Kentucky Aquatic Nuisance Species Management Plan

Commonwealth of Kentucky
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Approved by Steve Beshear, Governor — Date 9/19/08

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Executive Summary

This management plan has been created to help Kentucky deal with the myriad of problems associated with aquatic nuisance species (ANS). The aim of the plan is to describe ANS problems within Kentucky and to provide specific management actions that can mitigate current situations and prevent future problems. Mandated by federal legislation and developed by the Kentucky ANS Task Force (KYANSTF), this document will guide our efforts to address ANS problems on a state, regional, and national level over the next 2-3 years.

Aquatic nuisance species are non-native, aquatic species that threaten the diversity or abundance of native species, the ecological stability of waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters. Unfortunately, human activities can contribute to the adverse impacts of ANS by facilitating introductions and expediting their spread. In Kentucky, some of the major pathways by which humans contribute to ANS spread include:

- Physical transport between water bodies.
- Fragmentation and spread of existing populations within a habitat.
- Release (unintentional and intentional) into the wild.

Kentucky's abundant freshwater resources make it highly vulnerable to invasions of ANS. The Commonwealth shares a common border with seven other states (Missouri, Illinois, Indiana, Ohio, West Virginia, Virginia, and Tennessee), making their ANS problems our problems (and vice-versa). Some of Kentucky's state borders are defined by aquatic systems (the Mississippi and Ohio Rivers in the west, the Ohio River in the north, and the Big Sandy River to the east). The state's temperate climate and variety of ecosystems provide many opportunities for adaptable and tolerant ANS to thrive. Many ecosystems are fragile and include imperiled species (plants, fish, and mussels). Fragile ecosystems are more prone to disturbance, and an ANS introduction could threaten entire biotic communities. Furthermore, the costs of managing ANS once introduced can be staggering. These factors compel Kentucky to prevent and/or mitigate the negative impacts of ANS.

Once established, ANS have adverse biological, socio-economic, and aesthetic impacts. They can:

- Disrupt the balance of food webs.
- Degrade previously undisturbed habitats.
- Reduce abundance of native organisms by increasing competition (i.e., food resources, nesting areas).
- Decrease biodiversity.
- Deplete limited management (agencies, non-governmental organizations, etc.) funds and other resources.
- Disrupt industrial operations (i.e. hydroelectric plants) and damage drainage ditches.

- Spoil or diminish recreational experiences (swimming, boating, sportfishing, etc.).
- Reduce property values.
- Interfere with commercial fishing and aquaculture operations.
- Endanger public health.

Efforts to prevent and control ANS in Kentucky have been limited, and we are indebted to other states that have led the way in developing management plans. This plan aims to narrow that gap and allow Kentucky to become an important contributor at the state, regional, and national level in the fight against ANS. Specifically, this plan describes ANS problems in Kentucky and proposes management actions that can help mitigate and prevent current and future ANS problems.

This plan aims to identify and prioritize current and potential ANS within Kentucky. Unfortunately, due to global commerce, global mobility, and pathway utilization, new ANS can arrive at any time. To illustrate this sense of urgency, a new ANS *Didymo*, also known as rock snot, was discovered in Kentucky while this plan was being drafted. The following established and potential new ANS arrivals to Kentucky, are described herein:

Plants:

- Eurasian watermilfoil (*Myriophyllum spicatum*)
- Purple loosestrife (*Lythrum salicaria*)
- Brazilian watermilfoil (*Myriophyllum aquaticum*)
- Common reed (*Phragmities australis*)
- Curly pondweed (*Potamogeton crispus*)
- Japanese stiltgrass (*Microstegium vimineum*)
- Reed canarygrass (*Phalaris arundinacea*)
- Japanese knotweed (*Polygonum cuspidatum*)
- Alligator weed (*Alternathera philoxeroides*)
- Water hyacinth (*Eichhornia crassipes*)

Fish:

- Silver carp (*Hypophthalmichthys molitrix*)
- Bighead carp (*Hypophthalmichthys nobilis*)
- Black carp (*Mylopharyngodon piceus*)
- Snakehead (*Channa* sp. or *Parachanna* sp.)
- Round goby (*Neogobius melanostomus*)

Mollusks:

- Zebra mussel (*Dreissena polymorpha*)
- Asian clam (*Corbicula fluminea*)

Algae:

- Rock snot (*Didymosphenia geminata*)

Mammals:

- Nutria (*Myocastor coypus)*

To successfully implement Kentucky's ANS management plan, local, state, and federal officials hope to achieve the following **4 main goals**:

1. Stop new introductions of ANS to Kentucky.
2. Prevent the spread of ANS currently in Kentucky and neighboring states.
3. Limit damages from ANS that cannot be eradicated.
4. Educate the public and stakeholders so they do not facilitate introductions and/or dispersal of new or existing ANS.

The **4 objectives** necessary to meet these goals include:

1. Raise public and stakeholder awareness of ANS issues.
2. Provide programs to prevent introductions and transport of ANS.
3. Develop and utilize an ANS early detection and rapid response (EDRR) system.
4. Offer effective communication and coordination of ANS management activities.

The purpose of this plan is to outline an initial and cohesive approach to ANS management in Kentucky until a time when additional resources and knowledge (e.g., assimilation of baseline data) allow us to develop specific strategies for individual ANS. This plan will provide effective communication, coordination, leadership, and support for ANS control efforts through the creation of an ANS coordinator position. ANS management efforts are located under a central umbrella (the KYANSTF) in the hopes of increasing implementation efficiency and avoiding unnecessary duplication or gaps in efforts. Cooperation among all interested parties are key to developing this plan and even more so in the plan's execution.

