceus*): The black carp is a large river fish native to Pacific drainages in eastern Asia. Black carp entered the United States in the early 1970s as a contaminant in imported grass carp and are currently being maintained in research and fish production facilities in seven states including two that border Oklahoma (U.S. Fish and Wildlife Service 2002). Approximately 30 black carp escaped from a fish farm in Missouri into the Osage River, Missouri River basin, in April 1994. The first specimen reported from the wild was captured in March 2003 from Horseshoe Lake, Illinois. A second specimen was captured from the wild in the lower Red River, Louisiana in April 2004 (Nico and Fuller 2004). In 2007, the black carp was listed as an injurious species under the Lacey Act. Black carp are likely to survive in the wild and spread throughout the Mississippi drainage. Black carp are molluscivores but also feed on freshwater shrimp, crayfish, and insects thus competing for food with native fish and wildlife species (Nico and Williams 1996). If black carp become established in North American ecosystems, their feeding habits could drastically modify the ecological

balance and forever change the aesthetic, recreational, and economical values of native aquatic systems. This species would also be especially harmful to native unionid mussels, a taxonomic group that is already imperiled throughout its native range. It is highly probable that black carp would feed on and reduce populations of native mussels and snails (Nico and Williams 1996). Even at relatively small sizes (age 4), black carp will eat 3-4 lbs. of mollusks daily, posing a direct threat to one of the most diverse mollusk faunas in the world.

The risks that black carp pose to ecosystem integrity do not stop at its direct effect via mollusk predation. Mollusks serve a critical role in maintaining ecosystem health through their role as filter feeders. Mollusks also serve as "early warning systems" in identifying degrading water quality. Black carp also pose a threat to other aquatic organisms through competition for food with native molluscivores and serve as hosts to a wide array of parasites that could have negative impacts on native species and potentially humans. Black carp have not been reported in Oklahoma, but the potential ecological harm posed by black carp and their current proximity to Oklahoma make it a significant threat that warrants attention.

White perch (*Morone americana*): A native to the Atlantic coast region of North America, the white perch invaded the Great Lakes in the 1950s through the Welland and Erie canals (Boileau 1985). Through competition with native species, predation on fish eggs, preying on young fish, and hybridization with white bass *Morone chrysops*, white perch can quickly become the dominant species in freshwater lakes. White perch tend to stunt and become undesirable when over-population occurs in freshwater lakes (Scott and Crossman 1990). Since its arrival, it has been associated with declines in both walleye and white bass populations in those areas where it has become well-established. White perch were introduced in Kansas from a contaminated stocking of striped bass in Cheney Reservoir. A reproducing population subsequently became established followed by downstream migration in the Arkansas River. The species is now established in Kaw Lake, Oklahoma. White perch populations have spread into Kaw, Sooner and Keystone Lakes in Oklahoma with continued migration downstream throughout the Arkansas Rivers system appearing likely. This is a priority species, and demands immediate attention and management.

Brook Stickleback (***Culaea inconstans***): Brook sticklebacks occur in Canada and the northern United States, but have become established to the south, including Oklahoma, through bait bucket transfers. Pigg et al. (1993) discovered brook stickleback in a bait shipment of fathead minnows from Minnesota and suggested a possible link between its introduction into Oklahoma and the bait fish industry. A much earlier report in Oklahoma is apparently based on observations of this species in bait tanks near Ft. Gibson Reservoir in Wagoner County (Heard 1959; Moore and Riggs 1963). Although, there are no verified records from open waters, at least some individuals were likely introduced through discarded or escaped bait. The impact of their introduction is largely unknown at this time. Woodling (1985) stated that the species is pugnacious and preys on eggs. As such, its use as a bait fish is discouraged so as to prevent accidental range expansion.

Rudd (*Scardinius erythrophthalmus*): Introduced into the United States in the early

1900s as baitfish, this Eurasian native is found in 20 states, including Oklahoma (Nico and Fuller 2003). Similar in appearance to the golden shiner *Notemigonus crysoleucas,* the rudd is capable of growing to 20 inches in length. Currently, the rudd is one of the most rapidly spreading non-indigenous fishes in the United States. The greatest threat posed by the rudd is its ability to hybridize with the golden shiner which may endanger that species' genetic integrity (Burkhead and Williams 1991). While little is known about the threat posed by rudd, its occurrence in several Oklahoma rivers suggest the need to monitor this ANS.

Northern snakehead (*Channa argus*): Most likely brought into the United States as a food fish, the northern snakehead is a predatory fish native to Asia. It became a concern in the Mid-Atlantic after being discovered in Maryland ponds and the Potomac River (Courtenay and Williams 2004). A voracious predator with sharp teeth and mature body length from three to four feet, snakeheads have the potential to drastically alter freshwater ecosystems by out competing native fish species, including many sport fish. Snakeheads prey on fish, frogs, crustaceans, and aquatic insects. Many species of snakehead fish, including northern snakehead, have the ability to breath air and crawl short distances between waterbodies. Its native range suggests it could become established throughout the contiguous United States (Courtenay and Williams 2004). It is currently illegal to possess or import any species of snakehead (*Channa* spp.) or their eggs in Oklahoma. A reproducing population was confirmed in the Pine Creek drainage in eastern Arkansas in April, 2008. An eradication process was implemented by the Arkansas Game and Fish Commission to control the population. Northern snakeheads have not been reported in Oklahoma, but the potential ecological harm posed by northern snakeheads and their current proximity to Oklahoma make it a significant threat that warrants attention.

Zebra mussel (*Dreissena polymorpha*): The zebra mussel is one of the best known invaders of the Great Lakes region and other areas of the country where it has spread. Zebra mussels were introduced from Eastern Europe via ballast water discharge from European freighters. In the late-1980s, the zebra mussel was discovered in Lake St. Clair, between Lake Huron and Lake Erie. This species spread rapidly to 20 states in the Mississippi River drainage. Zebra mussels can easily survive overland transport while attached to boat hulls or in live wells, engine cooling systems, or bait buckets. Live zebra mussels have been found at California agricultural stations on boats from the Midwest, and in Washington on boats destined for British Columbia.

The zebra mussel is a prolific fouling organism with great potential to disrupt fish passage facilities and cause ecological and economic damage. It is a highly opportunistic mollusk, reproduces rapidly, and consumes large quantities of plankton from the water column (Trometer et al. 1999). The potential and profound impacts to fisheries include changes in food availability and spawning areas. Reductions in density and biomass of the zooplankton community may result in reduced growth or abundance of age-0 fish. The first year of a fishes' life is a time when it is most vulnerable to predation; reduced growth rates at this age may extend this period of vulnerability (Wu and Culver 1991).

Economic impacts of zebra mussels are primarily caused by their fouling characteristics.

Mussel build-up on water intake/discharge structures cause utilities, and industries to incur significant costs associated with monitoring, cleaning, and controlling infestations. According to a recent economic impact study, each of 84 Great Lakes water users reported average total zebra mussel control expenditures of $513,600 over the five-year period from 1989 to 1994 (Hushak et al. 1995). Nationwide expenditures to control zebra mussels in water control infrastructures are estimated at $3.1 billion over 10 years (U.S. Congress Office of Technology Assessment 1993).

In Oklahoma, Zebra mussels were first found in the McClellen-Kerr Arkansas River Navigation System 1993, most likely moving up the river with barge traffic. From there zebra mussels have moved up the navigation system and have attached to locks in the Port of Catoosa near Tulsa. Populations remained relatively low, rarely exceeding $5000/m^2$. However, a population explosion occurred in 2004, coincident with a mild summer, when densities in excess of $100,000/m^2$ were recorded. Zebra mussels were found in Oologah Reservoir in 2003, likely as hitchhikers on recreational boat traffic. Zebra mussels were found in Kaw Reservoir in 2004, likely moving downstream from a population established in El Dorado Lake, Kansas. Zebra mussels continued to move downstream, infesting Sooner and Keystone Reservoirs and can currently be found throughout the Arkansas River in Tulsa. Two zebra mussel adults were found in Grand Lake in 2006 but no veligers have been found there to date. Zebra mussels have been discovered on several boats by marina personnel who prevented the infested boats from being launched in the lakes. Adult zebra mussels were recently found in Hudson and W.R. Holloway lakes in 2009. Adult mussels have also been found in Lake Texoma and have become well distributed throughout the lake. Considered a high priority species, zebra mussels represent a serious threat to Oklahoma's aquatic resources and deserve immediate management action.

Quagga mussel (Dreissena bugensis): Quagga mussels are native to Caspian Sea drainage in Eurasia. They most likely arrived as stowaways in the ballast water of ocean going ships. They were discovered in the Great Lakes region in September 1989. The quagga mussel is related to the zebra mussel but was not identified as a distinct species until 1991. Quagga mussels like silty or sandy lake bottoms. They can live in waters ranging from warm and shallow to deep and cold. They are also able to tolerate somewhat salty water. A quagga mussel feeds all year, even in winter when zebra mussels are dormant. In addition, it may have the same potential as the zebra mussel to clog water intakes. Quagga mussels can easily survive overland transport while attached to boat hulls or in live wells, engine cooling systems, or bait buckets. Quagga mussels were recently found attached to a boat preparing to but prevented from launching at Eisenhower State Park on Lake Texoma. To date, no other reports of quagga mussels have been made in Oklahoma, but it is considered a priority species because of the potential for infestation and environmental damage.

Exotic waterflea (*Daphnia lumholtzi*): Native to Africa, Australia, and India, this Cladoceran species was first discovered in 1990 in Texas. It has since been found in several Midwestern states including Kansas, Missouri, and Oklahoma. Havel and Shurin (2004) reported *D. lumholtzi* from Atoka, Broken Bow, Coalgate, Copan, Fort Gibson, Grand, Greenleaf, Hugo, Humphreys, Keystone, Murray, Pine Creek, Raymond Gary, Robert S. Kerr, Sardis, Texoma, Tenkiller, and Waurika reservoirs in Oklahoma.

The continuing discovery of the organism in new locations could be due to contaminated stockings of fish through commercial trade. At the same time, the close proximity of affected reservoirs might lead to the conclusion that it may have spread by recreational boating from infested reservoirs (Benson et al. 2005). Analyses of pre-invasion zooplankton communities indicate that *D. lumholtzi* may be invading reservoirs in which native *Daphnia* species are rare. While the long-term effects of the invasion of *D. lumholtzi* are unknown, it has the potential to dominate late summer zooplankton communities in reservoirs (Dzialowski et al. 2000).

New Zealand mudsnail (*Potamopyrgus antipodarum*): Native to New Zealand, this species was discovered in North America in 1987 and has rapidly spread throughout the western United States. It is a parthenogenetic livebearer with a high reproductive potential. Mature New Zealand mudsnails (NZMS) average 5 mm in length; juveniles are much smaller, making them difficult to notice on gear. Snail populations can reach densities greater than 100,000/m^2 in suitable habitat. The highest recorded densities reported are 800,000/m^2 in Lake Zurich, Switzerland, where this species colonized the entire lake in less than seven years (Richards 2002). To date, few data have been reported or research conducted on the impacts of the animal on native macroinvertebrate populations or aquatic ecosystems.

Concern about the potential impacts of the NZMS on native species, fisheries and aquatic ecosystems in the western United States has been generated by the rapid spread of this species. NZMS degrade habitat with their high reproductive capacity and the subsequent impacts on invertebrate food sources. Its spread into new systems is considered to be primarily human-caused and unintentional transport by people is probably the primary vector for the spread of NZMS. The snail clings to the boots of anglers wading in infested streams. The NZMS has not been reported in Oklahoma, but is considered a priority species because of the late 2004 introduction into Colorado and the highly mobile nature of trout anglers.

Rusty crayfish (*Orconectes rusticus*): The native range of the rusty crayfish is Illinois, Indiana, and Ohio. However, in recent years its distribution has expanded because of the use of live crayfish as bait by anglers. They are more aggressive than other native crayfish, better able to avoid fish predation, and can harm native fish populations by eating their eggs and young. They can displace native crayfish, hybridize with them, and graze on and eliminate beneficial aquatic plants. Large populations can adversely impact native plant populations (Lodge et al. 2000). As a result of its voracious appetite, it competes with other aquatic organisms for food. Eradicating established infestations is currently impossible. The rusty crayfish has not been found in Oklahoma, but it has been transplanted to new waters in neighboring states where self-sustaining populations have become established. The species warrants attention.

Nutria (***Myocastor coypus***): The nutria is a large semi-aquatic rodent smaller than a beaver but larger than a muskrat. Nutria are strict vegetarians consuming approximately 25 percent of their weight daily. Nutria predominately feed on the base of plant stems and dig for roots and rhizomes in the winter. Native to South America, nutria were imported into the United States in the 1930's for fur farms. They were

released, either intentionally or accidentally, in the Louisiana marshes and soon after, feral populations were established near the Gulf Coast. Nutria continued to expand their range from there as they were trapped and transplanted into marshes from Port Arthur, Texas to the Mississippi River. Rapid population growth followed for several years thereafter and reports of agricultural damage increased. In 1958, nutria were taken off the list of protected wildlife. They have been found in far southeast Oklahoma where their impact on aquatic environments is primarily by reduction of native vegetation in marsh and riverine areas.

Golden Alga (*Prymnesium parvum*): Harmful algal blooms are ubiquitous world wide in marine and freshwater systems. Texas has documented fish kills from golden alga in inland waters since 1985. The spread of golden alga in Texas and resulting fish kills have had major ecological and economic ramifications. A fish kill in the upper Red River arm of Lake Texoma attributed to golden alga occurred in January 2004. A golden alga-related fish kill in Altus City Lake was documented in August 2004. Fish kills in the upper Red River arm of Lake Texoma occurred in February 2006 and again in March 2007. Given the history of reoccurrence of golden alga-related fish kills in Texas, it is anticipated that such kills will reoccur in infested waters and likely spread to waters not currently experiencing kills related to golden alga.

ODWC developed the Oklahoma Harmful Algal Bloom Response Plan to coordinate a timely interagency response to harmful algal blooms (Appendix C). In addition, ODWC is currently funding research conducted by the University of Oklahoma on the toxicology of the prymnesin toxin to various sport fishes and zooplankton and the ecological interactions of golden alga with phytoplankton and zooplankton communities in Lake Texoma. The University of Oklahoma is also currently monitoring golden alga abundance on Lake Texoma and investigating physical, chemical, and ecological triggers to blooms and toxin production. A proposed expansion of these efforts on a statewide basis would identify lakes at risk and focus on efforts to control the spread to currently uninfested water bodies.

Didymo (*Didymosphenia geminata*): Didymo is a diatom which is native to the northern hemisphere. Until recent years, it occurred at low levels in pristine lakes and streams but has become invasive, forming dense mats in many streams in North America. In close proximity to Oklahoma, Didymo has been found in Colorado and the White River in Arkansas. This invasive species attaches to rocks and plants in streambeds and may impact freshwater fish, aquatic plants, and important aquatic insects. Didymo can completely smother rocks and plants and reduce the area of clean substrate and interstitial spaces on which fish and their prey depend for spawning and feeding. It also tends to outcompete native algal species, many of which are food for aquatic insects, which are the main diet source of native stream fishes. Didymo mats have become so thick in some areas it became impossible for anglers to fish. Didymo is particularly fond of cold tailwaters and, as such, poses a particular threat to the trout fisheries in the lower Illinois and Lower Mountain Fork Rivers. Didymo was found in the Lower Mountain Fork River in April 2009 by ODWC and was officially confirmed by algal experts at the OU Biological Survey. Anglers have been the principle means of spread. This introduction was most likely caused inadvertently by trout anglers from Arkansas. Trout anglers who fish streams in the western United States and Arkansas, and return

Comment [j1]: Include text re: didymo presence in LMFR

to fish the lower Illinois and/or the lower Mountain Fork rivers must take precautions to avoid spreading Didymo to state waters.

Viral hemorrhagic septicemia: Viral hemorrhagic septicemia (VHS) has historically been considered as the most serious viral disease of salmonids reared in European freshwater environments. VHS has been associated with marine finfish species, and most recently has become an emerging disease of freshwater fish in the Great Lakes region of the United States and Canada. VHS is an aquatic rhabidovirus and is shed in the urine, feces, and sexual fluids. Infested waters include clinically ill fish and asymptomatic carriers. Transmission can occur through the water or by contact.

Prior to 2003, isolates of the VHS virus were limited in North America to saltwater finfish from the Atlantic and Pacific Oceans, including Chinook and Coho salmon, Pacific herring, Atlantic herring and cod. VHS was first detected in the Great Lakes region in the Bay of Quinte, Lake Ontario, in 2005, and was subsequently detected in an archived 2003 sample from Lake St. Clair. VHS virus also was detected in Lake St. Clair in 2005 and in Lake Ontario, Lake Erie and the St. Lawrence River in 2006 in a variety of fish species. Since 2005, the list of species known to be affected by VHS has risen to more than 40, including a number of ecologically and recreationally important fish.

Retail sales and live release of baitfish into the wild represent an area of concern for the potential introduction and/or spread of VHS. Fish belonging to the cyprinid family and other species are collected from the Great Lakes and used as bait for sport fisheries around the U.S. Baitfish from Canada are also routinely exported to the U.S. Additionally, some aquaculture producers collect baitfish brood stock from the Great Lakes to produce commercial baitfish in their facilities. The destinations and numbers of baitfish moved are not well documented, and regulation of this sector is inconsistent among States, or lacking entirely. Live sale of fish by commercial fishers is also a concern. Fish from Lake Erie are sold live in Ontario, Canada for transport to pond aquaculture facilities in the Midwest U.S. The species, volume and destinations of these fish are not well documented.

Recent federal restrictions on interstate movement of fish from the Great Lakes region are aimed at slowing the spread of VHS. The virus has not been detected in Oklahoma but monitoring and disease-free certification of imported fish should be a priority.

Largemouth Bass Virus: Largemouth Bass Virus (LMBV) is one of more than 100 naturally occurring viruses that affect fish but not warm-blooded animals. The origin is unknown, but it is of the Iridovirus family, genus Ranavirus. LMBV is related to a virus found in frogs and other amphibians and nearly identical to a virus isolated in some fish imported to the U.S. for the aquarium trade. Although other species of fish can serve as carriers, symptoms of disease have been evident in largemouth bass only. The mode of transmission and disease triggers are unknown. The disease appears to differentially affect the larger individuals in a population and kills have resulted in negative impacts to sport fisheries. However, long-term impacts to largemouth bass fisheries have been negligible.

LMBV fish kills have been reported throughout the southeast and Midwest United States. Although LMBV-related fish kills have been suspected on a number of Oklahoma reservoirs, LMBV has been verified as the causative agent of kills only on Tenkiller in 2000 and Wes Watkins reservoirs in 2005. Since 2000, 26 lakes have been tested for LMBV with positive results found at Arbuckle, Eucha, Eufaula, Ft. Gibson, Grand, Hudson, Keystone, Konawa, Lawtonka, McGee Creek, Murray, Okemah, Oologah, Sardis, Skiatook, Sooner, Tenkiller, Texoma, Thunderbird, Webbers Falls and Wes Watkins. Lakes Arcadia, Bixhoma, Broken Bow, Crowder and Holdenville have so far tested negative for LMBV. Because of the short-term impact to economically valuable largemouth bass fisheries, and the vast amount of negative publicity generated by such kills, LMBV warrants attention in this plan.

Spring Viremia of Carp: Spring viremia of carp (SVC) is a contagious and potentially fatal viral disease affecting fish. As its name implies, SVC may be seen in carp in the spring season. However, SVC may also be seen in other seasons (especially in the fall) and in other fish species including goldfish and the European wells catfish. Until recently, SVC had only been reported in Europe and the Middle East. The first cases of SVC reported in the United States were in Spring 2002 in cultivated ornamental common carp (Koi) and wild common carp. The number of North American fish species susceptible to SVC is not yet known. The first signs of SVC disease in fish may be a change in behavior. The diseased fish may breathe and move more slowly, form groups in slow–flowing water near the pond bank, and lie on their side at the pond bottom. On the outside of a fish with SVC, the skin and gills may appear dark red, the eyes may bulge outward, the belly may be swollen, and bloody mucus may hang from the vent. On the inside of a fish with SVC, a lot of fluid may be in the belly cavity and internal organs, blood in the swim bladder, and reddening and swelling of the gut. However, not all fish showing these signs necessarily have SVC, as these same signs may also be seen in many other diseases. Those fish that don't die from SVC may recover and appear healthy, but these fish actually may remain infected with the virus and continue to shed and spread the virus to other fish. Because the SVC virus may remain hidden in infected fish, the disease is difficult to eliminate from a site. Diagnosis of the SVC virus in fish can be confirmed through virus isolation and other sophisticated diagnostic tests done by an approved laboratory.

The spread of SVC may occur through contact with water contaminated with the infected fish's feces, urine, or mucus. The virus may be spread through contaminated equipment, fish parasites, predatory birds, and on the outside of an infected fish's eggs. Once SVC is established at a site, it may be difficult to eradicate because of virus–infected carrier fish. It may be necessary to destroy all aquatic life in a pond to eliminate the disease from the site. Although complete eradication is difficult, SVC can likely be controlled and contained within high–risk zones through surveillance and better management practices, including strict biosecurity procedures. People may transmit the virus from place to place on their clothing, footwear, equipment, etc, but the virus does not cause disease in humans.

SVC has not been confirmed in Oklahoma; however. in 2006 a Koi retailer received a shipment of fish that exhibited many of the classic SVC symptoms. The merchant destroyed the dead and dying fish but released those that were still alive into Lake

Hefner in Oklahoma City. The popularity of Koi and the regular importation of these fish from other parts of the U.S. and abroad, warrant careful attention and inclusion of SVC in this plan.

Whirling Disease (*Myxobolus cerebralis*): Whirling disease is a metazoan parasite that penetrates the head and spinal cartilage of fingerling trout where it multiplies very rapidly, putting pressure on the organ of equilibrium. This causes the fish to swim erratically (whirl), and have difficulty feeding and avoiding predators. In severe infections, the disease can cause high rates of mortality in young-of-the-year fish. Those that survive until the cartilage hardens to bone can live a normal life span, but are marred by skeletal deformities. Fish can, however reproduce without passing on the parasite to their offspring.

The minute whirling disease organism, native to the Eurasian continent, was introduced into North American waters in the late 1950s. So far its severe damage has been primarily to wild rainbow populations, although many other salmonid species can become infected, with or without clinical disease. Brown trout *salmo trutta*, also a European import, become infected but rarely suffer clinical disease. Under some circumstances infected brown trout suffer some mortality, but they always insure the survival of the parasite. Regardless of species, when each infected fish dies, many thousands to millions of the parasite spores are released to the water. The organism is virtually indestructible. Spores can withstand freezing and desiccation, and can survive in a stream for 20 to 30 years. Eventually, it must be ingested by its alternate host, the tubifex worm *Tubifex tubifex*, where the spore takes on the form that once again will infect trout fry.

The parasite that causes whirling disease will continue to spread to drainages now clean, since it is so easily and unknowingly transported by animals, birds and humans. The ODWC purchases trout for stocking in public waters from a variety of out-of-state commercial producers. Winter trout fisheries in various private waters, also supported by purchasing trout from out-of-state suppliers, have become popular. Although whirling disease has not been reported from Oklahoma, this disease is listed in this plan to help ensure that trout continue to be purchased from certified disease-free suppliers.

Non-indigenous Aquatic Plants

A draft list of non-indigenous aquatic plants in Oklahoma is included in Appendix A. This list is incomplete as information on non-indigenous aquatic plants in Oklahoma is somewhat limited. The following ANS species are considered of special concern in Oklahoma: Alligatorweed, Eurasian Watermilfoil, Hydrilla, Purple Loosestrife, Salvinia, and Water Hyacinth. Currently, Hydrilla is considered a high priority species. A discussion of each species follows.

Hydrilla (*Hydrilla verticillata*): Hydrilla is the most damaging aquatic weed in the United States. It was imported into the United States from Asia in the early 1950s for use in aquariums, and was likely introduced into the wild near Tampa and Miami, Florida. It was popular in the aquarium trade until Federal regulations banned its interstate sale and movement. Distribution in the United States now ranges from Connecticut southward along the coast to Texas. The plant is also present in California and Washington. Several inland states (Illinois, Michigan, Pennsylvania, Tennessee and Arizona) also have populations.

Hydrilla plants produce long stems with whorled leaves and are profusely branched at the water surface. It thrives in low light conditions and can be found in streams, ponds, lakes and reservoirs. Reproduction is by fragmentation, seeds, tubers, and turions. Hydrilla is most likely to spread when plant fragments are carried on boat trailers into new habitat.

Hydrilla causes major problems with water use. In drainage and irrigation canals, it greatly reduces flow and causes clogging, which can result in flooding and damage to canal banks, structures, and pumps. In utility cooling reservoirs, hydrilla can disrupt flows necessary for adequate water-cooling. Hydrilla can interfere with recreational and commercial vessel navigation. In addition to interfering with boating by fisherman and water skiers, hydrilla hampers swimming, displaces native vegetation communities, and can damage sport fish populations. The economic consequences of aquatic weed infestations can be staggering. Annual expenditures to control aquatic weeds in the United States (most of them non-natives, such as hydrilla) are reported to be $100 million (OTA, 1993). Three hydrilla infestations are known to occur in Oklahoma (Arbuckle, Murray and Sooner reservoirs), although surveillance efforts have been limited.

