Mississippi
State Management Plan
for Aquatic Invasive Species

Waterhyacinth (*Eichhornia crassipes*) management - Crane Lakes, Pascagoula River

Final Draft Management Plan

Mississippi Department of Environmental Quality—Henry Folmar and Mike Beiser
EPA Gulf of Mexico Program—Phil Bass
Mississippi Aquatic Invasive Species Task Force

Made possible by a grant from the Mississippi Department of Environmental Quality's Coastal Impact Assistance Program to the University of Southern Mississippi, the Mississippi Department of Environmental Quality, and the Mississippi Department of Marine Resources

Compiled and written by the Tulane / Xavier Center for Bioenvironmental Research—Alysia Kravitz Loshbaugh, Richard Campanella, Shelley Meaux, and members of the Mississippi Aquatic Invasive Species Task Force.

March 20, 2013

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF PHOTOS

LIST OF GRAPHS

Acknowledgements

Mississippi is blessed with diverse and abundant aquatic resources. From the Mississippi River on its western border to the Tennessee-Tombigbee Waterway in the east, from the large flood control reservoirs in north Mississippi to the coastal marshes and bays of the Gulf Coast, these waters support water supply, recreation, transportation, agriculture and commerce and are an important part of the quality of life for the people of this state. Aquatic invasive species pose a threat to these waters and their beneficial uses. Recognizing the importance of this issue to Mississippi, Governors Ronnie Musgrove, Haley Barbour and Phil Bryant were steadfast in initiating and supporting the Mississippi Aquatic Invasive Species Task Force.

The MAIS Task Force was formed in 2003 to develop an aquatic invasive species management plan for the state, and was comprised a broad group of experts representing government, academia, agriculture, industry, and other stakeholders. We enthusiastically thank all of the task force members who gave their time, energy and expertise to help write the Mississippi Aquatic Invasive Species Management Plan. A list of members is provided in Appendix A.

In addition, we owe a debt of gratitude to the following people who provided leadership, funding, guidance, perseverance or extraordinary effort toward the successful completion of this plan:

- Mr. Phil Bass, Mississippi Department of Environmental Quality, and EPA's Gulf of Mexico Program Office
- Mr. Ron Lukens and Mr. James Ballard, Gulf States Marine Fisheries Commission.
- Mr. Richard Campanella and Ms. Shelley Meaux, Center for Bioenvironmental Research at Tulane and Xavier Universities.
- Ms. Elizabeth Barber, Coastal Impact Assessment Program.
- Ms. Harriet Perry and Ms. Lisa Hendon, University of Southern Mississippi, Gulf Coast Research Laboratory.
- Dr. Craig Tucker, Mississippi State University.
- Ms. Stephanie Showalter, Mississippi-Alabama Sea Grant Program.
- Ms. Alysia Kravitz Loshbaugh, contractor.
- Dr. Gary Tucker, FTN and Associates.
- Mr. Dale Diaz and Mr. Mike Pursley, Mississippi Department of Marine Resources.
- Mr. Dennis Riecke, Mississippi Department of Wildlife Fisheries and Parks.
- Finally, a special thanks to Ms. Marilyn Barrett-O'Leary with the Southern Aquatic Resources Partnership whose knowledge, passion and persistence about invasive species helped keep the Task Force informed and moving forward.

Thanks to this group of dedicated professionals, Mississippi now has a plan that provides us with a framework for prevention, education, and mitigation of problems that may arise due to aquatic invasive species.