Introduction

The state of Kentucky is located in the east-central United States and contains numerous aquatic habitats, including lakes, rivers, streams, cave streams, springs, and wetlands. Residing in these habitats are diverse native flora and fauna, many of which are identified by federal agencies as threatened or endangered (U.S. Fish and Wildlife Service, 2007). Like many states, Kentucky is experiencing adverse biological, socio-economic, and aesthetic impacts from ANS that threaten freshwater ecosystems statewide.

Federal legislation introduced in 1990, and amended in 1996, deals specifically with problems associated with ANS. The Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA) calls on states to develop ANS plans and provides federal funds to help states enact, maintain, and achieve the goals of their plans.

The legislation calls on coordinating local, state, and federal interests to ensure efficient implementation of the ANS management plan. The Federal ANS Task Force has provided state plan guidelines that have helped Kentucky develop our plan. Many organizations, agencies, and authorities have been involved in the process to help achieve the objectives and goals of the plan.

At the federal and national level, the KYANSTF has sought guidance and/or input from:

- **United States Fish and Wildlife Service**
- **United States Department of Agriculture Wildlife Services**
- **United States Army Corps of Engineers**
- **National Park Service**
- **United States Department of Agriculture Forest Service**
- **United States Department of Agriculture National Resources Conservation Service**

Involvement at the state and regional level has included:

- **The Governor's Office**
- **Kentucky Department of Fish and Wildlife Resources-Division of Fisheries**
- **Kentucky Department of Fish and Wildlife Resources-Division of Wildlife**
- **Kentucky Division of Water**
- **Kentucky State Nature Preserves Commission**
- **Kentucky Department of Agriculture**
- **Kentucky Division of Forestry**
- **Kentucky Transportation Cabinet-Division of Environmental Analysis**
- **Kentucky State University**
- **Eastern Kentucky University**
- **University of Kentucky**
- **University of Kentucky Extension Service**
- **Commercial Fishermen**

- **Bait Suppliers**
- **Fish Processors**
- **An Environmental Consulting Firm**
- **Kentucky Nursery and Landscape Association**
- **Southeast Aquatic Resources Partnership**
- **The Nature Conservancy**

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This plan will attempt to incorporate realistic and efficient objectives to achieve the desired goal of minimizing the adverse effects of ANS by using the most environmentally sound and effective methods available. The plan will be submitted to the Federal ANS Task Force and, when approved, provide 75:25 matching funds (as provided in NANPCA) to help implement the program.

An implementation table (page 41) is included detailing existing funds appropriated to ANS programs. As of 1/17/08, $0 and 0 full time equivalencies (FTE) are dedicated to current ANS programs, of which $0 will be carried forward and 1 FTE will be created over the next 2-3 years. The plan requests $121,750 to help the Kentucky Department of Fish and Wildlife Resources to effectively implement the plan.

What are ANS?

Aquatic nuisance species are non-native, aquatic species that threaten the diversity or abundance of native species, the ecological stability of waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters.

Of course, these species did not migrate here naturally. Since the arrival of the earliest European settlers, native ecosystems have accommodated non-native introductions. Settlers brought many agricultural (cows, pigs, etc.) and horticultural (wheat) species to

North America in an effort to ease hardship and reap benefits provided by these species. Many of these species continued to benefit human populations and never caused significant harm to native species, ecosystems, and human utilization of these natural resources. However, once introduced (intentionally or accidentally), a relatively small percentage (~15%) of these introduced organisms can cause a great deal of harm to the nation's native flora and fauna and the human use of them. These species are termed "nuisance species," and if not managed effectively can cause great biological, socio-economic, and aesthetic harm. This plan does not try to manage all nuisance species within Kentucky, only those species primarily inhabiting aquatic environments, hence the term "aquatic nuisance species."

Why are ANS so successful?

Unfortunately, once introduced, most ANS are equipped for a speedy and successful takeover of native ecosystems. They have numerous adaptations and advantages that allow them to quickly colonize and spread.

Some of these adaptations include:

- Reproductive characteristics that facilitate rapid dispersal and colonization and self-sustaining populations. Many of these organisms have high seed/egg counts, high survival, and rapid maturation.
- Wide tolerance of diverse and fluctuating environmental conditions. Kentucky has a temperate climate and variety of ecosystems that allow many opportunities for ANS to thrive. Some of these ecosystems, such as Mammoth Cave National Park, are extremely fragile, increasing the need for preventing ANS introductions.

Because native populations evolved in balanced systems, there are checks and balances that prevent a single organism from dominating a system. Aquatic nuisance species did not coevolve with the native organisms in their new environment and therefore lack natural controls resulting in competitive advantages.

Some of these advantages are:

- Lack of predators that limit a species in its native range.
- Ability to utilize and compete for limited food supplies.
- Tolerance of a wide range of environmental conditions.

These adaptations and advantages help ANS populations explode because they can quickly outcompete and overrun existing native species.

Is Kentucky vulnerable?