Giant Salvinia (*Salvinia molesta*): The number one noxious aquatic plant in the world, Giant Salvinia is a perennial, aquatic fern, from South America which is very common in the water garden and aquarium industries. In favorable environments, plants may be expected to double in volume within a week. Giant salvinia is a small, floating plant with round to oblong, light green leaves that have hair-like projections on their surface. Submerged leaves function as modified roots. The plant prefers shallow, fertile waters to moist soil areas. It can be found in ponds, lakes and slow moving streams. Reproduction is by fragmentation and spores. It forms extensive mats that can completely cover water surfaces resulting in the degradation of natural habitats by shading native plants, reducing available dissolved oxygen, and creating large amounts of decaying plant material. The mats are reported to be up to three feet thick, which

hinders management by chemical control, and the weed reproduces so rapidly that infestations quickly become impossible to eradicate. It is known to over-winter easily by blanketing sister plants. Giant Salvinia can clog water intakes, which interferes with irrigation, drainage, and electrical generation. In the United States it has been observed in Arizona, South Carolina, North Carolina, Texas, Louisiana, Mississippi, and California. Its expected range includes portions of southern and western Oklahoma (USGS, 2000). Within a year of its 1998 discovery in the United States, Giant Salvinia was found in six states and over a dozen watersheds. Human transport will spread Giant Salvinia locally, with plants adhering to and carried overland on anything entering infested waters, including boats, trailers, vehicular wheels, intakes and gear and other plants. It has been found for sale in a number of nurseries in Oklahoma, mostly for use in water gardens. The Oklahoma Department of Agriculture, Food and Forestry (ODAFF) has issued stop-sell orders to all vendors and confiscated and destroyed plants. However, shipments of plants from other states where Salvinia infestations are unchecked still occur and local nurseries report receiving "hitchhiking" Salvinia regularly. Internet sale and shipments of the plant continue unchecked.

Alligator weed (*Alternanthera philoxeroides*): Alligatorweed is a member of the pigweed family that has spread quickly throughout the southern United States. Several members in this genus are readily available in the ornamental trade. It produces white, clover-like flowers on hollow stems supporting oppositely arranged leaves. The plant can grow in most aquatic environments from fully submerged to moist soil. It reproduces by fragmentation and seed. This plant is difficult to control once established. Alligatorweed easily displaces native species by producing thick monocultures. It is established in Oklahoma in the Chouteau and Newt Graham pools of the McClellan-Kerr Arkansas River Navigation system and in several homeowners' association ponds on Spring Creek in Oklahoma City. Alligatorweed flea beetles *Agasicles hygrophila* were imported into Oklahoma in 2005 as a bio-control experiment on the Spring Creek chain of lakes. Results were marginal in 2005, but 2006 releases reduced infestations by as much as 50% on some of the ponds while in others, the plants were reduced by over 75%. Oklahoma winters are likely severe enough to prevent over-wintering of the beetles so annual releases will be necessary to maintain control.

Purple loosestrife (*Lythrum salicaria*): A showy wetland plant, purple loosestrife is popular in the ornamental trade because of the brilliant purple spike of flowers. It is still sold in some states, although 24 states, including Oklahoma, have listed it as a noxious weed and prohibit its sale. It grows up to 8 feet tall in thick stands. It has leaves that are arranged opposite along the stem and are lance shaped. It was originally imported from Eurasia in the early 1800s for its medicinal value and beautiful flowers. It inhabits damp terrestrial sites often bordering bodies of water. Reproduction is primarily by seed with each plant producing up to 2 million seeds. It can crowd out native wetland plants and has been spreading across the United States for decades. Estimated losses are $45 million per year in control costs and forage loss (ATTRA, 1997). It is found in 42 of the contiguous states, and could invade the remaining six. It is present in Oklahoma with a persistent stand at Guthrie City Lake.

Eurasian Watermilfoil (*Myriophyllum spicatum*): The most problematic non-indigenous plant in northern and central United States. It is a submersed, rooted perennial with branching stems that fill the water column. It has leaves divided into feathery, threadlike leaflets. It inhabits reservoirs, lakes, ponds and back water areas. Reproduction is primarily by fragmentation and it is capable of establishing new colonies when disturbed by recreational activity, and it is easily transported to new waterbodies through fouling of boat props and trailers. The species has also been introduced through the aquarium trade and water gardens. Once established in a waterbody, it can quickly grow into dense mats that shade out native plants, reduce fish habitat and recreational use. It is present in Oklahoma in several reservoirs (Fuqua, Longmire), many smaller city water supply lakes and numerous farm ponds.

Water Hyacinth (*Eichornia crassipes*): Water hyacinth is present in all Gulf Coast states as well as California. Its presence has caused massive problems with navigation, water based recreation, canal systems, and pumping stations as it can completely cover lakes with floating mats that become dislodged and stuck in water intakes. Although the risk of water hyacinth overwintering in Oklahoma is considered small due to cold winter air temperatures, its continued use in water gardens poses a threat that it will adapt to colder temperatures, or become established in thermal refugia. Water hyacinth has been found in Lake Eufaula, Soldier Creek in Midwest City and Landsbrook Lake in Oklahoma City, all probable releases from water gardens.

D. Goal

The goal of the Oklahoma ANS Management Plan is to:

Minimize the harmful ecological, economic, and social impact of ANS through preventing the introduction and managing the population growth and dispersal of ANS into, within, and from Oklahoma.

The goal will be achieved through implementation of a plan that:

- emphasizes prevention of introductions;
- requires a risk assessment and review for all aquatic non-indigenous species prior to their importation, transport, or use in Oklahoma;
- allows for early detection;
- includes development of contingency plans;
- permits appropriate and timely response to new and existing populations;
- protects and restores native plant and animal communities;
- provides for access to accurate up-to-date distribution and management information;
- incorporates education and research elements;
- recommends funding levels adequate for effective implementation;
- produces agency collaboration through an invasive species council;
- facilitates inter-jurisdictional coordination with state, federal and tribal agencies;
- seeks cooperative solutions with the private sector and user groups.

It is not possible to address all potential invaders, their impacts, and the constraints and contingencies that may develop. Consequently, this plan is intended to be adaptable to changing circumstances. As a result, continual review of the plan is imperative to use the most up-to-date information and procedures to limit the spread of ANS both into and within Oklahoma.

E. Existing Authorities and Programs

The State of Oklahoma currently has a limited number of statutory and regulatory authorities aimed at prevention and control of ANS. Existing statutes and regulations were drafted and passed with the intent of dealing with specific concerns as they arose and were not intended to be proactive in dealing with the threats of invasive species. State statutory authority pertaining to ANS is spread across several agencies and coordinated efforts to date have been lacking. One objective of Oklahoma's ANS management plan is to identify gaps in existing statutes and regulations and to recommend development of new legislation to address shortcomings in existing authorities and programs.

STATE

Oklahoma Department of Wildlife Conservation (ODWC)

The mission of the ODWC is the management, protection and enhancement of wildlife resources and habitat for the scientific, educational, recreational, aesthetic and economic benefits to present and future generation of citizens and visitors to Oklahoma. Existing statutory authorities are inadequate to protect Oklahoma's aquatic resources from invasive species and to help the agency meet its mission. Existing authorities include:

The Wildlife Conservation Commission will constitute a policymaking board for the restoration, conservation, and management of wildlife in Oklahoma (Oklahoma Statute Title 29, §§3-103A, 7-801A). A license is needed to engage in the private commercial production of catfish, minnows, fingerlings, fish, frogs, or other aquatic species (Oklahoma Statute Title 29, §4-102A). A license is also needed to harvest, sell, buy, ship, or transport minnows into or out of Oklahoma (Oklahoma Statute Title 29, §4-115A, B). No person may transport or sell non-game fish outside Oklahoma without a commercial fishing license and a special permit for transporting or selling the fish (Oklahoma Statute Title 29, §4-105A). Violations are punishable by a fine of between $25 and $200, imprisonment for up to 30 days, or by both (Oklahoma Statute Title 29, §§4-102E, 4-105B, 4-115C).
The importation into the State and/or the possession of the following exotic fish or their eggs is prohibited (Oklahoma Administrative Code §800:20-1-2):

(1) Walking Catfish: The Walking Catfish, (*Clarius batrachus*) and other members of the exotic catfish family Claridae, including but not limited to species of the genera *Clarias, Heteropneustes, Gymnallables, Channallabes*, and *Heterobranchus* are prohibited. Any live specimens of Walking Catfish or other Claridae species within the boundaries of the State of Oklahoma are contraband and subject to seizure by the Department of Wildlife Conservation.
(2) Grass carp: Release of grass carp, also known as white amur or Chinese carp (*Ctenopharyngodon idella*) or their hybrids into public waters is prohibited in accordance with 29 O.S., Section 6-504. Importation, possession and introduction of grass carp or their hybrids for the purpose of stocking private waters is permitted.

(3) Bighead carp (*Hypophthalmichthys molitrix*).
(4) Silver carp (*Aristichthys nobilis*).
(5) Black carp (*Mylopharyngodon piceus*).
(6) Boney-tongue group: *Osteoglossum* spp., and *Arapaima* spp.
(7) Piranha group: *Serrasalmus* spp., *Pygocentrus* spp., *Rooseveltiella* spp., *Catoprion* spp., *Hydrocynus* spp., and *Salminus* spp.
(8) Electric Eel (*Electrophorus electricus*).
(9) Electric catfish (*Malapterus electricus*).
(10) Gar-pike topminnow (*Belonesox belizanus*).
(11) Snakehead groups: *Opicephalus* spp., and *Channa* spp.
(12) Pavon or Peacock Bass (*Chichla temensis* and *Chichia ocellaris*).
(13) Parasitic South American Catfish group (*Candiru*), genera & species of the Trichomycteridae family. *Vandellia* spp., *Tridens* spp., and *Pyqidium* spp.
(14) Freshwater Stingray group: *Paratrygon* spp., *Potomotrygon* spp., and *Disceus* spp.
(15) Houri (from South America): *Macrodon* spp., and *Hoplias* spp.
(16) Rudd and rudd hybrids (*Scardinius* spp.).
(17) Blueback herring (*Alosa aestivalis*).

The following species shall be permitted by application and written letter of authorization from the Department of Wildlife Conservation for research purpose only (Oklahoma Administrative Code §800:20-1-2):

(1) Alewives (*Aloso pseudoharengus*).
(2) Rainbow smelt (*Osmerus mordax*).

Currently, no permits are active.

The use of *Tilapia* is restricted as follows (Oklahoma Administrative Code §800:20-1-2):

(1) The sale and use of all Tilapia species as bait is prohibited.
(2) The stocking of all *Tilapia* species in any heated-water reservoir including Sooner, Konawa and Boomer Reservoirs is prohibited.
(3) This shall not interfere with the sale of dead and/or processed *Tilapia* for human food or the sale or transport of *Tilapia* species for the purpose of aquatic vegetation control in privately owned ponds.

A noxious aquatic plant is any aquatic plant that may cause injury to the environment of Oklahoma and is declared noxious by regulation of the Oklahoma Wildlife Conservation Commission (Oklahoma Statute Title 29, §6-601B). It is unlawful for any person to import, transport, place, or cultivate any noxious aquatic plant or seed in Oklahoma waters (Oklahoma Statute Title 29, §6-601A). Violations are misdemeanors, punishable by a fine of between $10 and $100, imprisonment for up to 30 days, or by both (Oklahoma Statute Title 29, §6-601C). In addition to the provided criminal penalties, the commission may enforce the provisions by injunctive action (Oklahoma Statute Title 29, §6-601D). The following plants, seeds or plant parts are hereby declared to be noxious:

(1) *Azolla pinnata* – Mosquito Fern (aka – Water Velvet, Water Fern)
(2) *Caulerpa taxifolia* – Caulerpa (aka – Mediterranean Clone of Caulerpa)

(3) *Eichhornia azure* – Anchored Water Hyacinth (aka – Rooted Water Hyacinth, Blue Water Hyacinth, Saw-petal Water Hyacinth)
(4) *Hydrilla verticillata* – Hydrilla (aka – Florida Elodea, Star Vine, Oxygen Plant, Oxygen Weed)
(5) *Hygrophila polysperma* – Hygro (aka – Miramar Weed, Green Hygro, Oriental Ludwigia, East Indian Hygrophila)
(6) *Ipomoea aquatica* – Water Spinach (aka – Swamp Morning Glory, Chinese Water Spinach, Water Bindweed, Aquatic Morning Glory)
(7) *Lagarosiphon major* – African Elodea (aka – Oxygen Weed)
(8) *Limnophila* species – Ambulia (aka – Asian Marshweed, Limno, Red Ambulia, Indian Ambulia)
(9) *Lythrum salicaria* – Purple Loosestrife (aka – Loosestrife)
(10) *Marsilea quadrifolia* – Marsilea (aka – European Waterclover, Four-leaf Clover Fern, Water Fern, Water Clover, Hairy Pepperwort)
(11) *Marsilea mutica* – Australian Waterclover (aka – Varigated Water-clover, Nardoo)
(12) *Marsilea minuta* – Waterclover
(13) *Melaleuca quinquenervia* – Paperbark Tree (aka – Melaleuca, Cajeput, Punk)
(14) *Monochoria hastata* – Cat's Claw (aka – Monochoria)
(15) *Ottellia alismoides* – Duck Lettuce
(16) *Sagittaria sagittifolia* – Japanese Arrowhead (aka – Hawaiian Arrowhead, Common Arrowhead, Chinese Arrowhead)
(17) *Salvinia* spp. – all giant and common salvinia species – (aka – Salvinia, Butterfly Fern, Water Fern, Water Moss, Water Velvet, Karibaweed, Koi Kandy, Water Spangles, Floating Fern, South American Pond Fern)
(18) *Alternanthera* spp. – Alligatorweed and congeneric species (aka – Alligator-weed, Chaff Flower, lilacina, roseafolia)
(19) *Solanum tampicense* – Wetland Nightshade
(20) *Sparganium erectum* – Exotic Bur-reed
(21) *Glossostigma diandrum* – Mud Mat

The following species are classified as "Species to Watch" and are not currently listed as noxious aquatic plants. However, they are aquatic plants whose impact on the Oklahoma environment is presently unknown, and therefore, may be considered for inclusion on the noxious aquatic plant list (above) as additional information becomes available to, and as deemed necessary by, the Department of Wildlife Conservation:

(1) *Colocasia esculenta* – Wild Taro (aka – Green Taro, Elephant Ear, Taro, Dasheen)
(2) *Egeria densa* – Brazilian Waterweed (aka – Common Waterweed, Brazilian Elodea, Anacharis, Oxygen Weed, Elodea)
(3) *Eichhornia crassipes* – Floating Water Hyacinth (aka – Water-hyacinth)
(4) *Hydrocleys nymphoides* – Water-poppy (aka – Hydrocleys, Hydrocleis)
(5) *Iris pseudacorus* – Yellow Iris (aka – Yellow Flag, Yellow Flag Iris)
(6) *Ludwigia hexapetala* – Uruguay Seedbox (aka – Water Primrose)
(7) *Myriophyllum spicatum* – Eurasian Watermilfoil (aka – European Watermilfoil, Watermilfoil, Fox Tail)
(8) *Myriophyllum aquaticum* – Parrotfeather (aka – Parrot's Feather, Watermilfoil, Golden Myriophyllum)
(9) Najas minor – Brittle Naiad (aka – Slender Naiad, Spiny leaf Naiad)

(10) *Nymphoides peltata* – Yellow Floating Heart (aka – Floating Heart)
(11) *Panicum repens* – Torpedo Grass (aka – Torpedograss)
(12) *Pistia stratiotes* – Water Lettuce
(13) *Spirodela punctata* – Dotted Duckweed (aka – Punctate Duckweed, Spotted Duckweed, Giant Duckweed)
(14) *Trapa natans* – Water Chestnut (aka – European Water Chestnut)

Oklahoma Department of Agriculture, Food and Forestry (ODAFF)

ODAFF is the agency charged with licensing aquaculture facilities. The private commercial production of fish, frogs, or other aquatic species OAC 35:50-1-1 prohibits the importation or exportation of minnows and other fish species that are subject to the provisions of Sections 4-105, 4-115, and 7-602 of Oklahoma Statute Title 29. ODAFF conducts at least one inspection every two (2) years of each licensed aquaculture operation. It is unlawful for any person to operate a concentrated animal feeding operation without first obtaining a license from the State Board of Agriculture (Oklahoma Statute Title 2, §9-208).

ODAFF licenses all plant nursery operations (Oklahoma Statute Title 2, §2-3-32). Inspections of these facilities by authorized agents of the State Board of Agriculture are provided for under Oklahoma Statute Title 2, §2-3-32.2. Administrative Code 35:30-37-6 states that authorized agents have the authority to inspect any plant or plant product for the purpose of export. Under OAC 35:30-37-10, it is unlawful to knowingly propagate, sell, or offer for sale any aquatic plant pest, as listed under OAC 800:20-3-2. Under Oklahoma Statute Title 2, §2-3-32.3 the State Board of Agriculture, upon finding a plant pest at any facility, shall notify the owner in writing and issue a stop sale until treatment or destruction of the plant pest is completed. No damages shall be awarded to the owner for loss of infested or infected trees, plants, shrubs, or other plant material destroyed as a result of an order of the Board.

ODAFF licenses pesticide applicators under Oklahoma Administrative Code 35:30-17-1(8) and provides testing for such licenses under 35:30-17-4.

Oklahoma Department of Environmental Quality (DEQ)

Under Oklahoma Statute 252:611-3-1, any entity conducting an activity which may result in any discharge into, or pollution or alteration of the waters of the State of Oklahoma, shall first obtain a water quality certification from the DEQ.

Oklahoma State Statute 27A § 1-3-101 gives the DEQ the authority to issue swimming advisories. In conjunction with this requirement, DEQ has developed a Blue-Green Algae Response Plan to provide guidance for Public Drinking Water Supplies of the State.

The Federal Safe Drinking Water Act (SDWA) established primary and secondary drinking water standards for the nation's water supplies (40 CFR §141 and 40 CFR §143). These standards are contained in the Oklahoma Department of Environmental Quality (ODEQ) "Regulations Governing Operation of Public Water Supply Systems"

(Oklahoma Administration Code Chapters 626,631,652,690,and 710) as maximum allowable levels (primary standards), and recommended allowable (secondary standards) levels. DEQ Water Quality Division (DEQ WQD) is the primacy agency with regards to drinking water in Oklahoma. The DEQ WQD has public supply district engineers that manage the drinking water systems within the State.

Oklahoma State Statute 27A § 2-3-101 F gives the DEQ authority to investigate environmental issues for the State. This is carried out by the Environmental Complaints and Local Services Division (ECLS DEQ).

Oklahoma State Statute 27A § Supp. 207, Section 2-4-201 gives the DEQ the authority to acquire, operate, and maintain laboratories to analyze samples to obtain factual data to support any order, permit, function, or program of the department... This authority provides the funding and maintenance for the State Environmental Laboratory. This authority is utilized to maintain the Toxics in Reservoirs program which monitors toxics in fish and sets criteria for the DEQ to issue fish consumption advisories in accordance with Oklahoma Water Quality Standards. This authority is also utilized to maintain the Bio-trend program which collects and manages historical and current fish assemblage data across the State.

Oklahoma Water Resources Board (OWRB)

The OWRB has the following jurisdictional areas of environmental responsibility under Oklahoma Statute Title 27 §1-3-101:

OWRB is the lead agency for lakes eligible for funding under Section 314 of the federal Clean Water Act or other applicable sections of the federal Clean Water Act or other subsequent state and federal clean lakes programs; administration of a state program for assessing, monitoring, studying and restoring Oklahoma lakes with administration to include, but not be limited to, receipt and expenditure of funds from federal, state and private sources for clean lakes; and implementation of a volunteer monitoring program to assess and monitor state water resources, provided such funds from federal Clean Water Act sources are administered and disbursed by the Office of the Secretary of Environment; and Statewide water quality standards and their accompanying use support assessment protocols, anti-degradation policy and implementation, and policies generally affecting Oklahoma Water Quality Standards application and implementation including but not limited to mixing zones, low flows and variances or any modification or change thereof pursuant to Section 1085.30 of Title 82 of the Oklahoma Statutes.

Under Oklahoma Statutes Title 82 Chapter 14 Section 1085.2, the OWRB is hereby designated as the state agency to administer, receive, and manage all programs and funds associated with Section 314 or other applicable sections of the Federal Clean Water Act or other subsequent state and federal clean lakes programs having the purposes of assessing, monitoring, studying and restoring Oklahoma lakes, provided such funds from Federal Clean Water Act sources are administered and disbursed by the Office of the Secretary of Environment. In conducting the clean lakes program, the OWRB shall employ a cooperative agreement with the Oklahoma Conservation Commission (OCC) with regard to lake watersheds. The OCC may cooperate with the

OWRB in providing land use inventory/assessment and stream monitoring portion of the clean lakes program. The OWRB may enter into cooperative agreements with other federal, state and local agencies as necessary. Any Phase II Clean Lakes projects which require watershed implementation of non-point source pollution control practices shall be carried out by the OCC.

Oklahoma Conservation Commission (OCC)

Under Oklahoma Statute Title 27A O.S. § 3-2-106, the OCC has been designated to "act as the management agency having jurisdiction over and responsibility for directing NPS pollution prevention programs outside the jurisdiction or control of cities or towns in Oklahoma. The Commission, otherwise, shall be responsible for all identified non-point source categories except silviculture, urban storm water runoff and industrial runoff."

The OCC will "monitor, evaluate and assess waters of the state to determine the condition of streams and rivers impacted by nonpoint source pollution. In carrying out this area of responsibility, the Conservation Commission shall serve as the technical lead agency for nonpoint source pollution categories as defined in Section 319 of the Federal Clean Water Act or other subsequent federal or state nonpoint source programs." In addition, the OCC will administer the Blue Thumb volunteer monitoring and education program and "provide assistance to the Oklahoma Water Resources Board on lake projects through stream and river monitoring, assessing watershed activities impacting lake water quality, and assisting in the development of a watershed management plan."

FEDERAL

Federal regulations pertaining to the introduction and spread of aquatic invasive species are fragmented and incomplete. At least 20 agencies currently work at researching and controlling invasive species with no clear authority to prohibit or regulate the import of all classes of invasives or to regulate pathways for movement of invasives among states. Federal laws that apply directly to the introduction of invasive species include the Lacey Act, the Federal Noxious Weed Act, the Federal Seed Act, the Federal Plant Protection Act of 2000, the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990, and the National Invasive Species Act of 1996. Other Federal Laws indirectly promote the control of non-indigenous and invasive species by providing direction or guidance to properly manage public lands and programs. Therefore, the control of invasives is indirectly authorized. For example, the Endangered Species Act could require controls if an ANS was shown to threaten the survival of a federally listed species. The Endangered Species Act could also have indirect application if an ANS was shown to threaten the survival of a federally listed species. A description of federal agencies with programs specific to Oklahoma ANS follows.

U.S. Fish and Wildlife Service (USFWS)

The USFWS provides federal funding for implementation of state and regional ANS management plans that have been approved by the Aquatic Nuisance Species Task Force (ANSTF). One of the major USFWS efforts on ANS is the 100th Meridian Initiative. The goals of this Initiative are to 1) prevent the spread of zebra mussels and other ANS in the 100th meridian jurisdictions and west and 2) monitor and control zebra mussels and other ANS if detected in these areas. These goals will be attained through the implementation of the following six components: 1) information and education, 2) voluntary boat inspections and boater surveys, 3) involvement of those who haul boats for commercial purposes, 4) monitoring, 5) rapid response, and 6) evaluation. This initiative represents the first large-scale focused and coordinated effort, working with federal, state, provincial and tribal entities, potentially affected industries, and other interested parties to begin addressing the pathway to prevent the spread of zebra mussels. The success of this Initiative depends on the commitment of these groups to combat the spread of this destructive invader.

U.S. Army Corps of Engineers (USACE)

The USACE administers the only federally authorized research programs directed to manage and control non-indigenous and nuisance species. The Aquatic Plant Control Research Program (APCRP) develops technology for the management of non-indigenous aquatic plant species. The Zebra Mussel Research Program (ZMRP), which was expanded into the Aquatic Nuisance Species Research Program (ANSRP), conducts interdisciplinary research on the prevention, control, and management of aquatic nuisance species that impact USACE projects and public facilities. The programs are managed by the USACE Environmental Research and Development Center (ERDC) in Vicksburg, MS. ERDC has developed Information System Models for Plant Management, Aquatic Plants, and Zebra Mussels.

In July of 2005 a USACE Invasive Species Leadership Team (ISLT) was formed to fulfill Federal agency duties under Executive Order 13112. Comprised primarily of Division and District representatives, their responsibilities include 1) providing recommendations to headquarters, 2) providing strategic direction to research programs, 3) representing the USACE on regional invasive species councils 4) developing and implementing cost effective strategies to address invasive species problems that affect USACE water resource management missions, and 5) coordinating team initiatives with all concerned interests. The ISLT is currently developing a USACE Invasive Species Management Policy.

U.S. Coast Guard (USCG)

The U.S. Coast Guard gets its authority to regulate ballast water and ANS from NANPCA and NISA. NANPCA directed the Coast Guard to issue regulations and guidelines to control the introduction and spread of ANS in the Great Lakes ecosystem. It also required an assessment of ballast water management practices in all U.S. ports. NISA tasked the USCG with establishing a voluntary ballast water management (BWM) program for virtually all U.S. ports. The Coast Guard's BWM program is the primary

emphasis related to ANS in the inland river system. Current USCG efforts include establishing mandatory BWM standards and practices, establishing a program to approve ballast water treatment technologies, establishing penalties for failure to submit required reports, and increasing the applicability to all ships with ballast water tanks bound for all ports or places in U.S. waters.

REGIONAL

The Western Regional Panel WRP

The WRP on ANS was formed under a provision of NISA to help limit the introduction, spread, and impacts of invasives into western North America. This panel includes representatives from federal, state, tribal, Canadian provincial, local agencies, and from private environmental and commercial interests.