Make no mistake, Kentucky, with its abundance of freshwater resources, is vulnerable. Aquatic habitat within the state includes 89,431 miles of streams, 637,000 acres of wetlands, and 228,385 acres of publicly-owned lakes and reservoirs of which 18

reservoirs are 1000+ acres in size (Kentucky Division of Water, 2006). We share a common border with seven other states (Missouri, Illinois, Indiana, Ohio, West Virginia, Virginia, and Tennessee) making their problems our problems and vice-versa. The state's temperate climate and variety of aquatic ecosystems provide many opportunities for adaptable and tolerant ANS to thrive. Many ecosystems are fragile with numerous imperiled flora and fauna. Furthermore, the popularity of boating and fishing in the state assures the spread of ANS unless effective action is taken as soon as possible.

What does Kentucky have to lose?

Although all the impacts of existing ANS on Kentucky's aquatic habitats are currently unclear, our experiences, and the experiences of other states, warrant immediate action. Kentucky has one of the most diverse freshwater fish assemblages (242 native species) in North America (Kentucky Department of Fish & Wildlife Resources, 1993). There are 103 species of freshwater mussels within the state's waters, making it one of the most diverse mussel habitats in North America (Kentucky Department of Fish & Wildlife Resources, 2007). Twenty-three of these species are listed as endangered. There are also four fish and one shrimp species listed as endangered, and one fish is listed as threatened (U.S. Fish and Wildlife Service, 2007). Although there are other threatened or endangered species that spend part of their life cycle in aquatic habitat or depend on aquatic habitat, this plan will include only those species that spend the majority of their life cycle in aquatic habitat, with the exception of nutria due to their devastating negative impacts.

The Cumberland and Green River systems are two of the highest quality river systems in the U.S. With 151 species of freshwater fishes and 71 species of freshwater mussels, the Green River system is the fourth most important system in the country in terms of fish and mussel biodiversity (Nature Conservancy, 2007). These valuable and fragile ecosystems are more prone to disturbance, and an ANS introduction could threaten entire communities. Kentucky cannot afford to take chances and must resolve to be as proactive as possible. The single most important way to prevent biological, socio-economic, and aesthetic loss in this state is to prevent new introductions of ANS. Letting the "genie out of the bottle" is easy; coaxing the genie back in is not.

What are the negative impacts associated with ANS?

Once established, ANS have serious biological, socio-economic, and aesthetic impacts.

Biological impacts include:

- Disruption of balanced food webs.
- Degradation of previously undisturbed habitats.
- Reduced abundance of native organisms due to increased competition (i.e., food resources, nesting areas).
- Decreased biodiversity.

Approximately 42% of the 958 aquatic and terrestrial species listed as federally threatened or endangered are at risk primarily due to non-indigenous species (Wilcove *et. al.*, 1998).

Beyond the aquatic systems where ANS reside, their impacts are felt by local, state, and federal entities that must provide resources to prevent, contain, and limit the socio-economic impacts of ANS.

Socio-economic impacts include:

- Depletion of limited management resources.
- Disruption of industrial operations.
- Damage of drainage ditches resulting in increased risk of flooding.
- Lost tourism dollars when recreational experiences such as sportfishing, swimming, and boating are no longer possible or pleasant.
- Fouled rivers and lakes resulting in reduced property values of nearby homes.
- Hurt business groups when ANS interfere with commercial fishing and aquaculture operations.
- Compromised public health. For example, nutria, an ANS from South America, harbors a parasite that results in a severe and painful rash on its human host.

All of these problems must be mitigated, and the costs associated with managing ANS can soar. For example, damages associated with ANS and the control of ANS cost $9 billion annually in the United States (Pimentel *et. al.*, 2000). Kentucky simply cannot afford to act indecisively.

Finally, the loss of aesthetic value that is felt by every citizen and/or visitor to Kentucky due to ANS must be considered. For example, what dollar amount equals not being able to share a favorite childhood fishing spot with a child or grandchild? How many future memories will be lost because recreational swimming and boating activities have been degraded? Although biological and socio-economic loss can be quantified through losses of biodiversity and dollar amounts, aesthetic loss to current and future generations cannot.

Problem Definition and Ranking

Kentucky is relatively fortunate. To date, the ecological and economic impacts of ANS on the state's wildlife and water resources have been limited to specific areas or types of ecological systems without inflicting severe damage on the entire state. Most ANS identified in this section have spread to Kentucky through a combination of natural and human forces. Recognition of those forces is the first step in limiting future impacts.

By developing this plan, agencies and citizens throughout Kentucky can work to prevent invasions that could inflict more severe impacts while limiting the spread of those ANS already in the state. Implementation depends upon federal agencies, state agencies and citizens recognizing the importance of the state's watersheds in relation to economic, social, and biological activities. All must have knowledge of the invaders, agree to contain them, and cooperate to prevent introductions of new ANS.

Watershed and County Maps of Kentucky

To prevent and manage ANS in Kentucky, an understanding of the state's watersheds and their management is necessary. Kentucky watersheds are managed by the Kentucky Division of Water through the Watershed Management Initiative (WMI). The WMI focuses attention on selected watershed problems and priorities by providing a coordinated framework for public and private efforts. There are 12 drainage basins in Kentucky, which the WMI groups into 7 management units, primarily for administrative purposes. Each management unit is provided with a dedicated basin coordinator and staff. Because watersheds are naturally occurring, they are not limited by state or county boundary lines. Thus, regional and statewide coordination of ANS management efforts are essential because Kentucky shares river borders, lakes, and streams with neighboring states.

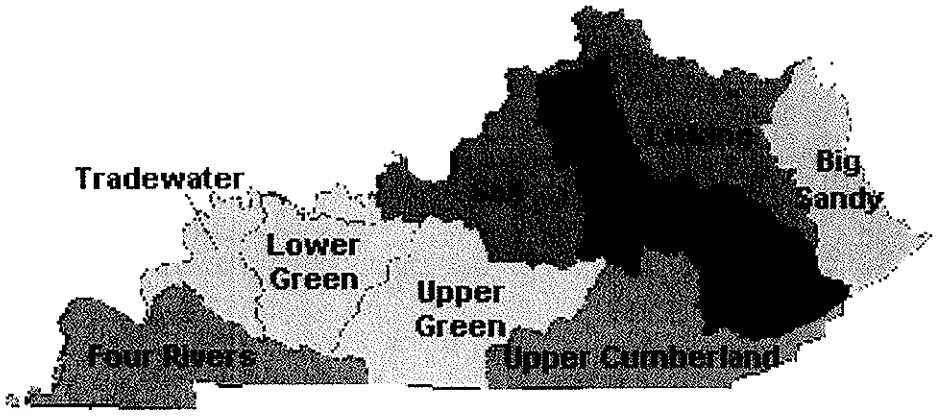

Figure 1. Map of the 7 watershed management units within Kentucky (http://www.water.ky.gov/watersheds/). The color scheme for each unit is as follows: Kentucky River Basin (Red), Licking River Basin and minor Ohio River tributaries (Green), Salt River Basin and minor Ohio River tributaries (Green), Green/Tradewater and Ohio River tributaries (Grey), Upper Cumberland River Basin (Blue), Four Rivers

(Cumberland, Tennessee, Ohio and Mississippi) (Blue), Big/Little Sandy and Tygarts River (Yellow).

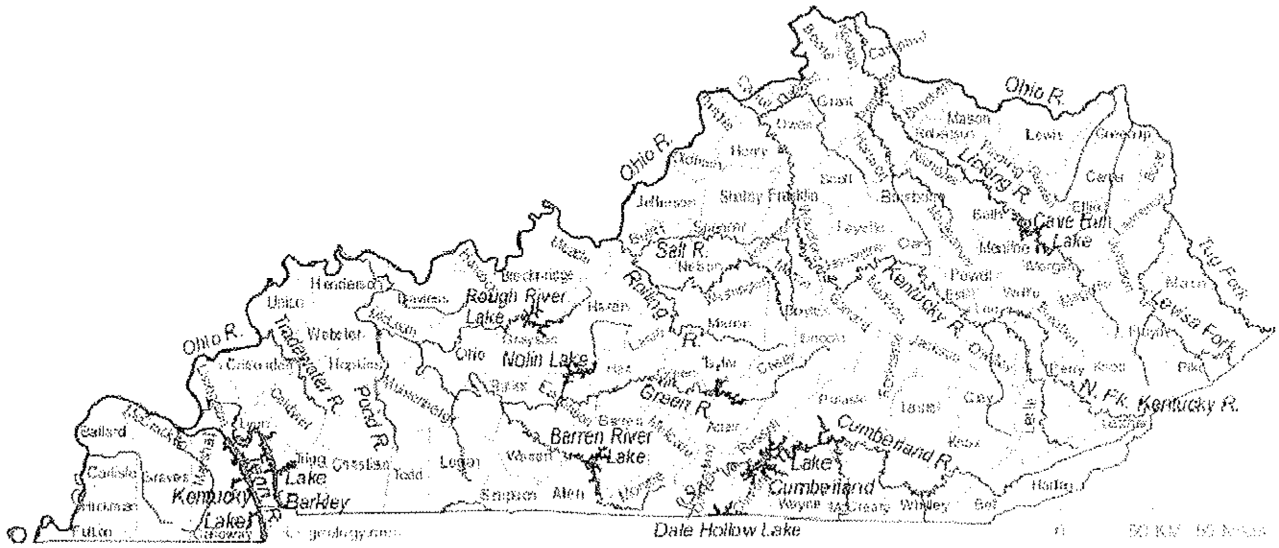

Figure 2. Map of Kentucky counties, major rivers, and lakes. A county map is provided because ANS distribution data in Kentucky are reported by county. Above is a map of Kentucky counties, major rivers, and lakes (http://geology.com/state-map/kentucky.shtml).

Many ANS have already invaded Kentucky, and more are poised to enter the state. Consequently, it is imperative to identify currently established and potential arrivals along with their associated pathways of introduction. The KYANSTF has worked to accomplish these tasks, and in the following section, Kentucky's pathways of concern are discussed and ANS most likely to cause significant harm described. These ANS are grouped by major taxa (i.e. plants, fish, etc.), and individual ANS are designated as "Established" or "Potential Arrival." Due to the immediate or potential threat of these ANS, they are considered candidates for active management. Additional established and potential arrival ANS identified by the KYANSTF, but deemed less of a threat, are listed in Appendix II. All ANS and their pathways will be reviewed annually and appropriate status changes made as necessary.

Pathways: How do ANS get here, and how do people contribute to their spread?

An important component of preventing and managing ANS is understanding pathways. Pathways are natural and manmade connections that facilitate the introduction or spread of ANS or their reproductive materials. Understanding these avenues of spread is particularly important because preventing new introductions is the single most effective way Kentucky can avoid the much higher costs of managing existing ANS problems. Aquatic nuisance species can be introduced by both natural phenomena such as floods and animal transport as well as human actions. Once established, ANS can spread via natural pathways much like native organisms. In Kentucky, such spread can decrease the

health and usability of aquatic systems that facilitate their increases. These aquatic systems are important to many in Kentucky for recreation and commercial use.