The Mississippi River Basin Regional Panel (MRBP)

The MRBP on ANS was formed under a provision of NISA to identify priorities for activities, develop and submit recommendations to the national ANSTF, coordinate ANS program activities, advise public and private interests on control efforts, and submit an annual report to the ANSTF describing prevention, research, and control activities in the Mississippi River Basin. This panel includes representatives from federal, state, tribal, and local agencies and from private environmental and commercial interests.

Western Governors Association (WGA)

The WGA is developing a new program to address undesirable non-indigenous aquatic and terrestrial species in the West because of the significant economic and ecological harm they cause. WGA has formed a working group of state and federal agencies, industry, non-governmental organizations and academia to develop strategies to limit the spread of these species.

F. Objectives, Strategies, Actions, & Cost Estimates

OBJECTIVE 1: Coordinate and implement a comprehensive management plan.

Problem Definition: There is no clear authority or agency charged with limiting and managing ANS in Oklahoma. Most management activities are focused on isolated problems and not concerned with addressing the issue of ANS comprehensively. Oklahoma needs an organized and centralized approach to ANS management to prevent duplication of effort and eliminate gaps in coverage of ANS issues. State ANS management efforts need to be coordinated with regional and national efforts. The lack of coordination, oversight, and funding has allowed many nuisance species to become established in Oklahoma, and permits new introductions.

Establishment of a management plan with appropriate implementation, authority and resources will permit effective prevention and management of ANS. Most importantly, native species and habitat can be protected from the competition, introduction of parasites and diseases, and predation caused by some ANS.

Current Agency Activities

ODWC

ODWC has regulated the use and development of warm water fisheries through lake management plans that emphasize the protection of native species. The introduction of fish species in Oklahoma streams and reservoirs, outside their native range, is evaluated closely and discouraged if any at risk species are compromised. ODWC has developed and implemented a Hazard Analysis Critical Control Point (HACCP) program to prevent the spread of ANS through Fisheries Division field and hatchery activities.

DEQ

DEQ has historical and current fish assemblage data across the State completed through the Bio-Trend Program. DEQ will develop and implement a HACCP plan.

DEQ's Environmental Complaints and Local Services Division is tasked with investigating environmental issues within the State. When a complaint that pertains to ANS is identified, the Customer Services Division of the DEQ will be contacted to assist in the investigation. ODWC will be notified at that time and data collected in conjunction with the investigation will be shared.

OWRB

OWRB has produced Technical Report 05-157 entitled, "Decontamination Protocol for Aquatic Nuisance Species". Recommendations within this report are to be followed by agency staff to reduce the risk of spreading ANS through their activities.
http://www.owrb.ok.gov/studies/reports/reports_pdf/DecontaminationdraftCP.pdf

OCC

The OCC has adopted decontamination protocols recommended by the OWRB as described above. Field personnel operate under these guidelines in order to decontaminate all equipment after use.

National Park Service (NPS)

Operates under ANS plan for all Park Service holdings

Gaps in State Management Programs and Authorities

- Authorities are unclear
- Activities are uncoordinated in the State and Region
- Staffing shortages and lack of funding

Recommended Strategies and Actions

Strategy 1A: Coordinate all ANS management programs and activities within Oklahoma.

Task 1A1: Create and fund an ANS Coordinator position with the ODWC. (ODWC)

Task 1A2: Create and fund ANS support staff positions within key state agencies. (ODWC)

Task 1A3: Develop an ANS training/management class for agency personnel associated with the ANS State Task Force. (USFWS)

Task 1A4: Conduct an annual symposium focused on ANS in Oklahoma and potential management alternatives. (ODWC)

Task 1A5: Coordinate with tribal governments regarding ANS management. (ODWC)

Task 1A6: Coordinate ANS activities with watershed-based organizations and other local governments and/or coordinating bodies. (ODWC)

Task 1A7: Assign a priority class to all established non-indigenous aquatic species present in Oklahoma. (ODWC)

Task 1A8: Develop a set of uniform definitions and terms to describe aquatic nuisance species. (ODWC)

Task 1A9: Develop, authorize, maintain and administer the Aquatic Nuisance Species Task Force in Oklahoma. (ODWC)

Strategy 1B: Participate in and support regional, federal, and international efforts to control ANS.

Task 1B1: The Oklahoma Aquatic Nuisance Species Program Coordinator will work with state, federal and private entities to identify personnel with ANS responsibilities. (ODWC)

Task 1B2: Support and participate in the Aquatic Nuisance Species Task Force's Mississippi River Basin Panel and Western Regional Panel. (ODWC)

Task 1B3: Support the 100th Meridian Project. (USFWS)

Task 1B4: Establish working partnerships with ANS management programs in regional states to facilitate the sharing of data and coordination of management activities. (USFWS)

Task 1B5: Support the Zebra Mussel Task Force in Oklahoma. (ODWC)

Task 1B6: Support the Golden Alga Task Force in Oklahoma. (ODWC)

Task 1B7: Support the ANS Plant Task Force in Oklahoma. (ODWC)

Strategy 1C: Develop a permanent funding mechanism for ANS management in Oklahoma.

Task 1C1: Explore ideas for permanent funding of ANS management activities. (ODWC)

Task 1C2: Work with the Oklahoma legislature to establish/create a permanent Foundation for ANS funding in Oklahoma. (ODWC)

Strategy 1D: Review and evaluate state efforts in addressing ANS.

Task 1D1: Conduct a periodic assessment of ANS species presence and abundance in Oklahoma. (ODWC)

Task 1D2: Support the development of a state benchmark on invasive species. (ODWC)

Task 1D3: Produce an annual update of the state ANS plan. (ODWC)

OBJECTIVE 2: Prevent the introduction of new ANS into Oklahoma.

Problem Definition: There are numerous pathways by which invasive species arrive and potentially become established in Oklahoma. For example, zebra mussels first became established in Oklahoma as a result of barge traffic moving from the Great Lakes down the Mississippi River and up through the McClellen-Kerr Arkansas River Navigation system. Zebra mussels have also spread naturally downstream from a founding population in El Dorado Lake, Kansas via the Arkansas River and now infest Kaw, Sooner, and Keystone reservoirs. Recreational boaters were the likely pathway for zebra mussels to become established in Oologah Reservoir. Anglers likely intentionally introduced hydrilla to Arbuckle, Murray, and Sooner Reservoirs. Pathways for the spread of golden alga are not well understood. Understanding how various pathways function as conduits for ANS into Oklahoma is critical for intercepting species and preventing introductions. Introduction of species into public waters by private individuals is currently legal upon receiving written permission from the Director of the Oklahoma Department of Wildlife Conservation. Implementation of a program that reviews (risk assessment) and regulates which species are intentionally allowed into Oklahoma, and monitors the pathways by which species can be unintentionally transported into the state, is necessary to slow the rate at which new species become established. Prevention is the most cost effective and environmentally sound method of addressing this problem. No comprehensive program currently exists in Oklahoma that would prevent new ANS introductions or establish control/eradication protocols should ANS become established.

Current Agency Activities:

ODWC

ODWC has hired a full-time ANS Coordinator.

ODWC reviews and maintains a list of prohibited fish and plant species. Introductions of all species by private entities into public waters must received written approval from the Director.

ODWC staff has participated in collecting boater surveys sponsored by the 100th Meridian Initiative of the Fish and Wildlife Service to determine if recreational boaters were transporting zebra mussels and whether individuals were aware of the threat posed by zebra mussels.

ODWC developed and distributes a "Don't Free Lily" brochure to aquatic plant retailers and water garden societies which lists prohibited plant species and recommends appropriate disposal strategies for unwanted plants.

ODWC has posted "Stop Aquatic Hitchhikers" signs at many lakes statewide. This is a campaign developed by "Protect Your Waters". This sign is posted at boat ramps and it explains the steps boaters must take to properly clean and inspect their boats and equipment.

ODWC has collected water samples from eight lakes statewide in 2009 to test for the presence of zebra mussel veligers. Samples are collected via plankton nets and are analyzed by PCR (Polymerase Chain Reaction) analysis through the Bureau of Reclamation.

A symposium devoted to ANS issues, cosponsored by the ODWC and the USFWS, was held at the annual meeting of the Oklahoma Chapter of the American Fisheries Society in February 2009. The symposium was attended by approximately 50 professional fisheries workers in Oklahoma.

ODAFF
ODAFF licenses plant nurseries and conducts inspections to check for presence of aquatic plants on the prohibited list. ODAFF licenses private aquaculture facilities and inspects those facilities for the presence of species on the prohibitive list.

USACE
The Tulsa District initiated and has served as the lead agency for the Oklahoma Zebra Mussel Task Force since 1993. They provide I&E material, conduct training, give presentations to water interests across the state, mailed information notices to water users and policy makers, provide interviews with media sources, and maintain a Zebra Mussel link on their web page to educate the public and agencies of the hazards of ANS introductions.

USFWS
USFWS has collected water samples from eight lakes statewide in 2009 to test for the presence of zebra mussel veligers. Samples are collected via plankton nets and are analyzed by PCR (Polymerase Chain Reaction) analysis through the Bureau of Reclamation.

Gaps in State Prevention Programs and Authorities

- Limited authority and funding to quarantine species and points of origin
- Limited authority to enforce regulations for possession of illegal species
- Limited inspection programs of plant nurseries and commercial fish operations
- Minimal penalties for violating existing statutes
- No regulation of mail order or internet sales of organisms
- Lack of legislated risk assessment protocol for approving introductions
- Lack of legislated criteria and/or risk assessment documentation incumbent for applicants to provide with introduction applications

Recommended Strategies and Actions

Strategy 2A: Identify ANS that have the greatest potential to infest Oklahoma waters and identify existing and potential pathways that facilitate new ANS introductions.

Task 2A1: Generate a regional list of ANS and evaluate the potential threat

posed to Oklahoma by each. (ODWC)

Task 2A2: Compile movement information of ANS on a regional level and predict the potential for possible invasion into Oklahoma waters. (ODWC)

Task 2A3: Identify existing and potential transport pathways that would facilitate the introduction of these ANS into Oklahoma. (ODWC)

Strategy 2B: Establish approaches to facilitate legislative, regulatory, and other actions needed to prevent new ANS movements into and out of Oklahoma and promote rules that establish the state's authority to control these movements.

Task 2B1: Promote legislation and regulatory rules that establish or increases the state's authority to control the introduction and movement of ANS. (ODWC)

- Establish the authority to detain and require cleaning of any vehicle, vessel or water based equipment containing or infested with ANS traveling in Oklahoma.
- Increase the authority of the State to regulate the importation of aquatic organisms and establish meaningful penalties for violations.
- Require that any intentionally imported or exported organism is free of diseases, parasites, and other unpermitted (nontarget) organisms.
- Amend Statutes and Administrative Codes to change use of diploid grass carp in private waters to exclusively triploid grass carp.
- Amend Title 800 to specifically prohibit and establish penalties for bait bucket releases unless bait was obtained from release site.
- Amend Title 800 to include protocols for evaluating and approving introduction requests
- Amend Title 800 to require risk assessment documentation from applicants seeking introduction permits
- Prohibit live transport of fish obtained in the wild unless specifically permitted to do so.
- Develop cooperative agreements with states that share common waters.

Task 2B2: Prohibit the importation of non-indigenous aquatic species based upon their invasive potential. (ODWC)

- Train ANS Coordinator in risk assessment methodologies
- Establish risk assessment protocols for proposed introductions of non-indigenous species.

Task 2B3: Develop a list of approved species that may be imported into Oklahoma. (ODWC)

- Establish legislation to change prohibited species list to list of species that can be possessed.

Task 2B4: Increase enforcement and awareness of existing laws controlling the transport, propagation, sale, collection, possession, importation, purchase, cultivation, distribution, and introduction of ANS and establish meaningful penalties for illegal introductions of ANS into Oklahoma waters. (ODWC)

- Train federal, state, and local aquatic regulation enforcement personnel on ANS identification and regulations.
- Distribute information on ANS laws to businesses that import aquatic organisms.

Task 2B5: Participate in regional and national forums to ensure coordinated efforts to prevent the introduction of new ANS into Oklahoma. (ODWC)

Objective 3: Detect, monitor, and eradicate ANS

Problem Definition: Once invasive species have arrived there is often a window of opportunity to eradicate small pioneering populations before they become a nuisance. However, ANS are often not detected until nuisance populations are formed. Usually it is too late or too expensive to eradicate a species once it has reached a nuisance level, and when management is conducted after a population is well-established, long-term routine activities will often be required to control the population and reduce environmental impacts. By initiating a detection and monitoring program, the State will be able to discover and manage pioneering infestations at a point when the species can be eradicated in a cost effective manner.

Current Agency Activities:

ODWC

ODWC reviews and maintains a list of prohibited fish and plant species. Introductions of listed species into public waters are prohibited.

ODWC developed and distributes a "Don't Free Lily" brochure to aquatic plant retailers and water garden societies which lists prohibited plant species and recommends appropriate disposal strategies for unwanted plants.

ODWC field staff looks for ANS during routine field/survey activities.

ODWC has collected water samples from eight lakes statewide in 2009 to test for the presence of zebra mussel veligers. Samples are collected via plankton nets and are

analyzed by PCR (Polymerase Chain Reaction) analysis through the Bureau of Reclamation.

ODAFF
ODAFF conducts inspections of plant nurseries to check for presence of aquatic plants on the prohibited list.

DEQ
DEQ has historical and current fish assemblage data across the State completed through the Bio-Trend Program. Data will be provided to ODWC to review for non-native fish populations. DEQ Field staff will also report any other nuisance species (mussels or plant) which are identified during any sample collection.
DEQ's Environmental Complaints and Local Services Division is tasked with investigating environmental issues within the State. When a complaint that pertains to ANS is identified, the Customer Services Division of the DEQ will be contacted to assist in the investigation. ODWC will be notified at that time and data collected in conjunction with the investigation will be shared.

OCC
The OCC employs a number of field personnel who regularly monitor water quality, conduct habitat evaluations, and sample macroinvertebrates and fish in streams across Oklahoma. The OCC field staff will document and report any nuisance species sighted during field activities. In addition, the Blue Thumb program has trained volunteers who monitor water quality across the state, and these individuals will look for and report nuisance species.

USACE
Lake staff monitors Zebra Mussel presence/absence and ANS plants at USACE lakes. Local water users are educated as to the potential pathways for infestations. Cooperation is solicited to monitor and detect ANS being brought to the lakes.

Tulsa District staff shares information with the ZMTF of changes and activities locally and across the nation; support monitoring and studies by other agencies and academia; and provide I&E materials and training.

USFWS
USFWS has collected water samples from eight lakes statewide in 2009 to test for the presence of zebra mussel veligers. Samples are collected via plankton nets and are analyzed by PCR (Polymerase Chain Reaction) analysis through the Bureau of Reclamation.

U.S. Bureau of Reclamation (BOR)
Monitored zebra mussel presence/absence at several lakes under BOR jurisdiction.

Conducted PCR analysis on water samples from 15 lakes in Oklahoma to test for the presence of zebra mussel veligers.

Oklahoma State University (OSU)
Compile databases on distribution of native and non-indigenous plants. Monitored zebra mussel populations at Oologah and Kaw reservoirs.

University of Oklahoma (OU)
University staff conducts periodic surveys and compile a database of known occurrences of all non-indigenous plants species. Monitor seasonal abundance of golden alga at Lake Texoma.

The Nature Conservancy (TNC)
TNC compiles lists of invasive species in their conservation areas through the use of sampling records, scientific literature and field surveys. TNC also establishes distribution data on those invasive species and incorporates that information into the development of their streams database.

Gaps in State Detection & Monitoring Programs and Authorities

- Limited inspection programs of plant nurseries and aquarium trade operations
- Minimal penalties for violating existing statutes
- No regulation of mail order or internet sales of organisms
- Lack of a risk assessment protocol for approving introductions
- Lack of training to identify ANS

Recommended Strategies and Actions

Strategy 3A: Implement a surveillance and early detection program.

Task 3A1: Identify and survey high-risk waters and establish baseline data. (ODWC)

Task 3A2: Create and train a citizen-monitoring network to work in cooperation with state agencies. (ODWC)

Task 3A3: Work with watershed-based organizations to ensure ANS are included in ongoing monitoring programs. (OCC)

Task 3A4: Distribute zebra mussel colonization substrates (Portland samplers) for individuals to deploy and monitor. (USFWS)

Task 3A5: Support ANS monitoring by the Grand River Dam Authority. (GRDA)

Task 3A6: Conduct periodic aerial surveys to detect colonies of plants. (ODWC)

Task 3A7: Identify high-risk waters for golden alga blooms and conduct surveys

to determine presence/absence. (OU/ODWC)

Strategy 3B: Develop an early response mechanism to deal with detected and potential invasive species.

Task 3B1: Develop an emergency response plan for all High Priority species

Task 3B2: Fund and manage an early response fund. (Leg./Gov./ANSTF)

Strategy 3C: Eradicate pioneering populations of ANS.

Task 3C1: Begin control of hydrilla at Lakes Murray and Sooner. (OTRD, ODWC)

Objective 4: Control and eradicate established ANS that have significant impacts.

Problem Definition: Established ANS populations can spread to uninfested waters, thereby increasing their potential for economic and ecological damage. Established non-indigenous species often create the most noticeable impacts, yet they are often impossible to eradicate or control. Management activities are most effective when they are directed at limiting the impacts of a population or stopping that population from spreading to new waterbodies. Management activities must be focused on populations of established species where there currently is or presumably will be a clear and significant impact on native species, and where the control or eradication of specific populations is feasible both economically and technically.

Current Agency Activities:

ODWC

ODWC issues permits for commercial fish, mussel, and turtle harvest, minnow seiners, and scientific collectors. ODWC developed and distributes a brochure that illustrates the need and methods to prevent spread of ANS through these activities. A similar brochure has been developed and distributed to bass fishing tournament organizers.

ODWC has developed and distributes a brochure that illustrates the Noxious Aquatic Plants that threaten Oklahoma and the need and methods to prevent spreading these ANS to new aquatic environments.

ODWC has posted "Stop Aquatic Hitchhikers" signs at many lakes statewide. This is a campaign developed by "Protect Your Waters". This sign is posted at boat ramps and it explains the steps boaters must take to properly clean and inspect their boats and equipment.

ODWC is the point contact with the ANS Plant Task Force (PTF). The PTF is in the process of developing protocols for management and control of Hydrilla in reservoirs.

ODWC has repeatedly treated pioneering populations of hydrilla in an isolated cove at Sooner Lake.

ODWC has developed protocols for reducing the risk of spreading ANS through its field and hatchery activities. These procedures can be found at http://www.wildlifedepartment.com/nuisancespecies.htm.

DEQ

DEQ monitors public drinking water systems across the State. Other agencies need to work with DEQ WQD to assess any vulnerability for contamination of a public drinking water system when utilizing chemicals for treatment or eradication of ANS. The contact for this program is Kay Coffey.

DEQ's Environmental Complaints and Local Services Division is tasked with investigating environmental issues within the State. When a complaint that pertains to ANS is identified, the Customer Services Division of the DEQ will be contacted to assist in the investigation. ODWC will be notified at that time and data collected in conjunction with the investigation will be shared.

OWRB

OWRB has produced Technical Report 05-157 entitled, "Decontamination Protocol for Aquatic Nuisance Species". Recommendations within this report are to be followed by agency staff to reduce the risk of spreading ANS through their activities. **http://www.owrb.ok.gov/studies/reports/reports_pdf/DecontaminationdraftCP.pdf**

OCC

The OCC has adopted decontamination protocols recommended by the OWRB as described above. Field personnel operate under these guidelines in order to decontaminate all equipment after use.

USACE

The ERDC has produced numerous Technical Notes detailing controls for ANS and maintains Information Systems on their website and on compact disk for Zebra Mussels, Plant Management, and Aquatic Plants.

The Tulsa District cooperates with water users being impacted by Zebra Mussels to educate them on possible control methods.

The Tulsa District monitors ANS plants at USACE lakes and implements controls as needed.

Gaps in State Control and Eradication Programs and Authorities

- No state agency has a clear program directed at controlling or eradicating ANS.
- Lack of information/training on control and eradication methods.
- Coordinated control efforts lacking.
- Current efforts are directed at individual populations and not at controlling a species distribution and extent.

Recommended Strategies and Actions

Strategy 4A: Limit the dispersal of established ANS to new waterbodies or to new areas of a waterbody.

Task 4A1: Establish protocols for priority ANS, that will provide guidance in designing and implementing control and eradication strategies. (ODWC)

Task 4A2: Support scientific research between state and federal agencies and academic institutions that investigate potential control strategies and associated environmental impacts. (ODWC)

Task 4A3: Ensure that the control strategies developed and implemented by the state are done in coordination with federal agencies, local governments, inter-jurisdictional organizations and other appropriate entities. (ODWC)

Task 4A4: Ensure that control strategies are based on the best available scientific information and conducted in an environmentally sound manner. (ODWC)

Task 4A5: Develop guidelines to ensure the cleaning of water-based equipment that may accidentally spread ANS when moved from infested to uninfested waters. (ODWC)

Task 4A6: Try to limit the spread of established ANS, through reducing the disturbance of existing populations by boats, through the use of warning signs and buoys in infested areas. (ODWC)

Objective 5: Inform the public, policy makers, natural resource workers, private industry, and user groups about the risks and impacts of ANS.

Problem Definition: The lack of awareness concerning ANS impacts is one of the largest management obstacles. Few people understand the threat some non-indigenous species pose and how their actions might introduce them. Uninformed people have introduced many ANS through the dumping of an aquarium or a bait bucket, launching of a contaminated boat, or stocking of a private pond. The improper importation and holding of organisms have allowed species to escape, or caused the receipt of unwanted organisms mixed in with intentionally imported ones. Many policy makers, natural resource administrators, and private interest groups have facilitated the intentional introductions of species for certain economic or recreational purposes, without understanding the effects these species would have on native species. These intentional and unintentional methods of introduction can be eliminated or curtailed by educating people about their potential to transfer non-indigenous species to Oklahoma.

Current Agency Activities:

ODWC
ODWC has included information on ANS in the state fishing regulations and on its website, developed a "Don't Free Lily" brochure, developed a zebra mussel brochure, developed a golden alga fact sheet, and included ANS information to private individuals and organizations requesting permits from the agency. Periodic press releases on ANS issues have been issued.

ODWC has posted "Stop Aquatic Hitchhikers" signs at many lakes statewide. This is a campaign developed by "Protect Your Waters". This sign is posted at boat ramps and it explains the steps boaters must take to properly clean and inspect their boats and equipment.

ODAFF
ODAFF conducts inspections of plant nurseries to check for presence of aquatic plants on the prohibited list.

DEQ
DEQ has developed a Blue-Green Algae Response Plan to provide guidance for Public Drinking Water Supplies of the State. In conjunction with this program, a fact sheet has been developed to educate the public on the effects of blue-green algae.

OCC
The OCC has incorporated information about ANS into its Blue Thumb educational program. This program offers training to new volunteers about six times per year. In addition, the OCC will include educational material about ANS in its area-specific projects, where applicable.

USACE
The Tulsa District initiated and has served as the lead agency for the Oklahoma Zebra Mussel Task Force since 1993. They provide information and education material, conduct training, give presentations to water interests across the state, mailed information notices to water users and policy makers, provides interviews with media sources, and maintain a Zebra Mussel link on their web page to educate the public and agencies of the hazards of ANS introductions.

Oklahoma State University
OSU is teaching an Ecology of Invasive Species Course in the College of Agricultural Sciences and Natural Resources.

Oklahoma University
OU has developed a golden alga website that addresses the research being conducted on Lake Texoma and throughout the state.
http://faculty-staff.ou.edu/H/Karl.D.Hambright-1/

Gaps in State Education Programs and Authorities:

- ANS is not addressed as an issue.
- Inadequate information is disseminated to the public.
- Few natural resource workers have the training to identify ANS.

Recommended Strategies and Actions:

Strategy 5A: Educate the public about ANS, how their actions can prevent the spread and introduction of ANS and how they can help reduce the impacts of existing ANS.

Task 5A1: Continue the incorporation of ANS information into state hunting and fishing regulations (ODWC)

Task 5A2: Create an educational curriculum on ANS for K1-12 schools. Explore options through 4-H programs to develop such curricula. (ODWC/AREP)

Task 5A3: Produce press releases on specific ANS. (ODWC)

Task 5A4: Create articles, videos and web-based media concerning ANS. (ODWC)

Task 5A5: Distribute information on ANS at various conferences, shows, fishing tournaments, and public gatherings. (ODWC)

Task 5A6: Develop ANS identification cards to be distributed with hunting and fishing licenses. (ODWC)

Task 5A7: Develop an "Oklahoma friendly" plant labeling system in conjunction with the nursery industry. (ODAFF)

Strategy 5B: Inform policymakers on the extent, impact, and potential for harm of ANS.

Task 5B1: Conduct field trips for policymakers to demonstrate ANS impacts and controls. (ODAFF/ODWC)

Task 5B2: Produce legislative information packets outlining the threats of ANS, management alternatives, and the funds needed to address ANS in Oklahoma. (ODWC/ODAFF)

Strategy 5C: Train natural resource workers in identifying ANS.

Task 5C1: Conduct identification seminars for field personnel. (ODAFF/ODWC)

Strategy 5D: Educate private industry on the laws regulating and effects of ANS.

Task 5D1: Expand distribution of a pamphlet for the nursery industry identifying ANS, the laws regulating them, and their effects in natural systems. (ODAFF)

Task 5D2: Distribute information on ANS to businesses selling aquatic organisms, such as pet stores. (ODAFF/ODWC)

Task 5D3: Provide information to fishing tournament organizers on ANS. (ODWC)

Objective 6: Conduct/support research to determine risks associated with pathways of introduction/spread; environmental conditions favorable for establishment of ANS; interactions with native species; and cost-effective and environmentally safe control/eradication measures.