Prevention depends upon controlling all pathways. However, this management plan focuses on introduction and spread facilitated by human activity. Below, are various ways in which humans contribute to the spread of ANS in Kentucky.

Physical transport between water bodies

Humans contribute to the spread of ANS by physically transporting them from one water body to another. Kentucky is the center of a waterway system utilized for commercial transport. With access to the Upper and Lower Mississippi, Ohio, and Tennessee-Tombigbee navigation corridors, Kentucky has a waterway link to the Great Lakes and Canada, to Mexican and South American markets, and to the ports of New Orleans, Louisiana and Mobile, Alabama. In addition to these major waterway corridors, barge traffic within the state is occurring on the Big Sandy, Cumberland, Green, and Licking Rivers (Kentucky Cabinet for Economic Development, 2006). Many initial introductions of ANS have occurred during bilge water exchange or after becoming detached from the hulls of vessels involved in commercial transport. Additionally, ANS can be moved from water body to water body attached to watercraft, trailers, water planes, and any equipment or gear associated with them. For example, investigations in Maine found that 3% of watercraft and trailers leaving boat launches have viable fragments of plants attached (Maine Interagency Task Force on Invasive Aquatic Plants and Nuisance Species, 2002). Many aquatic plants can reproduce asexually from fragments. Thus, fragments from an ANS could be easily spread. Further complicating the problem, Kentucky waters are used by many recreational boaters and anglers from neighboring and nearby states, increasing the chance of new ANS introductions into Kentucky from out-of-state sources. Proper rinsing and washing of boats and related equipment can prevent the spread of ANS through this pathway, but most boaters are currently unaware of this remedy or believe it unnecessary.

Fragmentation and spread of existing populations within a habitat

Existing ANS populations can be fragmented and spread to uninfested areas within the same habitat. This pathway usually spreads plant fragments that have been cut by an outboard motor then float or are carried to another part of the same lake or river, where the plant can begin to reproduce. Preventing movement of ANS through this pathway is especially important because small, localized populations of plant ANS are much easier to contain and/or eradicate. Once a population threshold is met, certain ANS plants can become nearly impossible to eradicate. Currently, exact areas infested with ANS plants in Kentucky are not known by all boaters, so unwitting spread of many existing ANS plants is possible, even probable.

Release into the wild

A source of ANS introductions in Kentucky has been through direct unintentional or intentional release into the wild. This can occur in several ways:

Angling

Some anglers may illegally release specific species of ANS such as alewife and crayfish in the belief that they may enhance a sport fishery. Other anglers may be unaware that dumping their unused live bait ("bait bucket release") may introduce ANS into the water body. Sometimes fingerlings caught and transferred from another water body may harbor diseases or parasites, which may then infect the target water body. In the juvenile stage, many species have a similar appearance. Thus, the young fishes being introduced may accidentally include invasive species along with desired species. These latter pathway problems may also characterize live bait.

Water gardens and aquariums

The sale of non-native aquatic plants and pets from nurseries or aquarium outlets is an economic asset to many communities, but inaccurate labeling plus lack of knowledge about native and non-native species provides a pathway for introducing and spreading ANS. Non-native species that have the ability to overwinter in Kentucky's aquatic habitats could be particularly problematic. Compounding the problem, many water garden and aquarium ANS species are available for purchase on the Internet. Spread occurs because these plants and animals do not remain contained by those who purchase them.

Water garden and aquarium enthusiasts may unintentionally or intentionally release ANS. ANS plants and fish can escape from water gardens during flooding and become established in Kentucky's aquatic ecosystems. Some aquarium owners may intentionally release ANS in the belief that they are acting humanely by "freeing" their no-longer wanted, perhaps too large pets. Nursery and pet wholesalers and retailers do not always ensure that species sold to the public are not ANS. Many do not know which species are problems. Some ANS available at nursery or pet stores may be mislabeled or confused with similar looking native plants or fish. Other non-invasive plants may have ANS "hitchhikers" attached to or mixed in with them.

Failure to maintain effective biosecurity

Aquaculture operations can introduce ANS pathogens, fish, and crustaceans if they improperly dispose untreated biological waste into uninfested waters. Also, operations that are not properly contained may allow ANS to escape into the wild. Researchers may release ANS when they fail to properly contain experiments and subjects or dispose of live material after a project has been completed. Furthermore, many ANS are readily available from biological supply houses and can be ordered through catalogues and the Internet.

Cultural

Ethnic or religious groups may intentionally release culturally familiar organisms for food, medicine, or religious reasons. The snakehead (*Channa* sp. or *Parachanna* sp.) may have been originally introduced into the U.S. as a food source through this pathway (Northern Snakehead Working Group, 2006). Although we are unaware of any ANS released into Kentucky through the cultural pathway, the pathway is problematic elsewhere, and therefore included here as a possible pathway.

Which ANS are currently established and which may arrive soon?

Dilemma of ANS definitions

As stated earlier, ANS are non-native, aquatic species that threaten the diversity or abundance of native species or the ecological stability of waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters. Although this definition accurately describes most species deemed the biggest threats to Kentucky and those listed in Appendix I, further explanation is needed because much of the terminology used in ANS management plans are not rigorously defined scientific terms. For example, the definition states that ANS are non-native. Non-native is usually used to describe organisms that are from another region or country. In Kentucky's plan, the KYANSTF has included organisms that are native to a particular ecosystem in Kentucky but are problematic when introduced into another part of the state. For example, the rusty crayfish, listed in Appendix II, is native to ecosystems of north central Kentucky, but not native to eastern Kentucky and is problematic there.