Problem Definition: Little is known about the extent and magnitude of the ANS problem in Oklahoma. Research is needed to clarify the effect ANS poses to Oklahoma water resources. Some of the research questions relevant to the ANS problem include: 1) determining the risks associated with pathways of introduction and spread; 2) the environmental conditions necessary for ANS to become established; 3) interactions among ANS and native species and the consequences of those interactions; and 4) which management options will provide the best results in controlling ANS populations.

Current Agency Activities:

Oklahoma State University
OSU is conducting research to determine the range and densities of zebra mussel populations within the Tallgrass Prairie Region as part of the Oklahoma State Wildlife Action Plan.

Oklahoma University
OU is conducting research on the toxicology of the prymnesin toxin to various sport fishes and zooplankton and the ecological interactions of golden alga with phytoplankton and zooplankton communities in Lake Texoma. OU is also currently monitoring golden alga abundance on Lake Texoma and investigating physical, chemical, and ecological triggers to blooms and toxin production. A proposed expansion of these efforts on a statewide basis would identify high-risk waters and focus efforts to control spread to uninfested water bodies. Development of a web-based database on golden alga survey work is ongoing.

OU has funding to initiate a study on *Daphnia lumholtzi* genetics and ecology.

ODWC
ODWC funds research on zebra mussels through OSU and golden alga through OU.

ODWC has collected water samples from eight lakes statewide in 2009 to test for the presence of zebra mussel veligers. Samples are collected via plankton nets and are analyzed by PCR (Polymerase Chain Reaction) analysis through the Bureau of Reclamation.

ODWC passed rules that go into effect 1 January 2010 that limits the use of grass carp for vegetation control in private impoundments to triploids. It is currently illegal to leave a boat ramp with any aquatic vegetation or zebra mussels attached to any equipment.

DEQ
DEQ collects annual fish assemblage data across the State completed through the Bio-Trend Program. Data will be provided to ODWC to review for non-native fish populations.

DEQ's Environmental Complaints and Local Services Division is tasked with investigating environmental issues within the State. When a complaint that pertains to ANS is identified, the Customer Services Division of the DEQ will be contacted to assist in the investigation. ODWC will be notified at that time and data collected in conjunction with the investigation will be shared.

USACE
The Tulsa District monitors the USACE lakes for ANS presence/absence and densities. They also support agency and academia research at the lakes, and keep informed of impacts to water users.

The Tulsa District is actively involved in national efforts and keeps informed of Zebra Mussel control and eradication research. Updates are provided to the ZMTF.

The ERDC has produced numerous Technical Notes detailing controls for ANS and maintains Information Systems on their website and on compact disk for Zebra Mussels, Plant Management, and Aquatic Plants.

USFWS

USFWS is conducting surveys of zebra mussel occurrence and abundance on selected water bodies using Portland samplers.

USFWS has collected water samples from eight lakes statewide in 2009 to test for the presence of zebra mussel veligers. Samples are collected via plankton nets and are analyzed by PCR (Polymerase Chain Reaction) analysis through the Bureau of Reclamation.

Gaps in State Prevention Programs and Authorities

- Limited funding is available to conduct research
- Poor understanding of basic biology and impacts of ANS
- Limited management options for control/eradication
- Lack of thorough survey of ANS distribution within the state

Recommended Strategies and Actions

Strategy 6A: Support research that identifies, predicts, and prioritizes potential ANS introductions.

Task 6A1: Identify life histories and impacts of introduced aquatic plants and animals. (ODWC)

Task 6A2: Identify critical data needed to prevent the introduction of new ANS. (ODWC)

Task 6A3: Attend scientific and technical conferences addressing the mechanisms by which new ANS spread. (ODWC)

Task 6A4: Monitor ongoing research efforts attempting to develop control mechanisms for new ANS. (ODWC)

Strategy 6B: Research management alternatives for their effect on ANS and native species.

Task 6B1: Investigate the relationship between human-induced disturbance of aquatic and riparian systems and ANS invasion, establishment, and impacts. (ODWC)

Task 6B2: Investigate new and innovative methods of control/eradicate ANS. (ODWC)

Strategy 6C: Facilitate the collection and dispersal of information, research results, and data on ANS in Oklahoma.

Task 6C1: Utilize existing field personnel to document the distribution and abundance of ANS. (ODWC)

Task 6C2: Create a database of stakeholders to receive annual ANS updates. (ODWC)

Task 6C3: Utilize the internet to distribute information and research findings via an agency website. (ODWC)

G. Priorities for Action

Often efforts to address ANS problems are implemented after the species has arrived and become widely distributed. As a result, these efforts are often reactive and ineffective. The purpose of this management plan is to expand the scope of efforts in Oklahoma to deal with the threats posed by all ANS. The goal of this management plan is to implement a coordinated strategy designed to minimize the risk of further ANS introductions into Oklahoma through all known pathways, develop funding mechanisms to implement and staff an Oklahoma ANS management program, where practical, stop the spread of ANS already present and eradicate or control ANS to a minimal level of impact. By forming this management plan, it is expected that the problems other states have experienced can be minimized or completely avoided. Initially, this plan will focus on the Priority Class 1 species listed below. As this program evolves, the focus will shift to the development and implementation of new programs designed to address the lower priority species and/or species yet to be determined as threats.

PRIORITY CLASS 1

Priority Class 1 species are present and established in Oklahoma, have the potential to spread in Oklahoma, and there are limited or no known management strategies for these species. These species can be managed through actions that involve mitigation of impact, control of population size, and prevention of dispersal to other water bodies.

- Bighead Carp (*Hypophthalmichthys nobilis*)
- Golden Alga (*Prymnesius parvum*)
- Grass Carp (*Ctenopharyngodon idella*)
- Hydrilla (*Hydrilla verticillata*)
- Silver Carp (*Hypophthalmichthys molitrix*)
- White Perch (*Morone americana*)
- Zebra Mussels (*Dreissena polymorpha*)
- Didymo (*Didymosphenia geminate*)

PRIORITY CLASS 2

Priority Class 2 species are currently not known to be present in Oklahoma, but have a high potential to invade and there are limited or no known management strategies for

these species. Appropriate management for this class includes prevention of introductions and/or eradication of pioneering populations.

- Black Carp (*Mylopharyngodon piceus*)
- Northern Snakehead (*Channa argus*)
- Quagga Mussels (*Dreisena bugensis*)
- Viral Hemorrhagic Septicemia
- New Zealand Mudsnail (*Potamopyrgus antipodarum*)
- Rusty Crayfish (*Orconectes rusticus*)
- Spring Viremia of Carp
- Whirling Disease (*Myxobolus cerebralis*)

PRIORITY CLASS 3

Priority Class 3 species are not known to be established in Oklahoma and have a high potential for invasion and appropriate management techniques are available. Appropriate management for this class includes prevention of introductions and/or eradication of pioneering populations.

- Giant Salvinia (*Salvinia molesta*)

PRIORITY CLASS 4

Priority Class 4 species are present and have the potential to spread in Oklahoma but there are management strategies available for these species. These species can be managed through actions that involve mitigation of impact, control of population size, and/or prevention of dispersal to other water bodies.

- Purple Loosestrife (*Lythrum salicaria*)
- Alligatorweed (*Alternanthera philoxeroides*)
- Exotic Water Flea (*Daphnia lumholtzi*)
- Eurasian Watermilfoil (*Myriophyllum spicatum*)
- Nutria (*Myocastor coypus*)
- Largemouth Bass Virus
- Rudd (*Scardinius erythrophthalmus*)
- Brook Stickleback (*Culaea inconstans*)
- Water Hyacinth (*Eichornia crassipes*)

H. Implementation Table

Currently, Oklahoma has funding for the development of an aquatic nuisance species management plan, but not for the implementation of the plan. Therefore, funding amounts on the implementation table will be dependent upon the level of federal funding allocated after plan approval and securing funding from additional outside sources.

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's)			Planned ($000/FTE's)	
Plan #	Description	Source	Agency	Agencies	FY 06	FY 07	FY 08	FY 09	FY 10
Objective 1: Coordinate and implement a comprehensive management plan									
1A	**Coordinate ANS Management Programs**								
1A1	Create and Fund an ANS Coor.		ODWC				40/1	50/1	50/1
1A2	Create and Fund ANS staff		ODWC						
1A3	Develop ANS Training		USFWS	USACE, ODWC					
1A4	Conduct Annual Symposium in OK		ODWC	USACE, USFWS				5/0.1	5/0.1
1A5	Coordinate With tribal Govt.		ODWC	USFWS					
1A6	Coord w/NGO's & local governments		ODWC	USACE,USFWS					
1A7	Assign priority class to all species		ODWC	USACE,USFWS					
1A8	Develop definitions and terms		ODWC	USACE,USFWS					
1A9	Authorize ANS Task Force in OK		ODWC	USFWS					
1B	**Support regional efforts for control of ANS in Oklahoma**								
1B1	Identify AGENCY responsibilities		ODWC	USACE,USFWS					
1B2	Support MRBP and WRP		ODWC	USFWS					
1B3	Support 100th Meridian		USFWS	USACE, ODWC					
1B4	Data Sharing on Regional Basis		USFWS ODWC	USACE, OCC, OU					
1B5	Support Zebra Mussel Task Force		ODWC	USACE,USFWS, OCC					
1B6	Support Golden Alga Task Force		ODWC	USACE, OCC, OU					
1B7	Support ANS Plant Task Force		ODWC	USACE, OCC					
1C	**Permanent Funding Mechanism**								
1C1	Explore Funding Ideas		ODWC						
1C2	Establish ANS Foundation		ODWC	USFWS					
1D	**Evaluate ANS Plan Progress**								
1D1	Conduct ANS Surveys		ODWC	USFWS, USACE	20/0.1	10/0.1	13/0.1	5/0.1	5/0.1
1D2	Establish Distribution Benchmark		ODWC	TNC					
1D3	Publish & Distribute Annual Update		ODWC	USFWS, USACE				2/0.1	2/0.1

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's)			Planned ($000/FTE's)	
Plan #	Description	Source	Agency	Agencies	FY 06	FY 07	FY 08	FY 09	FY 10
Objective 2: Prevent the introduction of new ANS into Oklahoma									
2A	**Identify ANS that have the greatest potential to infest Oklahoma**								
2A1	Generate a regional list of ANS		ODWC	USFWS, USACE, TNC					
2A2	Compile ANS movement data		ODWC	USFWS, USACE					
2A3	Identify transport pathways		ODWC	USFWS, USACE					
2B	**Establish approaches to prevent new ANS introductions**								
2B1	Strengthen statutory authorities		ODWC						
2B2	Prohibit transport of ANS		ODWC					2/0.1	
2B3	Develop list of approved species		ODWC	USFWS, USACE					
2B4	Increase awareness/enforcement		ODWC	USFWS, USACE, OCC, ODAFF					
2B5	Coordinate prevention		ODWC	USFWS, USACE, OCC					
Objective 3: Detect, monitor, and eradicate ANS									
3A	**Implement a surveillance and early detection program**								
3A1	Annual survey of high-risk waters		ODWC	USACE, USFWS	20/0.1	10/0.1	13/0.1	10/0.1	10/0.1
3A2	Create & train citizen network		ODWC	USACE, USFWS, OCC, OSU					
3A3	Work with watershed council		OCC						
3A4	Distribute zm colonization substrates		USFWS	USACE					
3A5	Support ANS monitoring by GRDA		GRDA	OCC, ODWC		5/0.1	5/0.1	5/0.1	5/0.1
3A6	Conduct surveillance flights		ODWC						
3A7	Conduct golden alga surveys		OU, ODWC	USACE, OWRB					
3B	**Develop an early response mechanism**								
3B1	Develop emergency response plan		ODWC	USACE, USFWS					
3B2	Fund & manage early response fund		Leg., Gov., ANSTF						
3C	**Eradicate pioneering populations of ANS**								
3C1	Treat hydrilla in Murray & Sooner		ODWC, OTRD			1.5/0.1	1.5/0.1	1.5/0.1	1.5/0.1

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's)			Planned ($000/FTE's)	
Plan #	Description	Source	Agency	Agencies	FY 06	FY 07	FY 08	FY 09	FY 10
Objective 4: Control and eradicate established ANS that have significant impacts									
4A	**Limit ANS dispersal across state**		ODWC	USFWS, USACE					
4A1	Establish protocol for priority rank		ODWC	USFWS, USACE					
4A2	Support research between state-fed		ODWC	USFWS, USACE	5/0.1				
4A3	Coor. Strategies w/other agencies		ODWC	USFWS, USACE, OCC, DEQ				1/0.1	1/0.1
4A4	Control strategies based on best info		ODWC	USFWS, USACE, DEQ					
4A5	Develop cleaning guidelines		ODWC	USFWS, USACE, DEQ	10/0.1				

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's)			Planned ($000/FTE's)	
Plan #	Description	Source	Agency	Agencies	FY 06	FY 07	FY 08	FY 09	FY 10
Objective 5: Educate resource user groups re: risks and impacts of ANS and how to reduce the harmful impacts									
5A	**Educate the public about ANS**								
5A1	Incorporate ANS info in regulations		ODWC	USFWS, USACE					
5A2	Create educational curriculum		ODWC, OK Aquarium	USFWS, USACE			20/0.1	5/0	5/0
5A3	Produce press releases		ODWC	USFWS, USACE				1/0.1	1/0.1
5A4	Create articles, video & web media		ODWC	USFWS, USACE				1/0.1	1/0.1
5A5	Distribute information on ANS		ODWC	USFWS, USACE, OCC, DEQ					
5A6	Develop ANS identification cards		ODWC	USFWS, USACE					
5A7	Develop a plant labeling system		ODAFF	USFWS, USACE					
5B	**Inform policy makers about the extent, impact, and potential for harm of ANS**								
5B1	Conduct field trips for policymakers		ODWC, ODAFF	USFWS, USACE					
5B2	Produce a legislative ANS manual		ODWC, ODAFF	USFWS, USACE					
5C	**Train natural resource workers in identifying ANS**								
5C1	Conduct ANS identification seminars		ODWC, ODAFF	USFWS, USACE, DEQ, OSU					
5D	**Educate private industry on the laws regulating and effects of ANS**								
5D1	ANS pamphlet for nursery industry		ODAFF						
5D2	Distribute information on ANS		ODWC, ODAFF	OCC, DEQ					
5D3	Provide information to tournaments		ODWC		1/0				

Strategic Actions/Tasks		Funds	Lead	Cooperative	Recent ($000/FTE's)			Planned ($000/FTE's)	
Plan #	Description	Source	Agency	Agencies	FY 06	FY 07	FY 08	FY 09	FY 10
Objective 6: Conduct & support research on ANS and control measures									
6A	**Support research that identifies, predicts, and prioritizes potential ANS introductions**								
6A1	Identify life histories and impacts		ODWC, OU	USFWS, USACE	192/3	445/3	271/3	363/3	361/3
6A2	Identify critical data needs		ODWC	USFWS, USACE					
6A3	Attend ANS-related conferences		ODWC	USFWS, USACE, OCC	3/0	3/0	3/0	3/0	3/0
6A4	Monitor on-going research efforts		ODWC	USFWS, USACE					
6B	**Research management alternatives for their effect on ANS and native species**								
6B1	Human-induced disturbance vs. ANS		ODWC	USFWS, USACE					
6B2	New methods of managing ANS		ODWC	USFWS, USACE					
6C	**Facilitate collection/ dispersal of ANS information, research results, and data**								
6C1	Document ANS distribution		ODWC	USFWS, USACE, OCC, TNC				2/0.1	5/0.1
6C2	Distribution list of ANS information		ODWC	USFWS, USACE, OCC					
6C3	Distribute ANS information via web		ODWC	USFWS, USACE, OCC, OSU, OU					

I. Program Monitoring and Evaluation

Evaluation of Oklahoma's ANS Management Program is vital to the program's success. This plan is intended to be fluid, allowing for mid-course corrections as deemed appropriate (adaptive management). Meeting the plan's stated objectives will require oversight, evaluation, and information dissemination.

An oversight committee will be established upon plan approval by the ANS Task Force. This committee will be comprised of external publics (as identified during the plan review process); representatives from agencies with plan implementation responsibilities; political representation (either legislative or executive); and members of the Steering Committee. The role of this interagency committee would be to annually review progress toward meeting the plan's stated objectives. The oversight committee should establish performance measures to assess the effectiveness of management actions. These measures could include:

- whether or not objectives were met
- rate of spread
- total acreage of habitat occupied by ANS
- changes in abundance of ANS and concomitant decline of impacted species
- level of public awareness of ANS issues.

Identifying funding sources should be an important focus of the oversight committee. Prior to plan approval by the ANSTF, temporary performance measures were established for the Oklahoma Aquatic Nuisance Species Coordinator. These performance measures will be reviewed quarterly by the Fisheries Division administration of the Oklahoma Department of Wildlife Conservation, and are subject to change by the oversight committee.

Program monitoring is important, as unforeseen factors may impact the progress of management actions. Unforeseen physical, chemical, or biological stressors have the potential to affect the success of management objectives. Examples of potential stressors include climate change, natural disasters, and chemical spills. Events like these can alter aquatic ecosystems, making them more susceptible to invasion by opening new pathways or niches. In the case that these types of events occur, program monitoring will allow us to gauge whether management actions are still effective, or need to be altered.

The ANS Coordinator will produce an annual report to be reviewed by the oversight committee and made available to all interested agencies and publics. The report should focus on the successes in achieving the objectives of the ANS plan and include recommendations for future management actions. The report should also recommend and justify any shifts in strategies deemed appropriate.

J. Glossary

Accidental introduction: An introduction of non-indigenous aquatic species that occurs as the result of activities other than the purposeful or intentional introduction of the species involved, such as the transport of non-indigenous species in ballast water or in water used to transport fish, mollusks, or crustaceans for aquaculture or other purposes.

Aquatic nuisance species (ANS): A species that is non-native to the affected ecosystem and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. This term is synonymous with an "invasive species" as defined by Executive Order 13112.

Baitfish: Fish species commonly sold for use as bait for recreational fishing.

Ballast water: Any water or associated sediments used to manipulate the trim and stability of a vessel.

Control: Limiting the distribution and abundance of a species.

Ecological integrity: The extent to which an ecosystem has been altered by human behavior; an ecosystem with minimal impact from human activity has a high level of integrity; an ecosystem that has been substantially altered by human activity has a low level of integrity.

Environmentally sound: Methods, efforts, actions, or programs to prevent introductions or to control infestations of ANS that minimize adverse environmental impacts.

Eradicate: The act or process of eliminating an ANS.

Exotic: Any species or other biological material that enters an ecosystem beyond its historic range on the continent.

Great Lakes: Lake Ontario, Lake Erie, Lake Huron (including Lake St. Clair), Lake Michigan, Lake Superior, and the connecting channels (Saint Mary's River, Saint Clair River, Detroit River, Niagara River, and Saint Lawrence River to the Canadian Border), and includes all other bodies of water within the drainage basin of such lakes and connecting channels.

Infested: Any waterbody where an aquatic nuisance species is known to occur.

Intentional introduction: All or part of the process by which a non-indigenous species is purposefully introduced into a new area.

Native: A plant or animal species that naturally occurs in Oklahoma and has not been introduced outside of its historic range.

Non-indigenous species: Any species or other variable biological material that enters an ecosystem beyond its historic range.

Pioneer infestation: A small ANS colony that has spread to a new area from an established colony.

Population: A group of individual plant or animal species occupying a particular area at the same time.

Transplant: A species that is native to Oklahoma but has been moved outside its native range.

K. Literature Cited

Belanger, S.E., J.L. Farris, D.S. Cherry, and J. Cairns, Jr. 1985. Sediment Preference Of The Freshwater Asiatic Clam, Corbicula Fluminea. The Nautilus 99(2-3):66-73.

Benson, A.J. E. Maynard, and D. Raikow. 2005. *Daphnia lumholtzi* . Non-indigenous Aquatic Species Database, Gainesville, FL.

Benson, A. J., P. L. Fuller, and C. C. Jacono. 2001. Summary report of non-indigenous aquatic species in U.S. Fish and Wildlife Service Region 4. USFWS report. Arlington, VA.

Boileau, M. G. 1985. The expansion of white perch *Morone americana* in the Lower Great Lakes. Fisheries 10(1):6–10.

Burkhead, N. M., and J. D. Williams. 1991. An intergeneric hybrid of a native minnow, the golden shiner, and an exotic minnow, the rudd. Transactions of the American Fisheries Society 120:781–795.

Courtenay, W.R., and J.D. Williams. 2004. Snakehead (Pisces, Channidae): A biological synopsis and risk assessment. USGS Circular 1251.

Dzialowski, A. R., W. J. O'Brien and S. M. Swaffar. 2000. Range expansion and potential dispersal mechanisms of the exotic cladoceran *Daphnia lumholtzi*. Journal of Plankton Research 22(12):2205-2223.

Freeze, M. and S. Henderson. 1982. Distribution and status of the bighead carp and silver carp in Arkansas. North American Journal of Fisheries Management 2(2):197-200.

Gottfried, P.K., and Osborne, A. 1982. Distribution, abundance and size of Corbicula manilensis (Philippi) in a spring-fed central Florida stream. ID 1652.

Hargrave, C.W. and K. B. Gido. 2004. Evidence of reproduction by exotic grass carp in the Red and Washita Rivers, Oklahoma. Southwestern Naturalist 49:89-93.

Havel, J.E. and J.B. Shurin. 2004. Mechanisms, effects, and scales of dispersal in freshwater zooplankton. Limnology and Oceanography 49: 1220-1238.

Heard, W.R. 1959. Live bait imports: *Chrosomus eos* and *Eucalia inconstans* as potential additions to Oklahoma's fish fauna. Proceedings of the Oklahoma Academy of Science (for 1956) 37:47-48.

Hushak, L. J., Y. Deng, and M. Bielen. 1995. The Cost of Zebra Mussel Monitoring and Control. Aquatic Nuisance Species Digest 1(1).

Jenkinson, J.J. 1979. The Occurrence And Spread Of *Corbicula Manilensis* In East-central Alabama. Nautilus 94(4):149-153.

Kolar, C.S., D.C. Chapman, W.R. Courtenay, C.M. Housel, J.D. Williams, and D.P. Jennings. 2005. Asian carps of the genus *Hypophthalmichthys* (Pisces, Cyprinidae) — a biological synopsis and environmental risk assessment. Report to the U.S. Fish and Wildlife Service. U.S. Geological Survey, LaCrosse, WI. 184 pages.

Lachner, E. A., C. R. Robins, and W. R. Courtenay, Jr. 1970. Exotic fishes and other aquatic organisms introduced into North America. Smithsonian Contributions to Zoology 59:1-29.

Lodge, D. M., C. A. Taylor, D. M. Holdich, J. Skurdal. 2000. Non-indigenous crayfishes threaten North American freshwater biodiversity: lessons from Europe. Fisheries 25(8):7–20.

Mandrak, N.E. and B. Cudmore. 2004. Risk assessment for Asian carps in Canada. Canadian Science Advisory Secretariat, Department of Fisheries and Oceans Canada. Burlington, Ontario. Research Document 2004/103. 48 pages.

Moore, G. A., and C. D. Riggs. 1963. Checklist of known Oklahoma fishes. Pages 41-44 in Oklahoma Wildlife Commission. Know Your Oklahoma Fishes. Department of Wildlife Conservation, Oklahoma City, OK.

Nico, L. G., and P. Fuller. 2003. Rudd *Scardinius erythrophthalmus* fact sheet. USGS Non-indigenous aquatic species database. Gainsville, FL.

Nico, L. G., and P. Fuller. 2004. Black carp *Mylopharyngodon piceus* fact sheet. USGS Non-indigenous aquatic species database. Gainsville, FL.

Nico. L., P. Fuller, and P.J. Schofield. 2006. *Ctenopharyngodon idella.* USGS Non-indigenous Aquatic Species Database, Gainesville, FL. Available: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=514. Revision date: 2/2/2006.

Nico, L.G., J.D. Williams, and H.L. Jelks. 2005. Black carp: biological synopsis and risk assessment of an introduced fish. American Fisheries Society, Special Publication 32. Bethesda, Maryland.

Nico L.G. and J.D. Williams. 1996. Risk assessment on black carp (Pisces: Cyprinidae). Final Report to the Risk Assessment and Management Committee of the ANSTF. U.S. Geological Survey, Biological Resources Division, Gainesville, Florida.

Pigg, J., J. Stahl, M. Ambler, and J. Smith,. 1997. Two Potential Sources of Exotic Fish in Oklahoma. Proceedings of the Oklahoma Academy of Science 73:67.

Pigg, J., J. Smith, and M. Ambler. 1997. Additional records of bighead carp, *Hypophthalmichthys nobilis*, in Oklahoma waters. Proceedings of the Oklahoma Academy of Science 77:123.

Pimentel, D., L. Lach, R. Zuniga, and D. Morrison. 2000. Environmental and economic costs of non-indigenous species in the United States. BioScience 50:53-65.

Rendall, W. 1997. Non-indigenous species and upcoming guidelines for prevention. Aquatic Nuisance Species Digest 2 (2): 13, 18-19.

Richards, D. C. 2002. The New Zealand mudsnail invades. Aquatic Nuisance Species Digest Vol. 4(4):42-44.

Scott, W.B. and E.J. Crossman. 1990. Freshwater fishes of Canada. Bulletin of the Fisheries Research board of Canada 184. 966 pp.

Stites, D.L., A.C. Benke, and D.M. Gillespie. 1995. Population Dynamics, Growth, and Production Of The Asiatic Clam, Corbicula Fluminea, In A Blackwater River. Canadian Journal of Fisheries And Aquatic Sciences 52:425-437.

Trometer, E. S., Busch, W. D. N. 1999: Changes in Age-0 Fish Growth and Abundance Following the Introduction of Zebra Mussels *Dreissena polymorpha* in the Western Basin of Lake Erie. North American Journal of Fisheries Management 19:604–609.

U.S. Congress Office of Technology Assessment. 1993. Harmful non-indigenous species in the United States,OTA-F-565. Washington, DC.

USFWS (U.S. Fish and Wildlife Service). 2002. Conserving America's fisheries: Fisheries Program vision for the future. U.S. Department of the Interior. 27 pages. Available: www.fws.gov/pacific/Fisheries/Docs/VisionDocument.PDF

Woodling, J. 1985. Colorado's little fish: a guide to the minnows and other lesser known fishes in the state of Colorado. Colorado Division of Wildlife, Denver, CO. 77 pp.

Wu, L., and D. A. Culver. 1991. Zooplankton grazing and phytoplankton abundance: An assessment before and after invasion of *Dreissena polymorpha*. Journal of Great Lakes Research 17: 425-436.

Appendix A
List of non-indigenous* and transplanted** species in Oklahoma

Group	Scientific Name	Common Name	Non-Indigenous/ Transplant
Algae Diatoms	*Didymosphenia geminata*	didymo	Non-indigenous
Amphibians-Frogs	*Eleutherodactylus planirostris*	Greenhouse Frog	Non-indigenous
Amphibians-Frogs	*Hyla cinerea*	Green Treefrog	Non-indigenous
Coelenterates-Hydrozoans	*Craspedacusta sowerbyi*	freshwater jellyfish	Non-indigenous
Crustaceans-Cladocerans	*Daphnia lumholtzi*	water flea	Non-indigenous
Crustaceans-Copepods	*Eurytemora affinis*	calanoid copepod	Non-indigenous
Crustaceans-Crayfish	*Procambarus clarkii*	red swamp crayfish	Non-indigenous
Fishes	*Ambloplites rupestris*	rock bass	Transplant
Fishes	*Ameiurus nebulosus*	brown bullhead	Transplant
Fishes	*Astyanax fasciatus*	banded astyanax	Non-indigenous
Fishes	*Astyanax mexicanus*	Mexican tetra	Non-indigenous
Fishes	*Campostoma oligolepis*	largescale stoneroller	Transplant
Fishes	*Carassius auratus*	goldfish	Non-indigenous
Fishes	*Ctenopharyngodon idella*	grass carp	Non-indigenous
Fishes	*Culaea inconstans*	brook stickleback	Non-indigenous
Fishes	*Cyprinella whipplei*	steelcolor shiner	Transplant
Fishes	*Cyprinodon rubrofluviatilis*	Red River pupfish	Transplant
Fishes	*Cyprinus carpio*	common carp	Non-indigenous
Fishes	*Dorosoma petenense*	threadfin shad	Transplant
Fishes	*Fundulus catenatus*	northern studfish	Transplant
Fishes	*Hiodon tergisus*	mooneye	Transplant
Fishes	*Hypophthalmichthys nobilis*	bighead carp	Non-indigenous
Fishes	*Ictalurus furcatus*	blue catfish	Transplant
Fishes	*Lepomis auritus*	redbreast sunfish	Transplant
Fishes	*Lepomis microlophus*	redear sunfish	Transplant
Fishes	*Menidia beryllina*	inland silverside	Transplant
Fishes	*Micropterus dolomieu*	smallmouth bass	Transplant
Fishes	*Micropterus salmoides floridanus*	Florida largemouth bass	Transplant
Fishes	*Morone americana*	white perch	Non-indigenous
Fishes	*Morone chrysops x saxatilis*	wiper	Non-indigenous
Fishes	*Morone saxatilis*	striped bass	Non-indigenous
Fishes	*Notropis bairdi*	Red River shiner	Transplant
Fishes	*Notropis blennius*	river shiner	Transplant
Fishes	*Notropis boops*	bigeye shiner	Transplant
Fishes	*Notropis girardi*	Arkansas River shiner	Transplant
Fishes	*Notropis nubilus*	Ozark minnow	Transplant
Fishes	*Notropis potteri*	chub shiner	Transplant
Fishes	*Notropis shumardi*	silverband shiner	Transplant
Fishes	*Oncorhynchus mykiss*	rainbow trout	Non-indigenous
Fishes	*Oreochromis aureus*	blue tilapia	Non-indigenous
Fishes	*Perca flavescens*	yellow perch	Non-indigenous
Fishes	*Percina macrolepida*	bigscale logperch	Transplant
Fishes	*Phoxinus eos*	northern redbelly dace	Transplant
Fishes	*Piaractus brachypomus*	pirapatinga, red-bellied pacu	Non-indigenous
Fishes	*Pimephales promelas*	fathead minnow	Transplant
Fishes	*Pygocentrus nattereri*	red piranha	Non-indigenous

Group	Scientific Name	Common Name	Non-Indigenous/ Transplant
Fishes	*Pygocentrus or Serrasalmus sp.*	unidentified piranha	Non-indigenous
Fishes	*Salmo trutta*	brown trout	Non-indigenous
Fishes	*Sander vitreus*	walleye	Non-indigenous
Fishes	*Scardinius erythrophthalmus*	rudd	Non-indigenous
Fishes	*Tinca tinca*	tench	Non-indigenous
Fishes	*Umbra limi*	central mudminnow	Non-indigenous
Fishes	*Xiphophorus helleri*	green swordtail	Non-indigenous
Mammals	*Myocastor coypus*	nutria	Non-indigenous
Mollusks-Bivalves	*Corbicula fluminea*	Asian clam	Non-indigenous
Mollusks-Bivalves	*Dreissena polymorpha*	zebra mussel	Non-indigenous
Mollusks-Gastropods	*Cipangopaludina japonica*	Japanese mysterysnail	Non-indigenous
Mollusks-Gastropods	*Pomacea paludosa*	Florida applesnail	Non-indigenous
Plants	*Alternanthera philoxeroides*	alligatorweed	Non-indigenous
Plants	*Landoltia (Spirodela) punctata*	dotted duckweed	Non-indigenous
Plants	*Ludwigia hexapetala*	Uruguay seedbox	Non-indigenous
Plants	*Lythrum salicaria*	purple loosestrife	Non-indigenous
Plants	*Myriophyllum aquaticum*	parrot-feather	Non-indigenous
Plants	*Myriophyllum spicatum*	Eurasian water-milfoil	Non-indigenous
Plants	*Najas minor*	brittle naiad	Non-indigenous
Plants	*Nasturtium officinale*	water-cress	Non-indigenous
Plants	*Nymphoides peltata*	yellow floating-heart	Non-indigenous
Plants	*Marsilea quadripholia*	water clover	Non-indigenous
Plants	*Potamogeton crispus*	curly pondweed	Non-indigenous
Reptiles-Crocodilians	*Alligator mississippiensis*	American Alligator	Transplant
Reptiles-Crocodilians	*Caiman crocodilus*	Common Caiman	Non-indigenous

*Non-indigenous: not native to OK; **Transplant: native to OK but moved outside native range

Appendix B
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Appendix C:

OKLAHOMA HARMFUL ALGAL BLOOM RESPONSE PLAN

OKLAHOMA DEPARTMENT OF WILDLIFE CONSERVATION
NATURAL RESOURCES SECTION

December 7, 2005

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Notification
Initial Response
Contact for Species Confirmation
Effects on Wildlife
Surveillance
Announcing the End of a Bloom

BACKGROUND

Concern among state and federal agencies in Oklahoma for the effect of harmful algal blooms on fish and wildlife and human health has grown since the first reported HAB related death in the United States. On July 2002 in Dane County Wisconsin a group of children took a midnight swim in a golf course pond. All experienced acute diarrhea and abdominal pains, one child died of a seizure. The algal toxin, Anatoxin-a, found in a sample of the boy's tissue was enough to have caused all the symptoms experienced by the group, including death. The alga in the pond was *Anabaena flos-aquae*. Anatoxins and Saxitoxins are predominately produced by the blue green algae genus of Anabaena and Aphanizomenon. Microcystin is the algae toxin of most concern in the United States. This toxin, although produced by a variety of blue-green algae species, is predominately linked to the blue-green algae genus *Microcystis*. Microcystin has been implicated in the deaths of 18 livestock last year in Utah. 49 dialysis patients in Brazil died after inadvertent exposure to 19.5 µg/L microcystin via the potable water supply. The symptoms and subsequent liver damage were identical to that found with previous laboratory animal experiments involving microcystin exposure. The State of Nebraska has 20µg/L threshold (recreational exposure) for beach closings. New York's threshold for (recreational exposure) beach closures is 6 µg/L of microcystin. Cylindrospermopsis is another algae toxin of concern. This blue-green algae toxin, cylindrospermopsin, was implicated in the fish kills of three lakes in Arizona last summer. The release of this toxin from a bloom treated with copper sulfate caused the hospitalization of over 100 children after drinking potable water in Australia.

The icthyotoxin producing "Golden Alga", *Prymnesium parvum,* has caused fish kills in Lake Texoma and Altus City Lake and major fish kills in lake across Texas. The Texas fish kills have caused significant economic and recreational losses. Its current distribution is spreading in southwestern Oklahoma. Environmental variables that trigger blooms, toxin release and toxin release are not well understood. However, research into the life history, life cycle, necessary environmental conditions and control and management continues to be the focus of some funding sources. Further, the ODWC is monitoring for *P. parvum* on Lake Texoma and other high risk waterbodies in an attempt to collect vital environmental data and determine whether cells are present.

INTRODUCTION

Most HAB events are revealed primarily through investigation of fish and/or wildlife kills. Potentially harmful algal cells can also be identified through probabilistic sampling as proposed by the Oklahoma Water Resources Board (OWRB) or through routine monitoring by other agencies. A one-year generic HAB sample regime conducted by the OWRB indicated most all eutrophic reservoirs in Oklahoma have the potential for algae toxin production. A response plan is essential in conducting investigations into HABs whether to confirm algal toxins have been released into the environment or identify another source of injury or death.

This contingency plan is intended for state and federal agencies or organizations that are required to respond to environmental events that cause harm to fish and wildlife, water quality or human health. This document may also help members of the media, public, researchers, and other local, state and federal organizations understand how Oklahoma responds to HABs. Further, this response plan reflects the plan objectives of adjacent states (i.e., Texas).

OBJECTIVES

1. To ensure all environmental resource agencies and other organizations are prepared to investigate and manage response to HAB events;
2. To ensure public health and environmental safety through effective and coordinated response, including monitoring, research, and assessment during HABs and related fish mortality events
3. To help in communication efforts with the public and other affected parties;
4. To support HAB research on conditions favoring these outbreaks, human health threats, and possible control options;
5. Provide adjacent states with Oklahoma's plan of action if HAB events should occur across state boundaries or in a shared waterbody.

Golden alga, *Prymnesium parvum*

Background (Golden Alga)

Harmful algal blooms are ubiquitous world wide in marine and freshwater systems. The state of Texas has documented fish kills from golden alga, *P. parvum*, in inland waters since 1985. The spread of *P. parvum* has had significant ecological and economic ramifications to Texas water bodies, which resulted in the creation of a Texas Parks and Wildlife Golden Alga Response Team.

In January 2004, the Oklahoma Department of Wildlife Conservation (ODWC) biologists documented a large fish kill in a tributary to the Red River. The Red River is a major tributary of Lake Texoma Reservoir and is a Public and Private Water Supply (PPWS). In August of 2004, a significant fish kill in Altus City Lake, also a public water supply, was reported by ODWC regional staff members. Both events resulted in the loss of thousands of fish and potential threat of recurring blooms in subsequent months.

The fish kill at Lake Texoma spawned the Oklahoma Golden Alga Task Force (OGART) which consists of members from Oklahoma resource agencies, other states (i.e., Texas), federal agencies and academia. The purpose of OGART is to implement appropriate response protocols and provide proactive solutions to *Prymnesium parvum* (*P. parvum*) blooms in Lake Texoma and other waterbodies that may be at risk. Primary components of OGART include response, control and management, water quality, research and laboratory techniques. The

ODWC has also provided general information about golden alga on the ODWC website
www.wildlifedepartment.com/index.htm and a link to the Texas parks and Wildlife Department (TPWD) website at www.tpwd.state.tx.us/hab/ga/

Notification (Golden Alga)

Dead and dying fish usually trigger a phone call to the ODWC , although the cause of the injury is often unknown by the caller. Golden alga blooms are typically associated with fish that are piping at the surface, dead fish, discolored water and foam along the shoreline. If any of these symptoms are observed, notifications should be made to the ODWC natural resources section. See Appendix A for a general call down list, ODWC regional fisheries office locations and contacts, and list of ODWC game wardens for Oklahoma. In the event of a large fish kill or event, assistance from other state and federal agencies as well as local officials may be necessary. A list of these agencies/officials is in Appendix A. A significant bloom may include any of the following indicators:

1. fish kill that is greater than 1,000 fish;
2. presence of dying fish;
3. presence of dead or stressed freshwater mussels and/or other wildlife;
4. discoloration of the water;
5. foam on the surface of the water;
6. presence of *P. parvum* cells in the water column;
7. presence of toxins in the water column;
8. percentage of *P. parvum* cells is the dominant algal species.

Initial Response (Golden Alga)

Most of the indicators listed above will not be obvious to the caller or the first responder. If a golden algal bloom is suspected, the first course of action is to confirm the presence or absence of *p. parvum* cells. The following guidelines are for use when collecting and transporting water samples:

Live and preserved samples should be collected. Samples for confirmation should initially be from at least three sites. Water should be collected in clean plastic or glass containers. Be sure to rinse bottles of any prior substance before using. Preferably, plastic HPDE 60 ml bottles should be used for all collections. Sampling depth should be elbow-deep, or one (1) foot below the surface.

-<u>Preserved Samples</u>

Collect 50-100 ml and preserve with buffered Lugol's solution to the amber color similar to weak iced tea (1-2 drops per 100 ml). Keep the samples refrigerated or on ice, if possible and in the dark until analysis. Samples should be preserved in the field immediately after collection. Put sample in Ziploc bag to avoid leaks. Include another copy of collection information in a separate Ziploc bag in case of a leak.

-Live Samples

Collect 50-100 ml sample in a clean container, wrap in wet paper and maintain as close as possible to water temperature at collection, but do not allow the samples to overheat. Live samples should not be refrigerated or put on ice. Sample container should be completely full with no air space. Microscopic analysis should be done the same day as collection or as soon as possible thereafter. Put sample in Ziploc bag to avoid leaks. Include another copy of collection information in a separate Ziploc bag in case of a leak.

1. Each sample should be marked with the following information:
   - Waterbody
   - Site/location
   - Date
   - Type of analysis (i.e., *p. parvum*, toxin, etc.)

2. In addition to information contained on the bottle, sample submissions should be accompanied by a Chain of Custody (COC). See form A in Appendix B.

3. Samples should be collected for water chemistry analysis. Additionally, other parameters should be collected in the field. The following is a list of parameters that should be analyzed in the laboratory with each *P. parvum* collection event. Form B found in Appendix B should be used to record all information.

Sulfate	Total Suspended Solids	Turbidity
Nitrogen, Ammonia as N	Nitrogen, Kjeldahl	Calcium
Nitrogen, Nitrate as N	Nitrogen, Nitrite as N	Magnesium
Phosphorus, Ortho as P	Phosphorus, Total P	
Total Alkalinity	Total Hardness	

   - Three samples per site should be collected in 1 liter HPDE plastic containers. One sample should contain no preservative. The other two samples should contain nitric acid and sulfuric acid as provided by a certified laboratory. All samples should be transported on ice immediately to the ODEQ laboratory in Oklahoma City or other approved laboratory after verifying with Ferrella March, Natural Resources Section, transport and change of custody. Contact information for ODEQ follows:

     Oklahoma Department of Environmental Quality
     707 N. Robinson
     Oklahoma City, OK 73101-1677
     405-702-1000

- The following parameters should be collected in the field if using an YSI 85, Hydrolab, or other comparable equipment.

  Dissolved Oxygen
  % Oxygen
  Specific Conductance
  Salinity
  Water temperature
  Ph

- Other observations should be included on Form B which include:

Cloud Cover	Secchi Depth
Wave Condition	Ph
Air Temperature	GPS Location
Wind Speed	Wind Direction

4. All samples should be coordinated through the following person:

   Buck Ray
   Oklahoma Department of Wildlife Conservation
   Oklahoma City Zoo Office
   405-424-6062

5. When a fish kill is involved, ODWC staff should document the kill using the American Fisheries Society Special Publication 30: Investigation and Monetary Values of Fish and Freshwater Mussel kills and modifications reflected in the ODWC Fish and Mussel Kill Protocol. This protocol involves counting, identifying and size classification (inch or lbs depending on size). Documentation of such kills will enable the ODWC to provide economic and recreational loss values. Form C in Appendix B can be used to record such information.

6. In the event of a significant kill that requires additional time, personnel, or other agencies, the incident command system (ICS) should be implemented. Natural Resources will coordinate this effort and identify command posts.

7. Dead fish and wildlife should be disposed of consistent with local regulations and state statutes. The ODWC is not responsible for clean up or disposal of carcasses.

Media Strategy (Golden Alga)

ODWC Media Contact: Micah Holmes – Information Supervisor (405-522-4872).

In the event of a serious fish kill, this crisis response plan is designed to educate and inform the public, particularly anglers and other user groups, about golden alga blooms in Oklahoma.

The ODWC Media Contact should be made aware of any potential golden alga blooms by Buck Ray or Barry Bolton (Fisheries Division). Good communication between the Media Contact and the biologists is critical to the success of the media response plan. If the bloom occurs at Lake Texoma, the Media Contact will contact Steve Lightfoot, with TPWD, so that communication efforts can be complementary.

The Media Contact will coordinate with other agency personnel to draft three separate information items

- A fact sheet with known location and effects of the bloom to be distributed to agency personnel and other cooperating agencies
- A new release to be distributed to selected media outlets.
- Talking points for agency personnel that may be talking with the media. These points will guide individuals to focus on certain issues (such as perspective of the severity of the kill, not harmful to humans, economic impact, etc...).

If possible, all media calls should be funneled through the Media Contact who will then get them in contact with the appropriate person (biologist, Fisheries Chief, etc...).

If necessary, the Media Contact will establish an on-site presence at the lake where the bloom occurred and notify Rich Fuller with the ODWC Information and Education Division for potential video coverage.

The Media Contact will call local media outlets to brief them on the current situation.

If appropriate the Media Coordinator will coordinate a news conference. At the conference a basic media kit will be provided including the golden alga brochure, press release, B-roll ready for television coverage, lake map etc...

The Media Contact will communicate with ODWC personnel to place information on the Web site or "Outdoor Oklahoma" television show.

If needed, the Media Contact will assist Fisheries personnel in coordinating and promoting a public meeting with local citizens, marina operators and anglers.

The Media Contact will coordinate with Buck Ray announcing the end of a bloom.

Public Health Concerns (Golden Alga)

During a bloom, golden alga may release toxins in sufficient quantities to kill fish and other gill breathing animals that come in contact with it. However, there is no evidence that golden alga has lethal effects on other organisms or humans.

Even though golden alga is not linked to human health issues, the ODWC strongly recommends that people should not pick up dead or dying fish for consumption.

Monitoring (Golden Alga)

Surveillance of golden alga cells in affected waterbodies should continue until the bloom has completed its cycle. However, long term monitoring should be considered in water bodies that have been previously affected for the following reasons: 1) to identify the early stages of a bloom; 2) collect important water quality information to determine possible trigger mechanisms and predict when subsequent blooms are likely to occur. All monitoring should be coordinated through the Natural Resources Section.

Blue-green Algae, Cyanobacteria

Background (Blue-green Algae)

Blue-green algae are also called cyanobacteria because they are biologically similar to bacteria in many ways. As single cells, large colonies and filaments, blue-green algae grow in a wide variety of conditions and can become the dominant algae in nutrient-rich water bodies. One of the characteristics of these cyanobacteria is their ability to form blooms. When a bloom occurs, the water appears to be blue-green in color and can cause taste and odor problems in water supplies. More importantly, blue-green algae can produce toxins that can have human health implications and can cause toxicity in fish, wildlife, domestic animals and livestock. Anatoxins and Saxitoxins are predominately produced by the blue green algae genus of Anabaena and Aphanizomenon. Microcystin is the algae toxin of most concern in the United States. This toxin, although produced by a variety of blue-green algae species, is predominately linked to the blue-green algae genus *Microcystis*. Awareness is a growing need to ensure blue-green algal toxins do not affect water treatment plants without being adequately removed or affect. Likewise, it is important that blue green algae blooms are monitored due to the increasing levels of nutrients that currently being introduced into Oklahoma's waterbodies.

Notification (Blue-green Algae)

Dead and dying fish or wildlife usually triggers a phone call to the ODWC, although the cause of the injury is often unknown by the caller. Blue-green algae blooms are typically associated thick scum on the surface of the water that looks like blue-green paint. If such symptoms are observed, notifications should be made to the ODWC natural resources section. See Appendix A for a general call down list, ODWC regional fisheries office locations and contacts, and list of ODWC game wardens for Oklahoma. In the event of a large fish kill or event, assistance from other state and federal agencies as well as local officials may be necessary. A list of these agencies/officials is in Appendix A. A significant bloom may include any of the following indicators:

1. fish kill that is greater than 500-1,000 fish;
2. presence of dying fish;
3. presence of dead or stressed freshwater mussels and/or other wildlife;
4. discoloration of the water;
5. presence of blue-green algae cells in the water column;
6. presence of toxins in the water column;
7. percentage of blue-green algae cells is the dominant algal species.

Initial Response (Blue-green Algae)

Most of the indicators listed above will not be obvious to the caller or the first responder. If a blue-green algae bloom is suspected, the first course of action is to confirm the presence or absence of blue-green algae cells. The following guidelines are for use when collecting and transporting water samples:

- Samples should be collected in a one-liter Nalgene container
- Samples should remain cool (either in a cooler with freezer packs or refrigerated) until analysis can be performed
- Samples should be processed within 24-72 hours of collection
- Transfer of samples should be coordinated through Ferrella March, Natural Resources Section

8. Each sample should be marked with the following information:
   - Waterbody
   - Site/location
   - Date
   - Type of analysis (i.e., *p. parvum*, toxin, etc.)

9. In addition to information contained on the bottle, sample submissions should be accompanied by a Chain of Custody (COC). See form A in Appendix B.

10. Samples should be collected for water chemistry analysis. Additionally, other parameters should be collected in the field. The following is a list of parameters that should be analyzed in the laboratory with each collection event. Form B found in Appendix B should be used to record all information.

Sulfate	Total Suspended Solids	Turbidity
Nitrogen, Ammonia as N	Nitrogen, Kjeldahl	Calcium
Nitrogen, Nitrate as N	Nitrogen, Nitrite as N	Magnesium
Phosphorus, Ortho as P	Phosphorus, Total P	
Total Alkalinity	Total Hardness	

- Three samples per site should be collected in 1 liter HPDE plastic containers. One sample should contain no preservative. The other two samples should contain nitric acid and sulfuric acid as provided by a certified laboratory. All samples should be transported on ice

immediately to the ODEQ laboratory in Oklahoma City or other approved laboratory after verifying with Buck Ray, transport and change of custody. Contact information for ODEQ follows:

Oklahoma Department of Environmental Quality
707 N. Robinson
Oklahoma City, OK 73101-1677
405-702-1000

- The following parameters should be collected in the field if using an YSI 85, Hydrolab, or other comparable equipment.

  Dissolved Oxygen
  % Oxygen
  Specific Conductance
  Salinity
  Water temperature
  Ph

- Other observations should be included on Form B which include:

Cloud Cover	Secchi Depth
Wave Condition	Ph
Air Temperature	GPS Location
Wind Speed	Wind Direction

11. All samples should be coordinated through the following person:

    Buck Ray
    Oklahoma Department of Wildlife Conservation
    Oklahoma City Zoo Office
    405-424-6062

12. When a fish kill is involved, ODWC staff should document the kill using the American Fisheries Society Special Publication 30: Investigation and Monetary Values of Fish and Freshwater Mussel kills and modifications reflected in the ODWC Fish and Mussel Kill Protocol. This protocol involves counting, identifying and size classification (inch or lbs depending on size). Documentation of such kills will enable the ODWC to provide economic and recreational loss values. Form C in Appendix B can be used to record such information.

13. In the event of a significant kill that requires additional time, personnel, or other agencies, the incident command system (ICS) should be implemented. Natural Resources will coordinate this effort and identify command posts.

14. Dead fish and wildlife should be disposed of consistent with local regulations and state statutes. The ODWC is not responsible for clean up or disposal of carcasses.

Media Strategy (Blue-green Algae)

ODWC Media Contact: Micah Holmes – Information Supervisor (405-522-4872).

In the event of a serious fish kill, this crisis response plan is designed to educate and inform the public, particularly anglers and other user groups, about harmful algal blooms in Oklahoma.

The ODWC Media Contact should be made aware of any potential harmful alga blooms by Buck Ray or Barry Bolton (Fisheries Division). Good communication between the Media Contact and the biologists is critical to the success of the media response plan

The Media Contact will coordinate with other agency personnel to draft three separate information items

- A fact sheet with known location and effects of the bloom to be distributed to agency personnel and other cooperating agencies
- A new release to be distributed to selected media outlets.
- Talking points for agency personnel that may be talking with the media. These points will guide individuals to focus on certain issues (such as perspective of the severity of the kill, harmful/not harmful to humans, precautions, economic impact, etc…).