The management plan uses an expanded version of the scientific term "aquatic." Aquatic is usually defined as "living in or on the water for all or a substantial part of an organism's life span" (Biology-Online.org, 2006). However, in Kentucky's plan, the KYANSTF has expanded this definition to include some "borderline" species that may not precisely fit this definition, but nonetheless negatively impact aquatic habitats and the human use of these habitats. For example, the KYANSTF decided to include several plant species (e.g., Japanese knotweed, white poplar) that do not live directly in aquatic ecosystems but can negatively impact native organisms that do. Another example is nutria. While nutria swim in the water and are usually found in close proximity to water, they do not live in the water. However, when present, nutria can decimate native aquatic ecosystems and the valuable human use of them. Usage of these expanded definitions and inclusion of associated exceptions in this management plan will strengthen this plan to protect Kentucky's native aquatic ecosystems and the valuable human uses of these ecosystems.

Lastly, the KYANSTF has decided not to include aquatic non-native human disease causing microbes such as West Nile virus in this management plan. While such organisms clearly fit our ANS definition, organizations such as the Kentucky Department for Public Health and the Center for Disease Control and Prevention are better equipped and prepared to deal with such problems. While the KYANSTF acknowledges their threat, issues related to these microbes will be addressed by the appropriate medical and public health entities.

Problem-causing ANS in Kentucky

An important component of this plan is to identify ANS established in Kentucky and those that may potentially arrive. Potential arrivals may exist in neighboring states or have life histories conducive to surviving Kentucky's aquatic habitats, climate, and environment. In Kentucky, existing ANS and potential arrivals include plants, fish, mollusks, algae, and mammals. The KYANSTF has deemed the ANS described below

the biggest threats to Kentucky. All other identified ANS are listed in Appendix II. Species on both lists are candidates for active management.

ANS Plants of Kentucky- Established

Eurasian watermilfoil (*Myriophyllum spicatum*)
Eurasian watermilfoil is a submerged aquatic plant native to Europe, Asia, and North Africa. This species is believed to have been initially introduced into the U. S. in 1942 around the Washington D. C. area via release into the wild, possibly as result of escaping from a water garden or dumped from an aquarium. In Kentucky, the plant occurs in some northern counties along the Ohio River and scattered throughout some western counties. Within our state, pathways for spread of Eurasian watermilfoil include physical transport between water bodies, fragmentation and spread of existing populations within infested waters, and release into the wild. The plant's preferred habitats are lakes, reservoirs, ponds, and low energy areas of streams and rivers. It is commonly found in water 1.6 – 8.2 ft deep and is able to tolerate a wide range of water temperatures, from frozen lakes in Canada to shallow bays in Florida (Global Invasive Species Database, 2006). Eurasian watermilfoil can form dense, vegetative mats that interfere with swimming, boating, and commercial/recreational fishing. These mats can also shade out and replace native aquatic plants as well as shade out phytoplankton, which can result in alterations to aquatic food webs. Decaying vegetative mats of the plant can reduce water column oxygen levels, possibly resulting in fish kills. Eurasian watermilfoil has less value as a food resource for native organisms, supports fewer aquatic insects, and reduces foraging space of large predatory fish (Aiken *et. al.*, 1979; Hoffman and Kearns, 1997).

Purple loosestrife (*Lythrum salicaria*)
Purple loosestrife is a wetland perennial native to Europe, Asia, and northern India. The plant was first introduced in the northeastern U. S. in the 1800s for ornamental and medicinal purposes and has since spread across the country. It most likely spread through release into the wild via water gardens or the cultural pathway. In Kentucky, the plant is mainly found in counties bordering the Ohio River, Fayette and Martin County, as well as along the Red River. Within the state, the plant continues to spread through physical transport between water bodies, fragmenting of existing populations in previously infested waters, as well as the release into the wild pathways. Purple loosestrife thrives in a variety of habitats including lakes, reservoirs, ponds, river and stream banks, and drainage ditches. Like many ANS plants, disturbed areas are more prone to infestation. Mature plants are extremely prolific and can produce up to 2.7 million seeds/plant annually (Thompson *et. al.*, 1987). Once established, purple loosestrife outcompetes and replaces native plants that provide a higher quality food source and habitat for a variety of native wildlife. If left untreated, the plant can form dense, single species stands resulting in decreased biodiversity as well as lost recreational and commercial fishing opportunities.

Brazilian watermilfoil (*Myriophyllum aquaticum*)
Brazilian watermilfoil is an aquatic perennial native to South America. The plant was introduced to the U. S. in the 1800s and was most likely spread through the release into

the wild pathway, most likely from aquariums or water gardens. There were no reports from KYANSTF members of the plant occurring in Kentucky, but distribution maps on Natureserve.org indicate a Kentucky presence. In Kentucky, the plant could spread through physical transport between water bodies, fragmenting of existing populations in previously infested waters, and release into the wild. It is often mislabeled and sold for use in watergardens and aquaria. Brazilian watermilfoil grow in lakes, reservoirs, ponds, and low energy areas of streams and rivers. The plant prefers shallow water but is well adapted to water level fluctuations, occurring as floating vegetation in deeper lake waters and surviving on the wet banks of rivers and lakes (Pieterse and Murphy, 1993). The plant forms dense vegetative mats that can crowd out native plants and harm native organisms dependent on these plants for food and habitat. These mats also shade out phytoplankton resulting in the disruption of balanced aquatic food webs. Furthermore, dense vegetative mats restrict recreational opportunities such as swimming, boating, angling, as well as commercial fishing.