If possible, all media calls should be funneled through the Media Contact who will then get them in contact with the appropriate person (biologist, Fisheries Chief, etc…).

If necessary, the Media Contact will establish an on-site presence at the lake where the bloom occurred and notify Rich Fuller with the ODWC Information and Education Division for potential video coverage.

The Media Contact will call local media outlets to brief them on the current situation.

If appropriate the Media Coordinator will coordinate a news conference. At the conference a basic media kit will be provided including a press release, B-roll ready for television coverage, lake map etc…

The Media Contact will communicate with ODWC personnel to place information on the Web site or "Outdoor Oklahoma" television show. If needed, the Media Contact will assist Fisheries personnel in coordinating and promoting a public meeting with local citizens, marina operators and anglers.

The Media Contact will coordinate with Buck Ray in announcing the end of a bloom.

Public Health Concerns (Blue-green algae)

During a bloom, blue-green algae may release toxins in sufficient quantities to harm humans and cause toxicosis to fish, wildlife, domestic animals and livestock. If water, fish or blue-green algal products containing elevated levels of toxins are ingested by a human, symptoms might include headache, fever, diarrhea, abdominal pain, nausea and vomiting. Itchy and irritated eyes and skin may result if a human is swims in contaminated water. If a person suspects they may have come into contact with cyanobacterial toxins and are experiencing any of these symptoms, any scum should be rinsed off their physician consulted immediately.

Unlike controls available with a drinking water source contaminated with cyanobacteria, there are very few options available once these algae accumulate in water used for recreational activities, such as swimming, boating, wind surfing and fishing. Blooms in recreational bodies of water are usually associated with unpleasant odors and offensive appearance on shorelines as the scum accumulates and decays. Although cyanobacterial toxins are probably not absorbed through the skin, they can cause skin irritation. The toxins, if present, can be absorbed from the water via ingestion or can become airborne and absorbed via inhalation. Individuals should avoid swimming and other water-related activities in areas with dense blooms.

The ODWC strongly recommends that people should not pick up dead or dying fish for consumption. Likewise, people should not handle dead animals affected by blue green-algae blooms and should wash anything that may have come in contact with the scum.

Monitoring (Blue-green Algae)

Surveillance of blue-green algae cells in affected waterbodies should continue until the bloom has completed its cycle. However, long term monitoring should be considered in water bodies that have been previously affected for the following reasons: 1) to identify the early stages of a bloom; 2) collect important water quality information to determine possible trigger mechanisms and predict when subsequent blooms are likely to occur. All monitoring should be coordinated through the Natural Resources Section.

APPENDIX D

BOR Zebra and Quagga Mussel PCR Results for 2008

Source	USBR #	Pisces #	Sampling Date	Source Information	Sample	Microscope # veligers/L	PCR Test Results					
							18S ZM/QM	ITS ZM	Mussel 18S	ITS QM	COX1 ZM	COX1 QM
BOR/KK	A0056	NR	12-May-08	Conchas Lake State Park	tow net/EtOH	NR	–	NR	NR	NR	n/a	n/a
BOR/KK	A0079	NR	24-May-08	Navajo Lake State Park	tow net/EtOH	NR	–	NR	NR	NR	n/a	n/a
BOR/KK	A0080	NR	25-May-08	Elephant Butte Lake State Park	tow net/EtOH	NR	–	NR	NR	NR	n/a	n/a
BOR/KK	A0113	86552	17-Jun-08	Cochiti Lake State Park	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0114	86553	17-Jun-08	Abiquiu Lake State Park	tow net/EtOH	NR	NR	–	vw+	–	n/a	n/a
BOR/KK	A0116	86551	19-Jun-08	Santa Rosa Lake State Park	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0117	86554	19-Jun-08	Ute Lake State Park	tow net/EtOH	NR	NR	–	+++	w+?	n/a	n/a
BOR/KK	A0136	86566	1-Jul-08	Heron Lake State Park	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0137	86555	2-Jul-08	Broken Bow Lake @ BB marina	tow net/EtOH	0.0	NR	–	vw+	–	n/a	n/a
BOR/KK	A0138	86558	2-Jul-08	Hugo Lake @ Hugo Lake Marina	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0139	86560	2-Jul-08	Pine Creek Lake – Lost Rapids	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0161	86564	2-Jul-08	Navajo Lake State Park	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0162	86556	3-Jul-08	Lake Eufaula @ Brooken Cove	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0163	86557	3-Jul-08	Lake Eufaula @ Hwy 9 Marina	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0164	86559	7-Jul-08	Lake Murray @ LM Lodge Pier	tow net/EtOH	0.0	NR	–	+	–	n/a	n/a
BOR/KK	A0140	86561	7-Jul-08	Lake Texoma @ Highport Marina	tow net/EtOH	0.0	NR	–	vw+	–	n/a	n/a
BOR/KK	A0141	86562	7-Jul-08	Lake Texoma @ Catfish Bay	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0156	86563	10-Jul-08	Elmer Thomas @ C.D.	tow net/EtOH	0.003	NR	–	–	–	n/a	n/a
BOR/KK	A0183	86565	22-Jul-08	Conchas Lake State Park	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0224	87502	20-Aug-08	Lake Altus Lugert Live Oak Courtesy Dock	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0220	87505	20-Aug-08	Foss Lake Main Southside Courtesy Dock Foss State Park	tow net/EtOH	0.12	NR	–	–	–	n/a	n/a
BOR/KK	A0221	87506	20-Aug-08	Lake Fort Cobb Eagle's Nest Cove Courtesy Dock	tow net/EtOH	0.002	NR	–	–	–	n/a	n/a
BOR/KK	A0222	87507	20-Aug-08	Tom Steed Reservoir Main Boat Ramp Courtesy Dock	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0137	87503	21-Aug-08	Broken Bow Lake @ BB marina	tow net/EtOH	NR	NR	–	w+	–	n/a	n/a
BOR/KK	A0223	87504	21-Aug-08	Canton Lake Big Bend Park Courtesy Dock	tow net/EtOH	0.0	NR	–	–	–	n/a	n/a
BOR/KK	A0299	87514	11-Sep-08	Hugo Lake @ Hugo Lake Marina	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0300	87515	11-Sep-08	Pine Creek @ Lost Rapids C.D.	tow net/EtOH	NR	NR	–	+	–	n/a	n/a
BOR/KK	A0304	87519	11-Sep-08	Broken Bow @ Broken Bow Marina	tow net/EtOH	NR	NR	–	w+	–	n/a	n/a
BOR/KK	A0298	87513	12-Sep-08	Texoma @ Highport Marina	tow net/EtOH	NR	NR	+	+	–	n/a	n/a
BOR/KK	A0302	87517	12-Sep-08	Texoma @ Catfish Bay	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0301	87516	15-Sep-08	Elmer Thomas @ C.D.	tow net/EtOH	NR	NR	–	vw+	–	n/a	n/a
BOR/KK	A0303	87518	15-Sep-08	Murray @ Murray Lodge Pier	tow net/EtOH	NR	NR	–	w+	–	n/a	n/a
BOR/KK	A0274	87508	16-Sep-08	Eufaula @ Brooken Cove	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0275	87509	16-Sep-08	Eufaula @ Hwy 9 Landing	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0277	87510	17-Sep-08	Lake Altus-Lugert Live Oak Courtesy Dock	tow net/EtOH	NR	NR	–	–	–	n/a	n/a

BOR/KK	A0278	87511	17-Sep-08	Tom Steed Lake Great Plains SP Main Boat Ramp Courtesy Dock	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0279	89433	17-Sep-08	Lake Fort Cobb Eagle's Nest Cove Courtesy Dock	tow net/EtOH	0.0	NR	–	n/a	–	–	–
BOR/KK	A0280	87512	18-Sep-08	Canton Lake-Courtesy Dock Big Bend Day Use Area	tow net/EtOH	NR	NR	–	–	–	n/a	n/a
BOR/KK	A0281	89434	18-Sep-08	Foss Lake Marina Del Rey	tow net/EtOH	2 questionable	NR	–	n/a	–	–	–
BOR/KK	A0281B	89435	18-Sep-08	Foss Lake Marina Del Rey – 2 questionable veligers	isolated vels	n/a	NR	–	n/a	–	–	–
BOR/KK	A0356	89432	22-Sep-08	Navajo Lake State Park	tow net/EtOH	NR	NR	–	n/a	–	–	–
BOR/KK	A0353	89429	23-Sep-08	Heron Lake State Park	tow net/EtOH	NR	NR	–	n/a	–	–	–
BOR/KK	A0354	89430	25-Sep-08	Conchas Lake State Park	tow net/EtOH	NR	NR	–	n/a	–	–	–
BOR/KK	A0355	89431	9-Oct-08	Elephant Butte Lake State Park	tow net/EtOH	NR	NR	–	n/a	–	–	–

NR = Not Requested

APPENDIX E

Acronyms Defined

Acronym	Definition
ANS	Aquatic Nuisance Species
ANSTF	Aquatic Nuisance Species Task Force
BOR	U.S. Bureau of Reclamation
BWM	Ballast Water Management
DEQ	Oklahoma Department of Environmental Quality
FTE	Full Time Employee
GRDA	Grand River Dam Authority
LMBV	Largemouth Bass Virus
MRBP	Mississippi River Basin Regional Panel
NANPCA	Non-indigenous Aquatic Nuisance Prevention and Control Act
NISA	National Invasive Species Act
NPS	National Park Service
NZMS	New Zealand Mudsnail
OCC	Oklahoma Conservation Commission
ODAFF	Oklahoma Department of Agriculture, Food and Forestry
ODWC	Oklahoma Department of Wildlife Conservation
OSU	Oklahoma State University
OTRD	Oklahoma Tourism and Recreation Department
OU	University of Oklahoma
OWRB	Oklahoma Water Resources Board
PTF	ANS Plant Task Force
SVC	Spring Viremia of Carp
SWAP	Oklahoma State Wildlife Action Plan
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
VHS	Viral Hemorraghic Septicemia
WGA	Western Governors Association
WRP	Western Regional Panel
ZMRP	Zebra Mussel Research Program
ZMTF	Zebra Mussel Task Force

APPENDIX F

2008 Oklahoma Aquatic Nuisance Species And Boating Survey

By: Curtis Tackett
Aquatic Nuisance Species Biologist

Oklahoma Department of Wildlife Conservation
1801 N. Lincoln
Oklahoma City, OK 73105

September 2009

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Survey Results

General Knowledge of Aquatic Nuisance Species

The respondents were asked to rank their knowledge of six aquatic nuisance species: zebra mussels/quagga mussels, golden alga, hydrilla, Viral Hemorrhagic Septicemia (VHS), Asian carp, and white perch. The ranking categories included "a large amount, a moderate amount, a small amount or none".

There were only two ANS out of six where there were more respondents who knew at least a small amount of information about the species than knew nothing at all. These include zebra/quagga mussels and Asian carp. Zebra/quagga mussels were the most well-known of the six species with 78% knowing at least some information about the species (Figure 1). This species also had the highest ranking of "a large amount" at 19%. These results were somewhat expected because of the increasing publicity of zebra/quagga mussels and the devastating apparent threats that they pose to our economy and our environment.

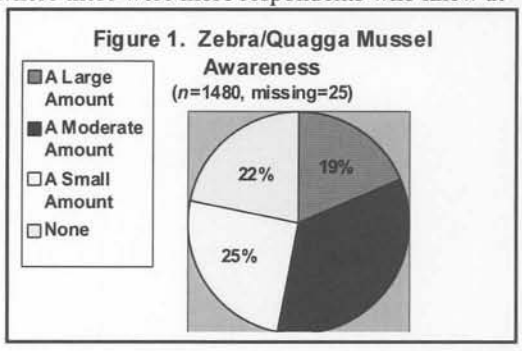


Figure 1. Zebra/Quagga Mussel Awareness
(*n*=1480, missing=25)

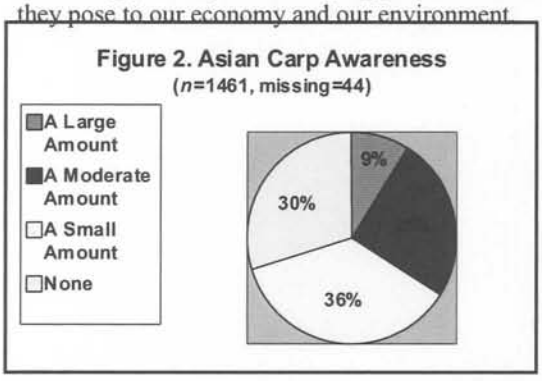


Figure 2. Asian Carp Awareness
(*n*=1461, missing=44)

Asian Carp were the second most well-known with 70% of the respondents having at least some knowledge of the species (Figure 2). This group of fish includes bighead, black, grass and silver carp. This group of fish also had the second highest ranking of "a large amount" at 9%. The awareness of this species is likely related to media accounts of Asian carp problems in the upper Mississippi River system and the use of grass carp to manage vegetation in private impoundments. Hydrilla was ranked third with 44% of respondents having at least some knowledge about the species (Figure 3). Although it ranked third, it was well behind zebra/quagga mussels and Asian carp when it came to general knowledge. The

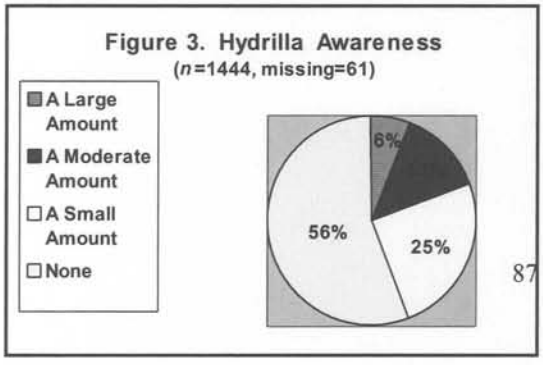
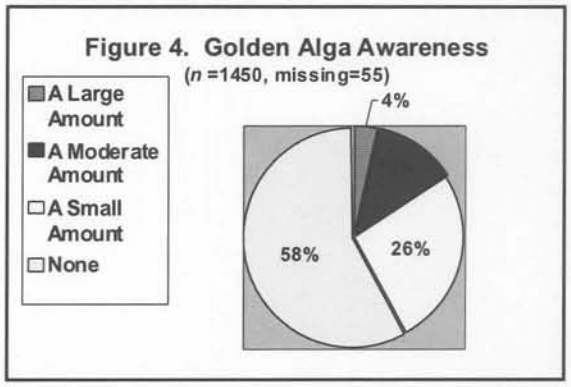
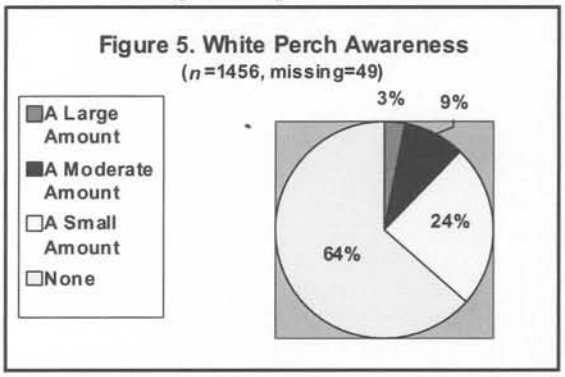


Figure 3. Hydrilla Awareness
(*n*=1444, missing=61)

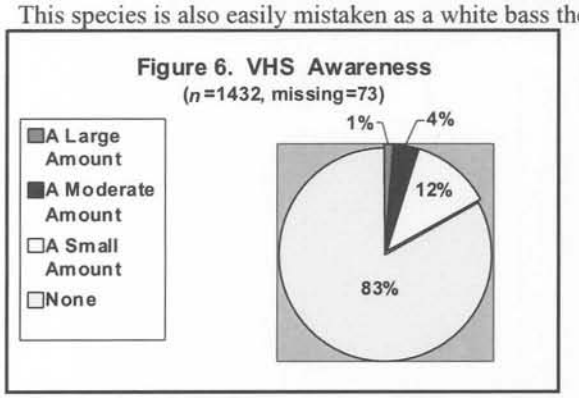
majority of the respondents that had at least some knowledge of hydrilla only knew "a small amount" at 25% and the "large amount" category only ranked at 6%. Hydrilla is currently found in Lakes Murray, Arbuckle and Sooner.



Golden alga is a species that has the potential to cause large fish kills in Oklahoma. It ranked closely behind hydrilla with 42% of the respondents having at least some knowledge (Figure 4). Only 4% of respondents knew "a large amount" about this species. This species has a well established population and usually causes blooms in Lake Texoma every year. Lake Texoma is a highly popular lake and this most likely attributes to the fair amount of awareness that golden alga receives.



White perch are a highly competitive species of fish which have established populations in Lakes Sooner, Kaw and Keystone. This species ranked next to last in general knowledge. Well over half, 64%, of respondents knew nothing at all about white perch (Figure 5). Only 3% of the respondents knew "a large amount" about this species. This low ranking of general knowledge is probably due to the fact that people rarely encounter white perch. This species is also easily mistaken as a white bass therefore misidentification probably plays a large role.



Viral Hemorrhagic Septicemia ranks last when it comes to general knowledge of the species. Out of the respondents, only 17% knew anything at all about VHS (Figure 6). VHS is a somewhat new fish disease that is mostly found in the Great Lakes region. It has not yet been found in Oklahoma and this most likely directly attributes to the 83% of respondents having no knowledge of it.

The importance of taking precautions to prevent the spread of ANS

Figure 7. Zebra Mussell Importance to Prevent Spread
(*n* = 1483, missing=22)

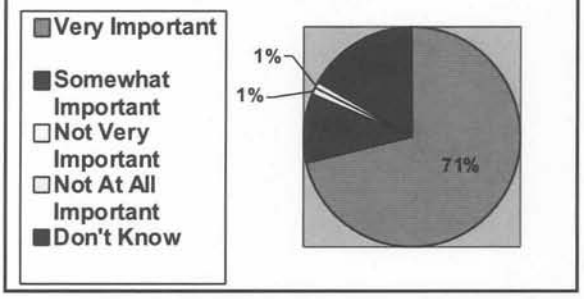


Figure 8. Golden Alga Importance to Prevent Spread
(*n* = 1460, missing=45)

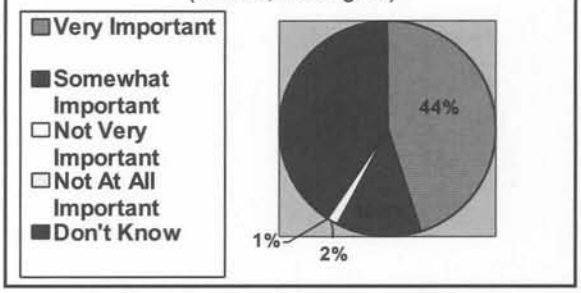
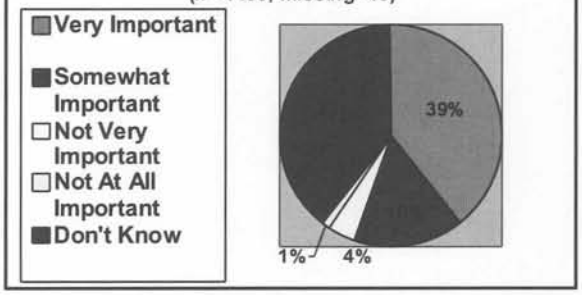
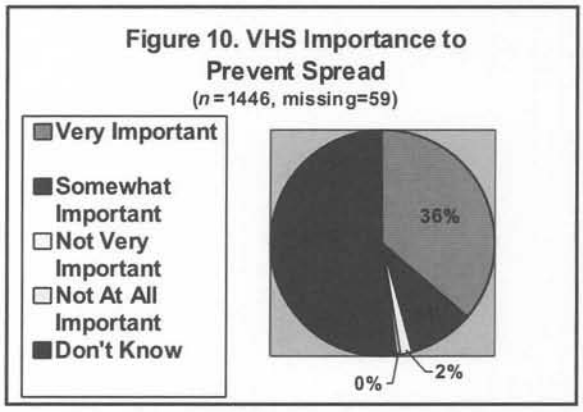


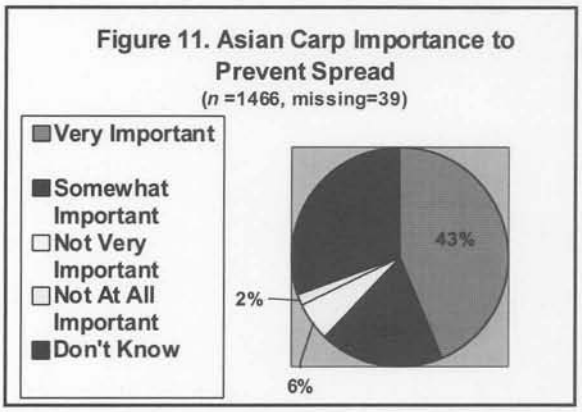
Figure 9. Hydrilla Importance to Prevent Spread
(*n* = 1460, missing=45)

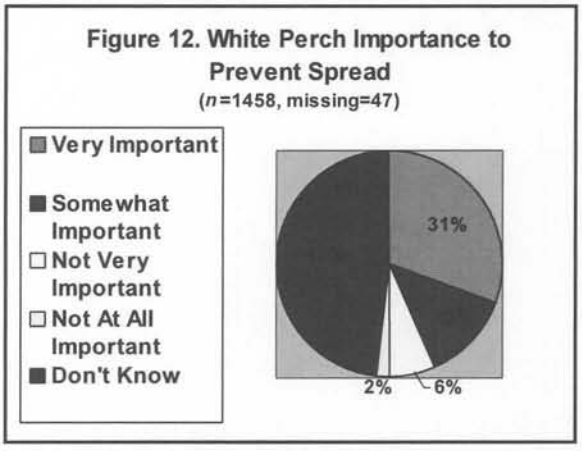


Boaters were asked to rank the importance of preventing the spread of each aquatic nuisance species from the previous question. Respondents were asked to rank the importance into five categories: very important, somewhat important, not very important, not at all important and don't know. These responses were generally correlated with the general knowledge question. If boaters had a high amount of knowledge about the ANS, then the level of importance to help prevent the spread was usually high. Overall the responses for "not very important" and "not at all important" were fairly low for each species (Figures 7 through 12). Nearly half of the respondents for each ANS, except zebra/quagga mussels and Asian carp, didn't know if it was important to prevent the spread. This clearly shows that we must increase our outreach efforts for these species.

Only 19% of the respondents were unsure about the importance to prevent spreading of zebra/quagga mussels (Figure 7). More than three quarters, 81%, of the respondents felt like it was at least somewhat important to prevent the spread. Asian carp ranked second in highest responses of importance (Figure 11). At least 61% of the respondents felt it was at least somewhat important to prevent spread of these species. VHS and white perch had the lowest responses for "very important" and the highest responses for the "don't know" category (Figures 10 and 12. This is directly correlated to the general knowledge question.







Sources of Information on ANS

Boaters were asked four series of questions that are related to general sources of ANS information and how effective different sources would be in getting them to take actions to help prevent the spread of aquatic nuisance species. These questions were designed to give us some insight on how future efforts for public awareness and education could be directed or enhanced.

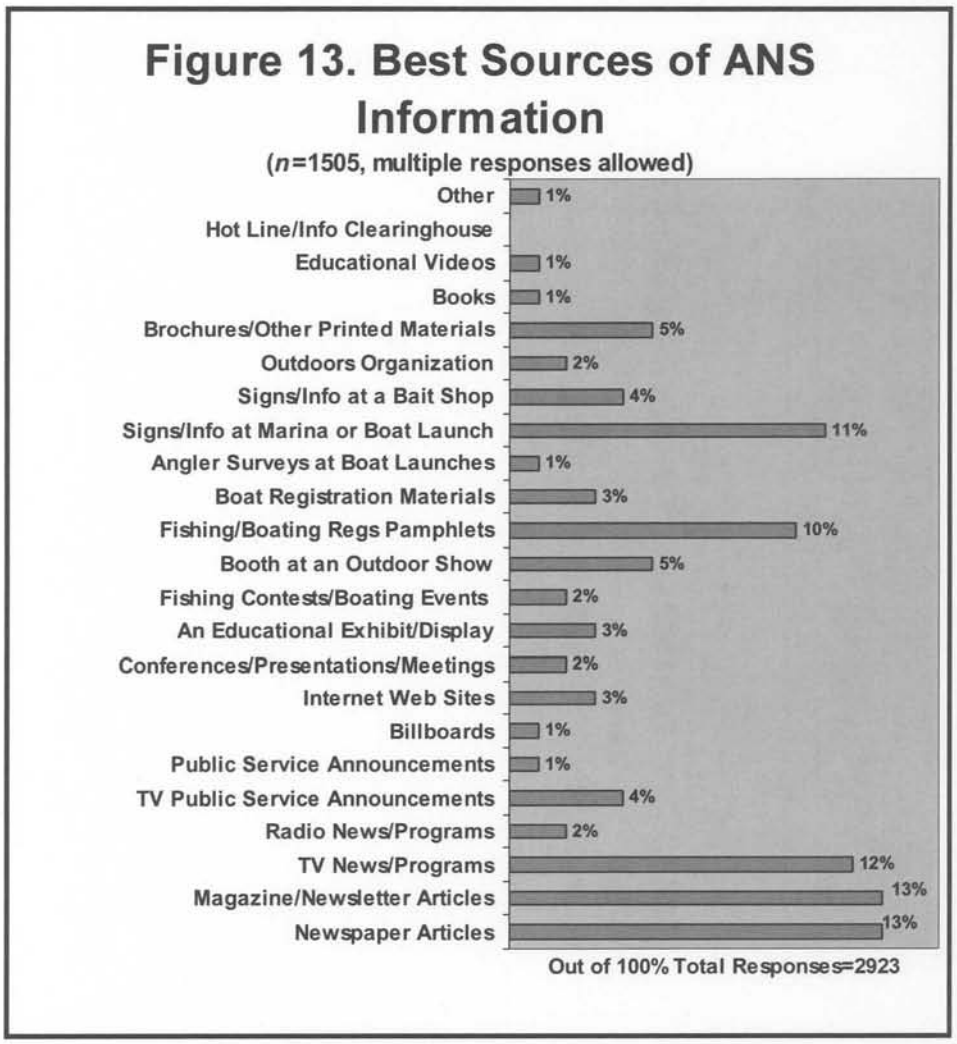
From a list of twenty two sources, boaters were asked if they have heard of or read about ANS. These sources are in four categories: media sources, events, fishing or boating sources, and other sources. Nearly half of the respondents had gained knowledge about ANS through sources such as newspaper articles, magazine or newsletters, television programs, and fishing or boating pamphlets. These sources were somewhat expected to yield high rankings because of the various publications and materials available to the public. Television or news programs had the highest ranking with 48% (Table 1). Magazine or newsletters and newspaper articles followed shortly after with 48% and 45%, respectively. Fishing or boating pamphlets were good sources or information with 42% and signs/information at marinas or boat ramps followed shortly after with 40%. Information sources effective in reaching 10% or less of the respondents included radio public service announcements, billboards, and conferences, presentations or meetings.

These results were also somewhat expected because of the lack of efforts. Oklahoma has yet to use billboards or conferences as outreach tools.

Table 1. Sources of ANS Information (*n*=1505)	Yes	No	Don't Know	No Opinion
Newspaper Articles	45%	33%	8%	14%
Magazine or Newsletter Articles	47%	30%	8%	15%
Television News or Programs	48%	31%	8%	14%
Radio News or Programs	12%	60%	12%	16%
Television Public Service Announcements	18%	55%	12%	15%
Radio Public Service Announcements	5%	65%	14%	16%
Billboards	7%	64%	13%	16%
Internet Web Sites	15%	57%	12%	17%
Conferences, Presentations, or Meetings	8%	67%	10%	16%
An Educational Exhibit or Display	18%	56%	10%	16%
Fishing Contests, Derby, or Sailboat Regattas	13%	61%	10%	16%
Booth at a Sport or Fishing Show or Similar Event	28%	49%	9%	15%
Fishing or Boating Regulation Pamphlets	42%	35%	8%	15%
Boat Registration Materials	17%	56%	11%	16%
Creel Surveys or Inspection Programs at Boat Launch	13%	61%	10%	15%
Signs/Information Provided at Marina or Boat Launch	40%	38%	8%	14%
Signs/Information Provided at a Bait Shop	23%	53%	9%	15%
Fish, Boat, Sport, or Environmental Organization	19%	55%	11%	15%
Brochures, Identification Cards, or Fact Sheets	27%	49%	10%	15%
Books	10%	65%	10%	16%
Educational Videos	6%	69%	10%	16%
Hot Line or Information Clearinghouse	1%	73%	11%	16%

Best sources of ANS information

Respondents were asked to choose up to four of the best sources of which they have heard about aquatic nuisance species (Figure 13). This referred to the previous question which had twenty two possible information sources. As compared to Table 1, these responses were nearly identical. The top responses for the best sources of information were newspaper and magazine articles, newsletters, fishing and boating pamphlets, and signs at marinas or boat docks. The responses that received the lowest amount of credit were billboards, public service announcements, angler surveys, books and educational videos.



Getting people to take action

Respondents were asked how effective certain things and events would be in getting them to take steps to prevent the spread of ANS. The choices were ranked on an effectiveness scale and included very effective, somewhat effective, and not very effective. In addition, the survey also asked if these certain things and events have already led them to take action.

"A desire to keep ANS out of our waters" had the most responses (65%) for "how effective it would be to get you to take action" (Table 2). "A desire to prevent damage to your boat" had the second most responses (63%) for this category. Respondents also had a strong opinion that it was a sense of personal responsibility (58%). "Signs at marinas or boat ramps" (56%) and "fishing and boating pamphlets" (47%) came in fourth and fifth for the most responses in this category.

The number one response for already leading people to take action (Table 3) was "a sense of personal responsibility" (31%). This was followed very closely by "a desire to keep ANS out of our waters" (28%). "A desire to prevent damage to my boat" (26%) and "talking with acquaintances and friends" (22%) were also effective sources of information that have led people to take action against ANS. "Signs at marinas and boat ramps also ranked high in this category at 17%.

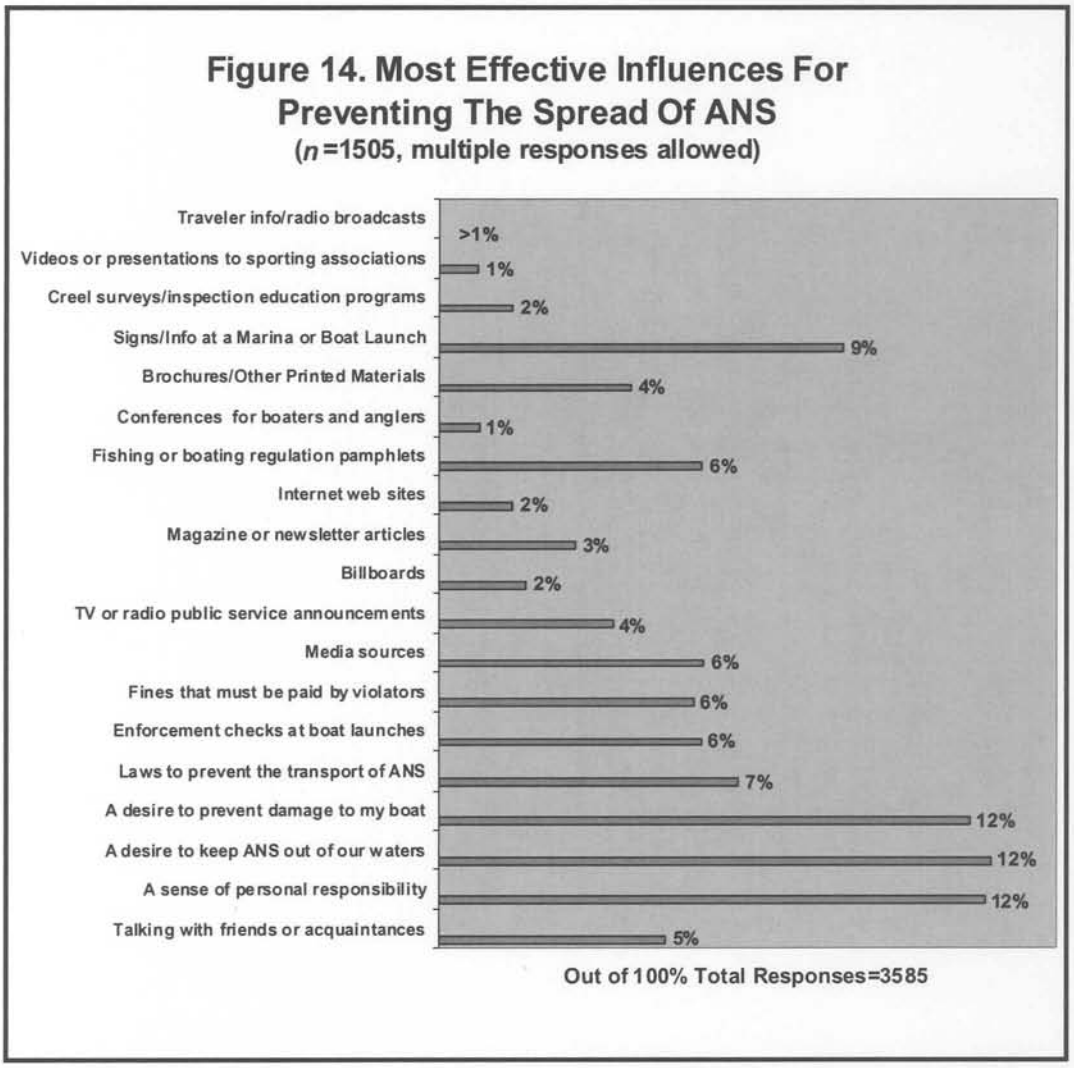
Boaters value their property and when there is a possibility that their personal boat or equipment may become damaged, they are willing to take measures for prevention. The survey shows that this is of great concern because 63% said it would be effective and 26% said it has already led them to action. Over half (58%) of the respondents felt like it is their personal responsibility to take action. People want to protect the waters that they use and therefore feel like it is their responsibly to help stop the spread of ANS.

The least effective influences in getting people to take action are presentations, educational programs, radio broadcasts, angler surveys, enforcement checks, billboards and internet web sites. Respondents said that radio broadcast (39%) and internet web sites (22%) would not be very effective influences. ANS billboards have not been used in Oklahoma as an awareness tool due to costs but some states are investing in billboards as a way to educate and outreach to the public. Conferences and workshops (21%) and videos or presentations (20%) were also looked at as very ineffective influences.

Table 2. How Effective Would This Be In Getting You To Take Action? (multiple responses allowed)	Would Be Very Effective	Would Be Somewhat Effective	Would Not Be Very Effective	No Response
Talking With Friends or Acquaintances	34%	39%	8%	19%
A Sense of Personal Responsibility	58%	22%	3%	17%
A Desire to Keep ANS Out of Our Waters	65%	16%	2%	17%
Regulations to Prevent the Transport of ANS	43%	29%	12%	17%
A Desire to Prevent Damage to my Boat	63%	15%	5%	17%
Enforcement Checks on the Road or at Boat Launches to Catch Violators	38%	28%	16%	18%
Media Sources (Newspapers and Radio and TV News/Programs)	43%	33%	7%	17%
TV or Radio Public Service Announcements	41%	34%	8%	17%
Billboards	25%	39%	18%	18%
Magazine or Newsletter Articles	35%	37%	11%	18%
Internet Web Sites	25%	34%	22%	19%
Fishing or Boating Regulation Pamphlets	47%	30%	5%	17%
Conferences or Workshops for Boaters and Anglers	23%	38%	21%	18%
Brochures, Species ID Cards, Fact Sheets, or Other Printed Materials	42%	33%	8%	17%
Signs at Marinas or Boat Launches	56%	23%	4%	17%
Creel Surveys or Inspection/Education Programs on Roads or at Boat Launches	28%	39%	15%	18%
Videos or Other Presentations to Boating, Lake, and Sporting Associations	23%	40%	20%	18%
Traveler Info or Low Power Radio Broadcasts Along Roads	11%	31%	39%	19%
Fines that Must be Paid by Violators	39%	27%	16%	19%

Most effective influences for preventing the spread

The final series of questions asked the respondents to choose four of the influences that would be the most effective in influencing and motivating them to prevent the spread of ANS. A desire to keep ANS out of Oklahoma's waters, prevent damage to their boat, and a sense of personal responsibility all ranked highest at 12% (Figure 14). Again, radio broadcasts, presentations and conferences all scored very low.



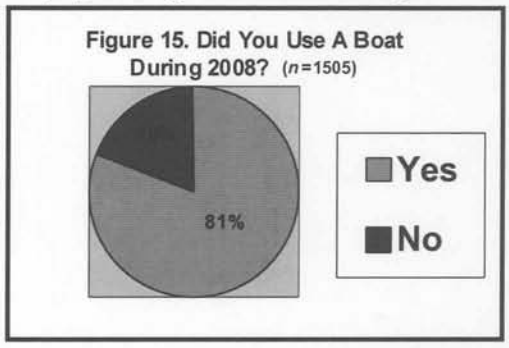
This has already led me to action

In the final column, respondents were asked which preventative steps had already led them to take action. They were asked to simply answer yes or no to each of the different approaches. A sense of personal responsibility scored highest at 31% shortly followed by talking with friends, preventing damage to boat, and keeping ANS out of Oklahoma's waters (Table 3). Signs at marinas and boat ramps scored respectively with 17% of the respondents saying it has led them to take action.

Table 3. **This Has Already Led Me To Action…** **(*n*=1505) multiple responses allowed**	Yes	No	No Response
Talking With Friends or Acquaintances	22%	26%	53%
A Sense of Personal Responsibility	31%	19%	50%
A Desire to Keep ANS Out of Our Waters	28%	20%	52%
Regulations to Prevent the Transport of ANS	10%	34%	55%
A Desire to Prevent Damage to my Boat	26%	22%	52%
Enforcement Checks on the Road or at Boat Launches to Catch Violators	6%	38%	56%
Media Sources (Newspapers and Radio and TV News/Programs)	14%	31%	56%
TV or Radio Public Service Announcements	9%	34%	56%
Billboards	5%	38%	57%
Magazine or Newsletter Articles	14%	30%	56%
Internet Web Sites	7%	36%	57%
Fishing or Boating Regulation Pamphlets	16%	28%	56%
Conferences or Workshops for Boaters and Anglers	4%	40%	57%
Brochures, Species ID Cards, Fact Sheets, or Other Printed Materials	11%	33%	56%
Signs at Marinas or Boat Launches	17%	28%	55%
Creel Surveys or Inspection/Education Programs on Roads or at Boat Launches	5%	38%	57%
Videos or Other Presentations to Boating, Lake, and Sporting Associations	4%	39%	57%
Traveler Info or Low Power Radio Broadcasts Along Roads	2%	41%	57%
Fines that Must be Paid by Violators	6%	38%	56%

Did you use a boat during the 2008 boating season?

In this question, respondents were asked whether or not they used a boat in the 2008 boating season. According to the survey, 81% of the people surveyed used a boat during the 2008 season while 19% said they did not use a boat (Figure 15). The people who answered yes continued answering more questions about boating while the people who answered no were told to skip to question 18. This shows that a large percentage of people who have registered boats actually use their boats on an annual basis.



What type of boat(s) did you use during 2008?

The people who answered yes to using a boat during the 2008 season were then asked what type or types of boats they used. The data in table 4 shows the most used boat was the small powerboat with 680 users followed by the large powerboat with 439 users and in third was personal watercraft with 220 users. The least used was the drift boat, or raft with only 10 respondents choosing it. Small personal watercraft can easily transport ANS from one body of water to another however larger powerboats, usually have a more complex engine system which can easily store aquatic nuisance species is more unseen areas.

Table 4. What Type of Boat(s) Did You Use During 2008? (*n*=1214)	Totals
Small Sailboat (less than 20 ft.)	59
Large Sailboat (20 ft. or longer)	43
Personal Watercraft (jet ski)	220
Duckboat	63
Small Powerboat (less than 20 ft.)	680
Large Powerboat (20 ft. or longer)	439
Canoe or Kayak	116
Driftboat or Raft	10
Other	180

How long was the boat in the water before being moved?

Respondents were then asked how long their boats were in the water before being transferred to another body of water, and also how often their boat was in the water for each time period given. Time spent in the water did not include time spent on a boat lift. Out of the people who moved their boats, the number one response was one day or less with over 60% of the boaters choosing this answer (Table 5). Fifteen to 30 days was the least chosen response with just 8% of the boaters choosing this option. Even though 15 to 30 days only scored at 8%, it only takes one or two occasions to spread ANS. Educational efforts and monitoring must be extended to these groups of boaters who keep their boats in a body of water for an extended period of time.

Table 5. How Long Were Your Boats In The Water Before Being Moved To A Different Waterbody? Multiple responses allowed (*n*=600 people moved boats; 614 never moved any boats; missing = 291)	% Circled
1 Day or Less	60%
2 to 4 Days	23%
5 to 14 Days	13%
15 to 30 Days	8%
More Than 30 Days	11%

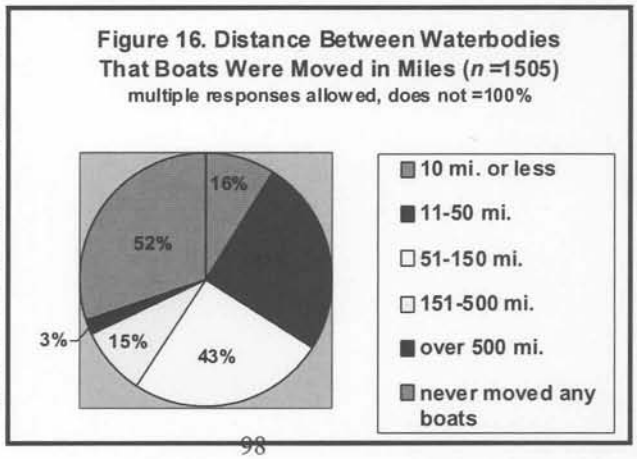
How long was the boat out of the water?

Next the boaters were asked how long they typically left their boats out of the water before placing them into a different body of water. The survey informed the boaters to write the number of times they left their boats out of the water for each time period given. The number one answer out of people who moved their boats was 5 to 14 days out of the water. Fourty-two percent of the people surveyed chose this response (Table 6). Two to 4 days was the least chosen answer with 14% of the boaters choosing this response, followed by 1 day or less with 15%. This data shows that the majority of boaters tend to keep their boats out of the water for more than a few days before entering another water body. Again, 15% is a concerning score when you consider how easily ANS can be spread if the proper precautions are not taken.

Table 6. How Long Were Your Boats Out Of The Water Before Being Moved To A Different Waterbody? Multiple responses allowed (*n*=597 people moved boats; 617 never moved any boats; missing = 291)	% Circled
1 Day or Less	15%
2 to 4 Days	14%
5 to 14 Days	42%
15 to 30 Days	28%
More Than 30 Days	26%

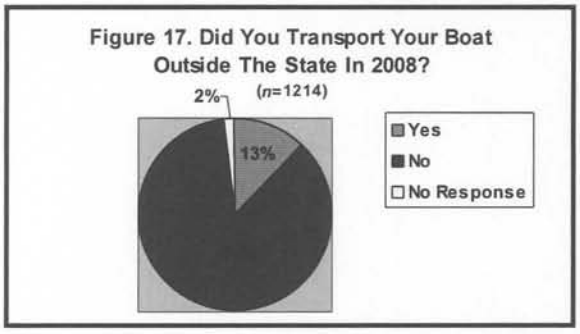
How far apart were the different bodies of water?

Next the boaters were asked how far apart the different bodies of water were that they brought their boats to. This question could have multiple responses for each respondent due to the fact that many boaters own more than one boat. Because of



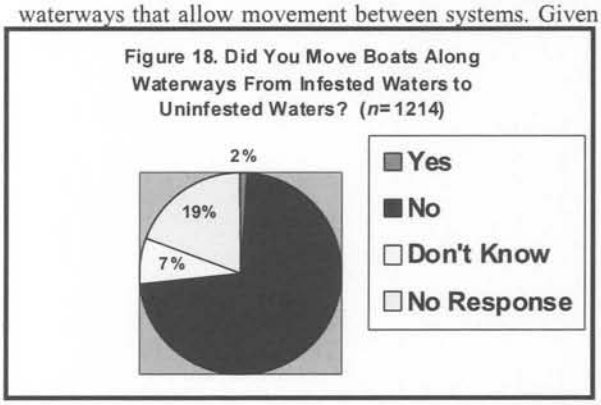
the possibility of multiple responses these results do not add up to 100%. They were told to fill in the number of times they traveled each distance during the 2008 boating season. More than half (52%) of boaters never moved their boats during the season (Figure 16). Of the 660 respondents that moved their boats among water bodies, 43% moved their boats 11-50 miles and an equal percentage moved their boats 51-150 miles. This question was designed to portray the likelihood of ANS being spread to other water bodies within certain distances.

Table 7. Number Of Times Boats Were Moved Certain Distances In Miles (*n*=580; multiple responses allowed)	**# Of Times Moved**
10 miles or less	85
11-50 miles	240
51-150 miles	231
151-500 miles	87
Over 500 miles	17



Did you transfer your boat outside of the state in 2008?
The vast majority of Oklahoma boaters (86%) did not transport their boats out of the state during 2008 (Figure 17). This helps reduce the chances of new ANS being introduced from surrounding states through this pathway.

Did you move boats along waterways from infested waters to uninfested waters?
With the exception of the Arkansas River Navigation System, Oklahoma does not have waterways that allow movement between systems. Given the choices, 71% said they did not move from infested to uninfested waters, 19.3% did not respond to the question, 7% said they did not know if they did, and 2% answered yes (Figure 18). Although three quarters of the respondents said they did not move from infested to uninfested waters the low level of ANS awareness makes it likely that many of these respondents did not know whether the system was infested or not.



Do you take any precautions before transporting your boat?

One-third of the people surveyed (34%), never moved their boat during 2008. Of those that did, 25 did not take precautions, while 20% said they did take precautions. The boaters who claimed to not take any precautions were then asked why they chose not to. Nearly half of the people surveyed answered that "they did not know exactly what to do"; 28% said they didn't boat on infested waters (Table 8). Given the low level of awareness, it seems likely that many respondents simply did not know whether or not a system was infested. This reinforces the fact that increased outreach efforts are needed to ensure boaters are aware of what to do to prevent spreading ANS.

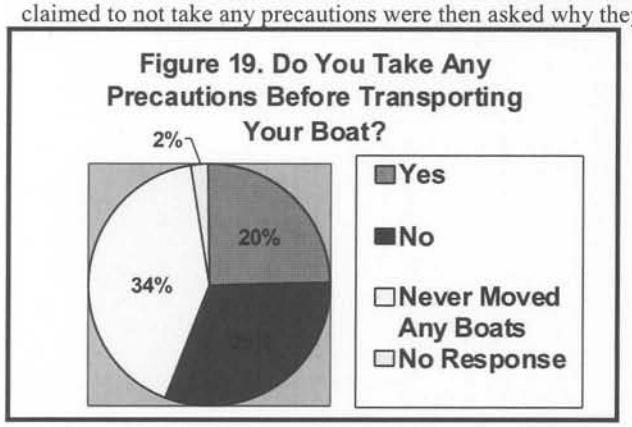
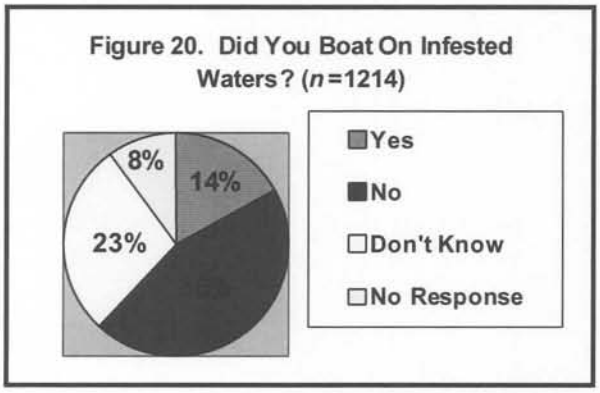


Table 8. If You Don't Take Precautions, Why Not? (n=381)	Totals
I don't believe it will prevent the eventual spread of ANS	2%
It's inconvenient, I don't have time to take precautions	2%
I don't know exactly what I'm supposed to do	49%
I didn't boat on infested waters	28%
I don't believe aquatic nuisance species are a problem	1%
Boat washing equipment was not readily available	14%
Other	16%



Did you boat on infested waters?

Respondents were asked whether or not they had boated on waters known to be infested with ANS, and if so how did they know that the waters were infested. The majority (36%) said they didn't boat on infested waters, while 23% didn't know if they had or not (Figure 20).

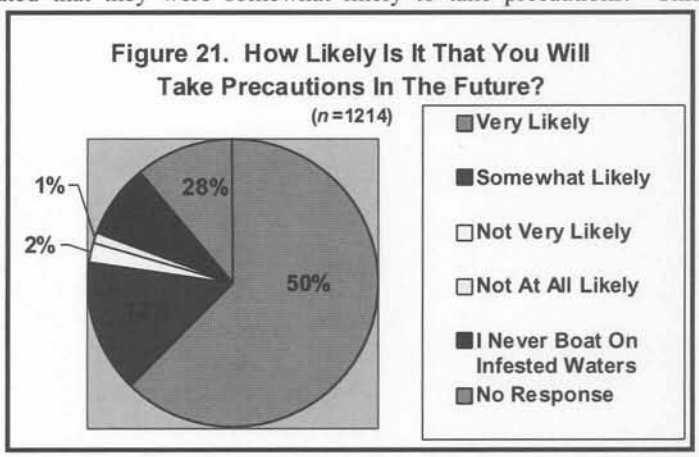
The people who had boated on infested waters were given a list of options explaining how they knew the waters were infested (Table 9). The most effective way of informing about ANS was through the use of signs or posters at the boat ramp. This response scored at 58%. The next most effective tool was word of mouth from a friend or relative. Neither watercraft educator nor hotline were selected by any of the respondents.

ODWC is currently addressing this issue and is posting ANS signs at all infested bodies of waters and also many uninfested waters.

Table 9. How Did You Know The Waters Were Infested With ANS? (*n*=208; multiple responses allowed)	Totals
Sign or poster at boat launch or marina	58%
Brochure, fact sheet, or flyer	11%
Fishing, boating or waterfowl regulations pamphlet	18%
Internet web site	6%
Watercraft educator/ inspector	0
Media sources (newspaper, radio, TV)	23%
Hot line or information clearinghouse	0
Heard about it from a friend or relative	31%
Other	18%

How likely is it that you will take precautions in the future?

Half of the respondents (50%) said they will likely take precautions in the future and an additional 12% indicated that they were somewhat likely to take precautions. This indicates that with additional efforts to increase awareness of the issues, the majority of the public would take the necessary steps to limit the spread of ANS through the recreational boat traffic pathway.