Common reed (*Phragmities australis*)

Common reed is a large perennial grass widely distributed throughout Europe, Asia, Africa, the Americas, and Australia. While there are native types of common reed, recent evidence suggests that invasive genotypes are responsible for the dramatic spread of this species into aquatic habitats where it was previously not found (Staltonstall, 2002). Some evidence suggests the more invasive genotypes have been introduced to North America from the Old World (Metzler and Rozsa, 1987). When the plant's invasive genotype was initially introduced in the U. S. is unknown, but it is believed to have occurred in states along the Gulf of Mexico. Common reed exhibits invasive characteristics and thrives in Kentucky's aquatic habitats. Within the state, the plant is prevalent in western Kentucky (especially in brackish water areas of strip mine sites) and along the Ohio River border counties. Common reed continues to spread in Kentucky through physical transport between waters, and fragmentation and spread of existing populations in previously infested waters. The plant can grow in disturbed as well as pristine areas but is especially common along roadside drainage ditches and in wetlands. The plant is highly tolerable of variable environmental conditions and thrives from alkaline soils to acidic wetlands and from brackish waters to freshwater areas (Marks *et. al.*, 1993). Common reed spreads aggressively, crowding out native wetland plants. This alters the wildlife support of diverse native plant assemblages and threatens native organisms dependent on them.

Curly pondweed (*Potamogeton crispus*)

Curly pondweed is a submerged aquatic plant native to Europe, Asia, and Africa and was first introduced into the U. S. in the 1850s (Stuckey, 1979). In Kentucky, the plant is found in some Ohio River border counties as well as scattered throughout the state. Curly pondweed continues to spread in the state through physical transport between water bodies, fragmenting of existing populations in previously infested waters, as well as release into the wild from aquariums and water gardens. The plant can be found in lakes, reservoirs, ponds, rivers and streams. Curly pondweed spreads primarily by dropping burr-like winter buds called turions. A single plant can produce hundreds of turions that germinate the following growing season. The plant also reproduces vegetatively from rhizomes and stem fragments (Vermont Department of Environmental Conservation and

Fish & Wildlife *et. al.*, 1998). During its growing season, curly pondweed forms dense vegetative mats that remove photosynthetic light from the water column, resulting in alterations to balanced aquatic food webs. The mats crowd out native vegetation and negatively impact native organisms dependent on native vegetation for food and habitat. These vegetative mats also interfere with economically important recreational activities such as boating, swimming, angling, as well as commercial fishing.

Japanese stiltgrass (*Microstegium vimineum*)
Japanese stiltgrass is an annual grass native to Asia. The plant was first discovered in the U. S. around 1919 in Tennessee. The initial U. S. introduction was possibly the result of the dried plant's use as packing material for imported goods. Currently, the plant is well established throughout Kentucky and continues to spread through physical transport between water bodies and fragmenting of existing populations in previously infested waters. Japanese stiltgrass grows on stream banks, river bluffs, wetlands, and in upland areas. The plant is slow to colonize undisturbed areas but can quickly form single species stands in disturbed areas. This results in fewer habitats for native plants and less food and cover for native animals. Once established, Japanese stiltgrass alters soil conditions by raising pH and immobilizing nitrogen, which promotes an unfavorable environment for native plants (Ehrenfeld *et. al.*, 2001).

Reed canarygrass (*Phalaris arundinacea*)
Reed canarygrass is a perennial grass native to Europe. It is unknown when the plant was initially introduced to the U. S., but this species now occurs across much of the country. The initial U. S. introduction occurred when the plant was released into the wild as a food source for grazing livestock. Within this state, the plant is now prevalent in western Kentucky and in many border counties along the Ohio River. The plant has continued to spread in Kentucky through physical transport between water bodies and the fragmenting of existing populations in previously infested waters. The plant thrives on lakeshores, river and stream banks, and in ponds and wetlands. Once established, reed canarygrass forms dense, impenetrable stands and continues to spread through creeping rhizomes. These dense stands crowd out native plants and displace native animals. The plant also promotes silt deposition, resulting in constriction of waterways and altered hydrologic regimes (Lyons, 1998).

Japanese knotweed (*Polygonum cuspidatum*)
Japanese knotweed is an herbaceous perennial native to Asia. The plant was first introduced to the U. S. in the late 1800s as an ornamental plant and for erosion control. Exactly where the plant was initially introduced is unknown. Within Kentucky, the plant has become well established in the central and eastern portion of the state. Japanese knotweed continues to spread in the state through physical transport between water bodies, fragmentation of existing populations in previously infested waters, and release into the wild from water gardens. Japanese knotweed grows rapidly on stream and riverbanks as well as in wetlands. The plant spreads through extensive rhizomes, has been observed growing through 2 inches of asphalt, and can produce up to 21 new shoots/square ft (Seiger, 1991). This species' leaves and stems fall quickly and are extremely persistent, preventing the germination and growth of native plants' seeds.

Japanese knotweed forms very dense thickets that crowd out native vegetation, consequently harming native organisms dependent on native plants for food and habitat and reducing overall biodiversity.