ANS precautions

Respondents were asked about a series of precautions and how often they performed these actions (Figures 22 through 28). The action most commonly practiced (85%) was draining of water from their boat. Allowing the boat to dry for at least five days scored second at 63%. These two responses were expected to yield fairly high responses because they are common practices. This doesn't necessarily mean that boaters perform these actions to prevent the spread of ANS therefore these actions may not be conducted properly. Nearly half of the respondents said they almost always visually inspect their boat and remove any plants and animals from their boat and trailer. Surprisingly 41% of respondents said they almost always avoid the release of live unwanted bait. Washing the boat with high pressure and flushing the motor's cooling system with tap water had the lowest responses. Lack of washing facilities in rural parts of the state likely

contributes to the low response rate and may warrant investment in boat wash stations.

Figure 22. How Often Do You Visually Inspect Your Boat? (*n*=1036)

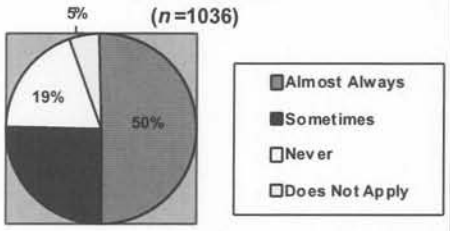


Figure 23. How Often Do You Drain Water From Your Boat? (n=1057)

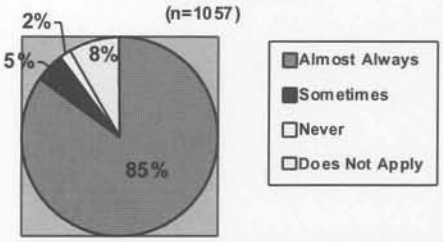


Figure 24. How Often Do You Avoid The Release Of Live Unwanted Bait? (*n*=1035)

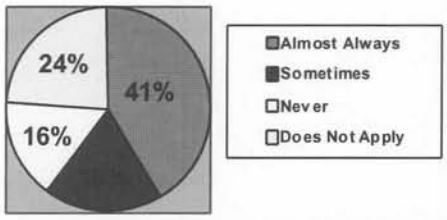


Figure 25. How Often Do You Remove Aquatic Plants And Animals From Your Equipment? (*n* =1024)

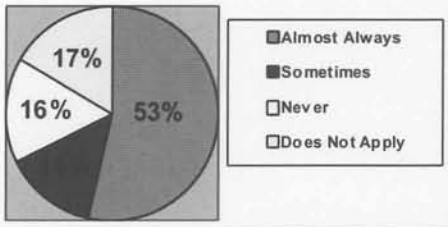


Figure 26. How Often Do You Flush The Motor's Cooling System With Tap Water? (*n*=1031)

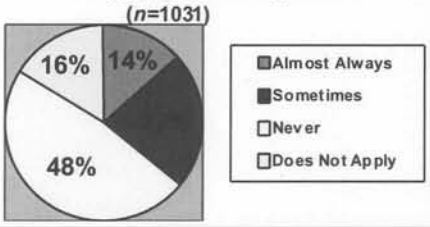


Figure 27. How Often Do You Rinse Your Boat With High Pressure and/or Hot Water? (*n*=1041)

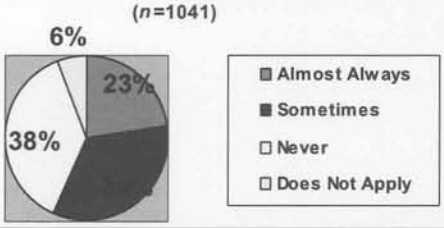
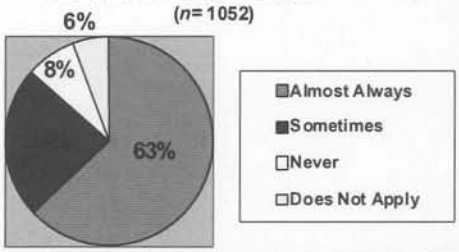
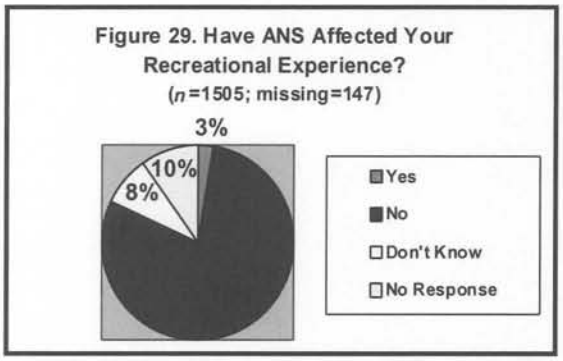


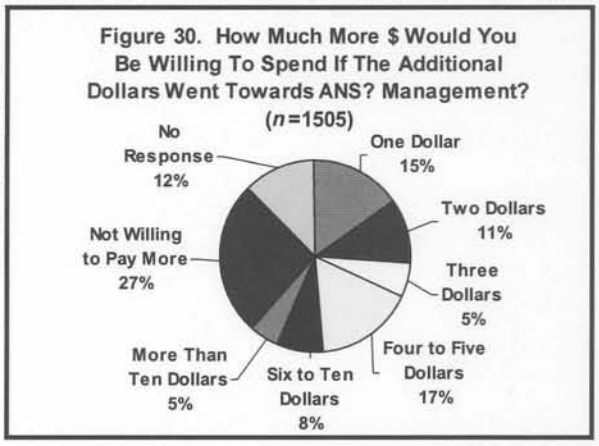
Figure 28. How Often Do You Allow Your Boat To Dry For At Least Five Days? (*n*= 1052)



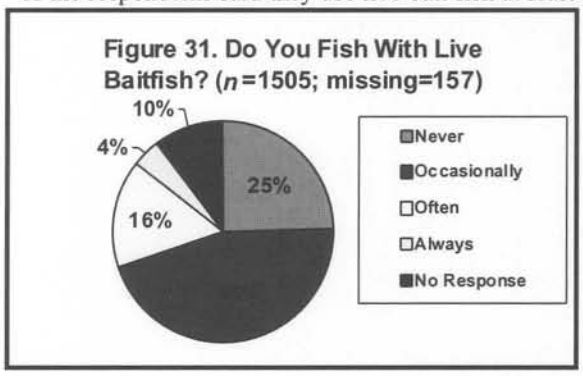


Have ANS affected your recreational experience?
More than three quarters of the respondents (79%) said that ANS issues have not impacted their recreational activities (Figure 29). Only 3% of the boaters said that ANS have impacted their recreational activities and 8% were not sure. Recreational activities may not be heavily impacted at this point but ecological and economic impacts are starting to be felt.

Increased fees to assist with ANS management
Every respondent was asked whether or not they would be willing to pay more for an Oklahoma fishing license if that money went towards ANS management. Overall, 61% of the respondents said they would be willing to spend at least one extra dollar. Out of the people willing to pay more, 17% said they would pay four to five extra dollars. A considerable number of respondents, 27%, were not willing to pay more for a fishing license.



The use of live bait fish
Respondents were asked how commonly they use bait fish, where they obtain their bait and how they dispose of their bait after their fishing experience. Of the responses, 65% of the respondents said they use live bait fish at least occasionally and 25% of the people surveyed never use bait fish. Most of the respondents (68%) said they obtain their bait from a bait shop and 14% said they catch their live bait from the wild. A concerning number of respondents (46%) said they release their live bait into the water. Since most respondents are getting their bait from a bait shop and are releasing the live bait into the water, we are not sure exactly what species of bait



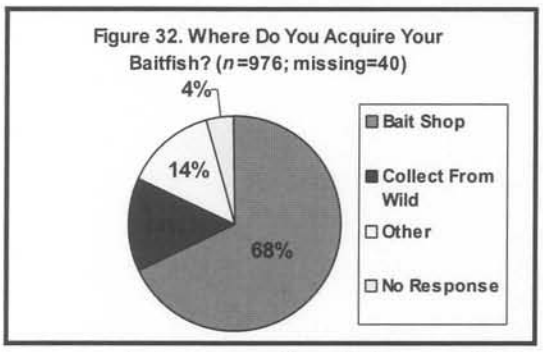


Figure 32. Where Do You Acquire Your Baitfish? (*n*=976; missing=40)

fish are being released into public waters.

Willingness to take precautions

Boaters were asked how willing they were to take precautions dealing with two issues: draining water from their boats and the use of live bait fish. An overwhelming 90% of the respondents said they would be willing to drain the water from their boats. This large percentage is somewhat related to the fact that 85% of the respondents said they almost always perform this action. Respondents were also asked if they would consider purchasing live bait only from a certified dealer. According to the survey, 63% said they would at least maybe consider purchasing live bait only from a certified dealer. A somewhat large portion of the respondents (21%) said they would not be willing to take this precaution. In addition, 66% of the respondents said they would be willing to use live bait fish only in the body of water that they came from. This response is most likely due to the fact 14% of the respondents catch and use their own bait.

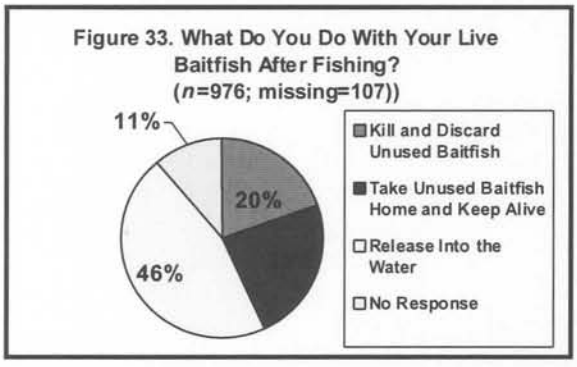


Figure 33. What Do You Do With Your Live Baitfish After Fishing? (*n*=976; missing=107))

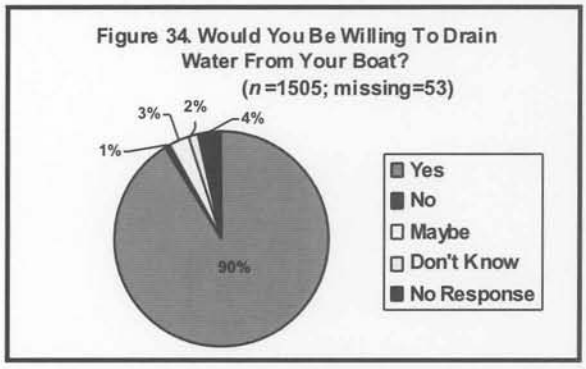


Figure 34. Would You Be Willing To Drain Water From Your Boat? (*n*=1505; missing=53)

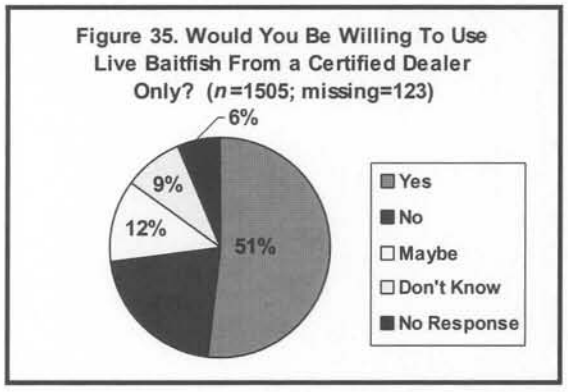


Figure 35. Would You Be Willing To Use Live Baitfish From a Certified Dealer Only? (*n*=1505; missing=123)

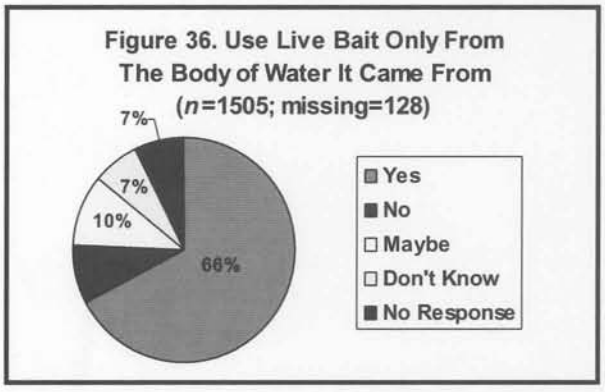


Figure 36. Use Live Bait Only From The Body of Water It Came From (*n*=1505; missing=128)

Conclusions

The results from this survey indicate the need to increase outreach efforts. Outreach efforts should focus on publications and educational materials, signs at boat ramps, and hosting more public events that target ANS issues.

Appendix G. Oklahoma Aquatic Nuisance Species and Boating Survey

AQUATIC NUISANCE SPECIES AND BOATING SURVEY

Please circle the number which corresponds to the answer closest to your opinion or situation. ALL INDIVIDUAL RESPONSES WILL BE KEPT CONFIDENTIAL. For the purpose of this survey, BOATS are defined as canoes, kayaks, duck boats, sailboats, personal watercraft, fishing boats, and recreational watercraft.

Q1. AQUATIC NUISANCE SPECIES are plants or animals that enter places where they have NOT always lived. They can be harmful to fish and wildlife and to commercial and recreational water uses. How much information have you heard or read about each of the AQUATIC NUISANCE SPECIES listed below? *(Circle one answer for each item.)*

How much information have you heard about...

Aquatic Nuisance Species	A Large Amount	A Moderate Amount	A Small Amount	None
a. Zebra mussels/quagga mussels	1	2	3	4
b. Golden alga	1	2	3	4
c. Hydrilla	1	2	3	4
d. VHS (Viral Hemorrhagic Septicemia)	1	2	3	4
e. Asian carp (bighead carp, silver carp, black carp & grass carp)	1	2	3	4
f. White perch	1	2	3	4
g. Other (please specify): _____	1	2	3	4

Q2. In your opinion, how important is it that boaters and anglers take precautions to prevent the spread of each of the following aquatic nuisance species from one body of water to another? *(Circle one answer for each item.)*

Taking precautions to prevent the spread is...

Aquatic Nuisance Species	Very Important	Somewhat Important	Not Very Important	Not at All Important	Don't Know
a. Zebra mussels/quagga mussels	1	2	3	4	5
b. Golden alga	1	2	3	4	5
c. Hydrilla	1	2	3	4	5
d. VHS (Viral Hemorrhagic Septicemia)	1	2	3	4	5
e. Asian carp (bighead carp, silver carp, black carp & grass carp)	1	2	3	4	5
f. White perch	1	2	3	4	5
g. Other (please specify): _____	1	2	3	4	5

Q3. Have you heard of or read about aquatic nuisance species from any of the following sources? *(Circle one answer for each source.)*

MEDIA SOURCES		Yes	No	Don't Know
a.	Newspaper articles	1	2	3
b.	Magazine or newsletter articles	1	2	3
c.	Television news or programs	1	2	3
d.	Radio news or programs	1	2	3
e.	Television public service announcements	1	2	3
f.	Radio public service announcements	1	2	3
g.	Billboards	1	2	3
h.	Internet web sites	1	2	3
EVENTS				
i.	Conferences, presentations, or meetings	1	2	3
j.	An educational exhibit or display	1	2	3
k.	Fishing contests, fishing derbys, or sailboat regattas	1	2	3
l.	A booth at a sport show, fishing show, or similar event	1	2	3
FISHING OR BOATING SOURCES				
m.	Fishing or boating regulation pamphlets	1	2	3
n.	Boat registration materials	1	2	3
o.	Creel surveys or inspection-education programs on roads or at boat launches	1	2	3
p.	Signs or information provided at a marina or boat launch	1	2	3
q.	Signs or information provided at a bait shop	1	2	3
r.	A fishing, boating, sporting, or environmental organization	1	2	3
OTHER SOURCES				
s.	Brochures, species identification cards, fact sheets, or other printed materials	1	2	3
t.	Books	1	2	3
u.	Educational videos	1	2	3
v.	Hot line or information clearinghouse	1	2	3
w.	Other (please specify): _____	1	2	3

Q4. Of the sources of information that you circled in Question 3, which four were your BEST sources of information about aquatic nuisance species? *(Write the letter for each item you select in the spaces provided below.)*

___ ___ ___ ___

Q5. How effective would each of the following be in getting YOU to take steps to prevent the spread of aquatic nuisance species? *(Circle one number for each item.)* In the last column, please tell us which ones ALREADY led you to take action. *(Circle Yes or No for each item.)*

How effective would this be in getting you to take action...

		Would be very effective	Would be Somewhat effective	Would NOT be very effective	This already led me to take action
a.	Talking with friends or acquaintances	1	2	3	Yes No
b.	A sense of personal responsibility	1	2	3	Yes No
c.	A desire to keep aquatic nuisance species out of our lakes or streams	1	2	3	Yes No
d.	A desire to prevent damage to my boat or equipment	1	2	3	Yes No
e.	Laws or regulations to prevent the transport of aquatic nuisance species	1	2	3	Yes No
f.	Enforcement checks on the road or at boat launches to catch violators	1	2	3	Yes No
g.	Fines that must be paid by violators	1	2	3	Yes No
h.	Media sources (newspapers and radio and TV news/programs)	1	2	3	Yes No
i.	Television or radio public service announcements	1	2	3	Yes No
j.	Billboards	1	2	3	Yes No
k.	Magazine or newsletter articles	1	2	3	Yes No
l.	Internet web sites	1	2	3	Yes No
m.	Fishing or boating regulation pamphlets	1	2	3	Yes No
n.	Conferences or workshops for boaters and anglers	1	2	3	Yes No
o.	Brochures, species identification cards, fact sheets, or other printed materials	1	2	3	Yes No
p.	Signs at marinas or boat launches	1	2	3	Yes No
q.	Creel surveys or inspection-education programs on roads or at boat launches	1	2	3	Yes No
r.	Videos or other presentations to boating, lake, and sporting associations	1	2	3	Yes No
s.	Traveler information or low power radio broadcasts along roads	1	2	3	Yes No

Q6. Of the items that you said "would be VERY EFFECTIVE" in Question 5, which would be MOST effective in getting you to take steps to prevent the spread of aquatic nuisance species? *(Write the letter for each item you select in the spaces provided below.)*

___ ___ ___ ___

The next questions are about your recreational use of ALL boat(s) during the 2008 boating season. Your answers will help us determine the movement of boats between waterbodies.

Q7. Did you USE a boat or boats during the 2008 boating season? *(Circle one.)*

1. YES
2. NO **(IF NO, SKIP TO QUESTION 18 ON PAGE 7)**

Q8. What type of boat(s) did you use during 2008? *(Circle all that apply.)*

a. Small sailboat (less than 20 feet)
b. Large sailboat (20 feet or longer)
c. Personal watercraft (jet ski)
d. Duckboat
e. Small powerboat (less than 20 feet)
f. Large powerboat (20 feet or longer)
g. Canoe or kayak
h. Driftboat or raft
i. Other type of watercraft (please specify) _____

Q9. Thinking about all boats you used during the 2008 boating season, about how long was the boat(s) IN the water before being moved to a different waterbody? Do NOT include time on a boat lift. *(Fill in the number of times during the 2008 boating season for each time period.)*

a. I never moved ANY boat(s) to a different waterbody
b. One day or less _____ times
c. 2 to 4 days _____ times
d. 5 to 14 days _____ times
e. 15 to 30 days _____ times
f. More than 30 days _____ times

Remember to write in the number of times

Q10. About how long was the boat(s) OUT of the water before you put it in a DIFFERENT waterbody than it was PREVIOUSLY used in? Include the amount of time on a trailer, on a boat lift, on a rack, or transported on a road. *(Fill in the number of times during the 2008 boating season for each time period.)*

a. I never moved ANY boat(s) to a different waterbody
b. One day or less _____ times
c. 2 to 4 days _____ times
d. 5 to 14 days _____ times
e. 15 to 30 days _____ times
f. More than 30 days _____ times

Remember to write in the number of times

Q11. If you moved any boat(s) to a different waterbody than it was previously used in, how far apart were the different bodies of water? *(Fill in the number of times during the 2008 boating season for each distance category.)*

a. I never moved ANY boat(s) to a different waterbody

b. Ten miles or less _____ times

c. 11 to 50 miles _____ times

d. 51 to 150 miles _____ times

e. 151 to 500 miles _____ times

f. More than 500 miles _____ times

Remember to write in the number of times

Q12. During the 2008 boating season, did you *TRANSPORT* (by truck, trailer, car top, etc.) any boat(s) to waters OUTSIDE the state where the boat is licensed? *(Circle one.)*

1. YES → → →
2. NO

a. How many different times did you transport boat(s) to another state or province in 2008? _____ times

b. Please list each state or province that you transported boat(s) to in 2008:

_____

Q13. During the 2008 boating season, did you move any boat(s) along connected waterways (such as rivers or canals) FROM waters that you knew were infested with any of the aquatic nuisance species listed in Question 1 INTO uninfested waters? *(Circle one.)*

1. YES → → →
2. NO
3. DON'T KNOW

a. Please list the names of the waterways that you went to and from in the boat(s):

WENT TO (uninfested waters): _____

WENT FROM (infested waters): _____

WHICH AQUATIC NUISANCE SPECIES: _____

Q14. Before you transport the boat(s), do you take any special steps to prevent the transport of water or aquatic nuisance species from one body of water to another? *(Circle one.)*

1. YES
2. NO → → →
3. I never moved ANY boat(s) to a different waterbody

(IF NO) If you do not take any special precautions, why not? *(Circle all that apply.)*

a. I don't believe it will prevent the eventual spread of aquatic nuisance species

b. It's inconvenient, I don't have time to take precautions

c. I don't know exactly what I'm supposed to do

d. I didn't boat on infested waters

e. I don't believe aquatic nuisance species are a problem

f. Boat washing equipment was not readily available

g. Other (please specify) _____

Q15. During 2008, did you boat on waters that you knew were infested with ANY of the aquatic nuisance species listed in Question 1 on the front page? *(Circle one.)*

1. YES → → →
2. NO
3. DON'T KNOW

(IF YES) How did you know that the waters you boated on were infested with an aquatic nuisance species? *(Circle all that apply.)*

a. Sign or poster at boat launch or marina
b. Brochure, fact sheet, or flyer
c. Fishing, boating, or waterfowl regulation pamphlet
d. Internet web site
e. Watercraft educator/inspector
f. Media sources (newspaper, radio, TV)
g. Hot line or information clearinghouse
h. Heard about it from a friend or relative
i. Other (please specify) _____

Q16. If you do boat on infested waters, how likely is it that YOU will take precautions in the future to prevent the spread of aquatic nuisance species between bodies of water? *(Circle one.)*

1. Very likely
2. Somewhat likely
3. Not very likely
4. Not at all likely
5. I never boat on infested waters

Q17. After removing boat(s) from the water, how often do you do the following? *(Circle one answer for each item.)*

Steps Taken:	Almost Always	Some-times	Never	Does Not Apply
a. Conduct visual inspection of boats and equipment for aquatic plants and animals	1	2	3	4
b. Drain water from boats, including live wells, bilge, and bait buckets	1	2	3	4
c. Avoid release of unwanted live bait into the water	1	2	3	4
d. Remove aquatic plants and animals from boats and equipment	1	2	3	4
e. Flush motor's cooling system with tap water	1	2	3	4
f. Rinse boat with high pressure and/or hot water	1	2	3	4
g. Allow boat to dry for at least five days	1	2	3	4
h. Other (please specify) _____	1	2	3	4

Q18. Have aquatic nuisance species caused problems for you or affected your recreational experience during the 2008 boating season? *(Circle one.)*

1. YES → → →
2. NO
3. DON'T KNOW

a. **(IF YES)** Please list all impacts, the aquatic nuisance species that were involved, and any associated costs you have experienced.

Q19. How much MORE would you be willing to spend for a boating or fishing license if the additional money was used to fund activities to prevent the spread of aquatic nuisance species and to reduce their harmful effects? *(Circle one.)*

1. $1
2. $2
3. $3
4. $4 to $5
5. $6 to $10
6. More than $10
7. Would NOT be willing to spend more

The following questions refer to your use of bait while fishing.

Q20. Do you fish with **live** baitfish?
1. Never
2. Occasionally
3. Often
4. Always

Q21. If you fish with live baitfish list the bodies of water where you fish with live bait fish most often.

_____ _____
_____ _____
_____ _____
_____ _____

Q22. If you do **NOT use live baitfish** why do you chose not to fish with live baitfish?
1. Don't fish in any bodies of water where live baitfish are allowed
2. Prefer to fish with artificial lures
3. Prefer to fish with other live bait such as leeches, worms or maggots
4. Using live baitfish is too expensive
5. Other (please specify): _____

Q23. If you use live baitfish where to you acquire your baitfish?
1. Bait shop
2. Collect it from the wild
3. Other (please specify): _____

Q24. How many dozen live baitfish do you use per year? _____ (dozen/year)

Q25. What do you do with your live baitfish after a day of fishing?
1. Kill and discard any unused baitfish
2. Take unused baitfish home and keep alive to use again but only on the one body of water
3. Take unused baitfish home and keep alive to use again on any other body of water
4. Release any unused baitfish into the water

Because of the risk of Aquatic Nuisance Species and fish diseases new regulations are being considered to try and prevent their introduction into Oklahoma waters and between Oklahoma waters.

Q26. Would you be willing to do the following:

1. Drain water from watercraft at boat ramp before transportation
   Yes ___
   No ___
   Maybe ___
   Don't Know ___

2. Use live baitfish from a certified bait dealer only i.e. no collection from the wild
   Yes ___
   No ___
   Maybe ___
   Don't Know ___

3. Use live bait fish only on the body of water where it originated or from a licensed bait dealer
   Yes ___
   No ___
   Maybe ___
   Don't Know ___

Please answer the following questions about yourself. This information will be used only to compare people's answers. It will not be used to identify you in any way.

Q27. What types of radio stations do you usually listen to? *(Circle all that apply.)*
a. Classical music
b. Country music
c. Public radio
d. New/alternative rock music
e. Oldies/classic rock music
f. Talk radio
g. Other (please specify) _____

Q28. What is your zip code or postal code? _____

Q29. What recommendations or other comments would you like to make about the spread of aquatic nuisance species in your state's waters? _____
_____
_____