Alligator weed (*Alternathera philoxeroides*)
Alligator weed is an aquatic emergent plant native to South America. It is unknown when the plant was first introduced to North America, but this species was most likely brought here for use as an ornamental plant in water gardens. Within the state, alligator weed thrives in wetlands, ponds, drainage ditches, and upland areas of western Kentucky. The plant continues to spread within the state through physical transport between water bodies, the fragmenting of existing populations in previously infested waters, as well as being released into the wild from water gardens. The plant forms roots in shallow water soils as well as dense mats extending over deeper water. Alligator weed continues to spread through its extensive underground rhizomes and the plants' canopy can smother most other herbaceous plant species (Gunasekera, 1999). Alligator weed crowds out native plants, decreasing biodiversity and reducing habitat and food resources for native organisms. Dense mats of this plant restrict sunlight penetration through the water column, resulting in disturbance to balanced aquatic food webs. Large infestations of the plant can create anoxic conditions, harming or killing native flora and fauna (Groves *et. al.*, 1995). Alligator weed mats can restrict or prevent economically important activities such as boating, angling, and swimming as well as disrupt commercial fishing operations.

Water hyacinth (*Eichhornia crassipes*)
Water hyacinth is a free-floating aquatic plant native to South America. It was initially introduced into the U. S. in 1884 at the Cotton States Exposition in New Orleans (Invasives.org, 2007), and has since spread across the southeastern U. S. and into parts of the northeastern and western U. S. The plant was first brought to the U. S. as an ornamental plant for water gardens and then subsequently released into the wild. In Kentucky, water hyacinth has been found in western regions of the state. The plant spreads in Kentucky through physical transport between water bodies, the fragmenting of existing populations in previously infested waters, as well as release into the wild from water gardens. Water hyacinth flourishes in lakes, reservoirs, rivers, ponds, and wetlands. The species is the fastest growing saltwater, terrestrial, and freshwater plant with the ability to double its biomass every 6-18 days, dependent on site and season (Lindsey and Hirt, 1999). The plant is particularly troublesome in low energy areas because its dense, floating vegetative mats can reduce dissolved oxygen, alter area hydrology, and increase rates of sedimentation (Toft, 2000). Vegetative mats also displace native plant and animal assemblages, interfere with commercial fishing operations, and ruin water recreation opportunities, especially boating and swimming.

ANS Fish of Kentucky- Established

Silver carp (*Hypophthalmichthys molitrix*)
Silver carp are large (up to 3 ft long) fish native to China. They were first introduced in the U. S. in 1973 and have since spread at least throughout the Mississippi River basin. Silver carp were imported into this country to control plankton blooms in ponds, lakes

and sewage lagoons. They were then accidentally released into the wild as a result of failure to maintain effective biosecurity and reached Kentucky through the middle Mississippi River basin. In Kentucky, they currently occur in the Mississippi River, Ohio River, lower Tennessee River, lower Cumberland River, part of the Green River, and in Kentucky and Barkley Lakes. Silver carp inhabit large rivers, lakes, ponds, and impoundments. They are large planktivores and pose a direct threat to native fish and mussels that depend on plankton as a food source (Spartaru and Gophen, 1985). Some of the native planktivores that silver carp directly compete with are commercially important filter feeding fishes such as bigmouth buffalo and paddlefish as well as the early life stages of important forage and sportfish species. Silver carp can damage commercial fishing nets that are usually not big and/or strong enough to hold them. Furthermore, these fish will jump out of the water when disturbed and have caused serious injury to both recreational boaters and commercial fishermen.

Bighead carp (*Hypophthalmichthys nobilis*)
Bighead carp are large fish (up to 3 ft long) native to China. In 1973, they were first introduced to the U. S. in Arkansas in an effort to control phytoplankton blooms and improve water quality in ponds and lakes. Subsequently, they were accidentally released into the wild as a result of failure to maintain effective biosecurity by escaping a state fish hatchery during a flooding event. By the 1980's, bighead carp began to appear in the open waters of the Mississippi and Ohio rivers (Jennings, 1988). Within Kentucky, they can currently be found in the Mississippi River, Ohio River, lower Tennessee River, lower Cumberland River, part of the Green River, Kentucky Lake, and Barkley Lake. Bighead carp thrive in large rivers as well as lakes, reservoirs, and ponds. They are planktivores that compete directly with native fish and native mussels that depend on plankton for food resources. Like silver carp, these fish directly compete with commercially valuable filter-feeding fish species such as bigmouth buffalo and paddlefish as well as the early life stages of important forage and sportfish species. Furthermore, these fish can damage commercial fishing nets that are usually not big and/or strong enough to hold them.

ANS Fish of Kentucky- Potential Arrivals

Black carp (*Mylopharyngodon piceus*)
Black carp is another large (up to 3 ft long) member of the carp family native to Asia. The fish was initially introduced to the U. S. in 1994 in the state of Missouri for use as a biocontrol for snails in aquaculture operations but were accidentally released into the wild due to failed biosecurity during a flooding event. The fish has not been recorded in Kentucky but has been documented in the Mississippi River raising concerns that the fish may eventually invade Kentucky waters. Thus far, black carp captured in the wild have been sterile triploid organisms, raising hopes that the species will not reproduce in Kentucky's waters. However, there have been concerns about the functional sterility of triploids of some species, prompting fears of possible spread and reproduction (Nico *et. al.* 2005). The black carp's preferred habitat is large, slow moving rivers such as the Mississippi and Ohio rivers. The fish is a bottom-dwelling molluscivore elevating concerns that this species could threaten Kentucky's diverse native mollusk community,