March 2013

Common Acronyms

AIS	Aquatic Invasive Species
ANSTF	Aquatic Nuisance Species Task Force
APHIS	Animal and Plant Health Inspection Service (USDA)
BPI	Bureau of Plant Industry (MDAC)
CAPS	Cooperative Agricultural Pest Survey
CIAP	Coastal Impact Assistance Program
CBP	US Bureau of Customs and Border Protection
CBR	Center for Bioenvironmental Research at Tulane and Xavier Universities
CIAP	Coastal Impact Assistance Program
COTP	Captain of the Port (US Coast Guard)
CSREES	Cooperative State Research, Education, and Extension Service
CSREES NRI	Cooperative State Research, Education, and Extension Service, National Research Initiative
CWMA	Cooperative Weed Management Area
EEZ	Exclusive Economic Zone
EPA	United States Environmental Protection Agency
FDA	Food and Drug Administration
FTE	full-time equivalent
FY	fiscal year
GCRL	Gulf Coast Research Laboratory (at USM)
GoMP	Gulf of Mexico Program
GRI	GeoResources Institute (at MSU)
GSMFC	Gulf States Marine Fisheries Commission
IPAMS	Invasive Plant Atlas of the MidSouth
KHV	Koi Herpes Virus
LDAF	Louisiana Department of Agriculture and Forestry
MAFES	Mississippi Agricultural and Forestry Experiment Station (at MSU)
MAIS	Mississippi Aquatic Invasive Species
MDAC	Mississippi Department of Agriculture and Commerce
MDEQ	Mississippi Department of Environmental Quality
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
MFB	Mississippi Farm Bureau
MIAIS Council	Mississippi Interagency Aquatic Invasive Species Council
MOU	Memorandum of Understanding
MS-GAP	Mississippi Gap Analysis Project
MSDH	Mississippi State Department of Health
MSU	Mississippi State University
MSU ES	Mississippi State University Extension Service
MWRRI	Mississippi Water Resources Research Institute
NAISA	National Aquatic Invasive Species Act (reauthorization in 2004)
NANPCA	Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990
NBII	National Biological Information Infrastructure
NBWC	National Ballast Water Clearinghouse at the Smithsonian Institute
NISA	National Invasive Species Act of 1996
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NWAC	National Warmwater Aquaculture Center (at MSU)
OIE	The Office of International Epizootics (English) or Office International des Epizooties (French)
PRVWSD	Pearl River Valley Water Supply District
SARP	Southeast Aquatic Resources Partnership
SAV	Submerged Aquatic Vegetation
SERC	Smithsonian Environmental Research Center
SRAC	Southern Regional Aquaculture Center

SVC(V)	Spring Viremia of Carp (virus)
TNC	The Nature Conservancy
USACE	United States Army Corps of Engineers
USCG	United States Coast Guard
USDA	United States Department of Agriculture
USDOI	United States Department of the Interior
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
USM	University of Southern Mississippi
VHS(V)	Viral Hemorrhagic Septicemia (virus)

1 Executive Summary

The Mississippi Aquatic Invasive Species (MAIS) Task Force was formed by request of Governor Ronnie Musgrove in the spring of 2003 and assembled eight times between October 2003 and July 2009. In 2004, after Governor Haley Barbour was elected, members of the MAIS Task Force met with representatives from the governor's office to brief them on the ongoing efforts, the Task Force was encouraged to continue its work.

The MAIS Task Force, along with other states in the Southeast Region, has determined aquatic invasive species (AIS) to be hazardous to Mississippi's economic and environmental well-being. Despite setbacks and delays caused by Hurricane Katrina, the temporary loss of funding and the BP Horizon oil spill, the Task Force proceeded with this important endeavor, and is pleased to submit this Plan for consideration to the National Aquatic Nuisance Species Task Force (ANSTF).

The MAIS Task Force, chaired by the Mississippi Department of Environmental Quality (MDEQ), is comprised of representatives from state and federal agencies, public and private universities, trade industries, and other stakeholder groups. The purpose of the *Mississippi State Management Plan for Aquatic Invasive Species* is to describe the aquatic invasive species problems facing the state, and to propose management actions as potential solutions.

Situated adjacent to Louisiana and Alabama and not far from Florida, all of which are particularly susceptible to aquatic invasive species due to their subtropical climates, international port activity, and extensive wetlands, Mississippi faces many of the same challenges as these neighboring states. The MAIS Task Force patterned this Plan in a similar fashion to the *State Management Plan for Aquatic Invasive Species in Louisiana*, since the states share very similar climates, habitats, pathways, and a long, common border. Overlapping regulatory jurisdictions can be difficult to address in emergency situations, and are compounded if efforts must extend to neighboring states. In order to maintain a level of consistency that should prove advantageous in the event a rapid response or control effort must be coordinated across state lines, the MAIS Task Force chose to adopt similar invasive species goals, objectives, and strategies as its neighbor to the west. Despite the similarities between the two management plans, there are also important differences, particularly with regard to the emphases placed on certain pathways and media of concern. International shipping routes, for example, are a major potential pathway in Louisiana. Mississippi's port system is not quite as extensive as Louisiana's, however, and this pathway is not considered as potentially problematic as others, such as horticulture, aquaculture, or the aquarium/pet industries.

The following pathways and media are described in this Plan:

- Shipping
- Recreational boating and fishing
- Natural disasters
- Transportation corridors (highways, railroads, waterways)
- Ballast water
- Fouling and dunnage
- Aquaculture introductions
- Sportfishing introductions
- Horticultural introductions
- Agricultural introductions
- Pet and aquarium introductions
- Fur industry introduction
- Introductions as part of cultural traditions

The Task Force also initially chose to recognize the following species of concern:

Water hyacinth	Bighead carp
Chinese tallow tree	Tilapia
Giant salvinia	Black carp
Common salvinia	Sailfin catfish
Water lettuce	Zebra mussel
Eurasian watermilfoil	Green mussel
Hydrilla	Nutria
Purple loosestrife	Australian spotted jellyfish
Cogongrass	Giant Malaysian prawn
Torpedo grass	Australian red claw crayfish
Wild taro	
Peruvian watergrass	Fish pathogens:
Common carp	Spring viremia of carp virus
Grass carp	Koi herpes virus
Silver carp	Viral hemorrhagic septicemia virus

Some reviewers of the draft Plan suggested exclusion of Chinese tallow tree and cogongrass from the Plan (see Section 13.L). Their recommended exclusion was based on the belief that although each species could occasionally be found in seasonal wetlands, they could not tolerate long-term saturation and would not be defined as "aquatic species." They are excluded from consideration in the Plan because the Cooperative Weed Management Area (CWMA) offers a better venue for tracking and managing non-aquatic invasive species in Mississippi. In the last two years, Asian tiger shrimp and lionfish have emerged as new aquatic invasive species threatening Mississippi and are the most recent additions to the species addressed by this plan.

The goal of this Plan is to provide a framework to help prevent and control the introduction of new nonindigenous species into Mississippi; control the spread and impact of existing AIS; and eradicate locally established AIS wherever possible. The following five objectives were adopted to help achieve this goal:

1. Coordinate all AIS management activities or programs within Mississippi and collaborate with regional, national, and international AIS programs;
2. Prevent and control the introduction/reintroduction of nonindigenous invasive species through education about species and pathways, targeting the general public (including schools), industries, user groups, government agencies, and nongovernmental organizations;
3. Eliminate locally established invasive species through monitoring, early detection, rapid response, and early eradication;
4. Control the spread of established invasive species through cooperative management activities designed to minimize impacts when eradication is impossible; and
5. Prevent the introduction of nonnative species, or the spread of existing ones, through legislation, regulation, and enforcement.

The Plan identifies specific management actions for addressing invasive species problems in the state, some of which are funded and ongoing, and others of which lack funding. Examples of ongoing, funded management actions in Mississippi include:

- Development of fact sheets on invasive aquatic plants in Mississippi;
- Monitoring of aquatic wildlife in Biloxi Bay Estuary; and
- Mapping and controlling the post-Hurricane Katrina population of giant salvinia in the Lower Pascagoula River.

Also, for the first time in Mississippi, this Plan provides proposed Approved, Restricted, and Prohibited Species lists to the Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). MDWFP was mandated by Mississippi statute to prepare and maintain these lists, but the lists were not developed in the past due to lack of input from other stakeholder groups. When the MAIS Task Force was convened, representatives from MDWFP agreed to allow the Task Force to propose the lists using input from all participating stakeholder groups. These lists are available for review in Appendix C (Section 13.C) of this Plan.

Recommendations

The MAIS Task Force strongly recommends the formation of a permanent Mississippi Interagency Aquatic Invasive Species (MIAIS) Council to oversee implementation of the Plan after its approval by the national ANSTF. In addition, the MAIS Task Force recommends the future Interagency Council immediately implement the following high-priority actions:

- Hire statewide MAIS Coordinator to coordinate and conduct invasive species management activities in the state at the direction of the Interagency Council;
- Establish Memoranda of Understanding to outline responsibilities and address overlapping jurisdictions;
- Develop a Rapid Response and Early Eradication Plan; and
- Work with MDWFP to adopt the proposed Approved, Restricted, and Prohibited Species Lists.

MDEQ and the MAIS Task Force recommend the approval of this Plan by the Governor of Mississippi so that implementation may commence.

2 Introduction

Colonists and settlers to the New World began introducing species from their homelands hundreds of years ago. Sometimes born of a desire for wanting something familiar in a new place (i.e., intentional introduction), and other times quite accidental (i.e., unintentional introduction), many of these introductions have proven beneficial, and are cornerstones of agricultural and economic prosperity. For example, corn, cattle, soybeans, and rice are nonnative species introduced to the United States hundreds of years ago which became particularly important crops and commodities. However, other species brought to the New World have proven problematic and are causing or have caused adverse economic and environmental impacts, including impacts on human health. One example of an invasive species with impacts on human health is the introduced mosquito *Aedes aegypti*, which brought a yellow fever epidemic to New Orleans, Louisiana; Vicksburg and Grenada, Mississippi; and much of the rest of the Mississippi River Valley in 1878.

In other instances, species were deliberately introduced with the best of intentions, but history has shown many of these introductions to be mistakes. Planting kudzu (*Pueraria montana*) was promoted by the US Department of Agriculture (USDA) Soil Conservation Service during the Dust Bowl in the 1930s to prevent soil erosion. Also known as Foot-a-Night Vine and Vine-That-Ate-the-South, kudzu was declared a weed in 1972, but this action was too late to prevent further distribution; the vine had already been widely planted throughout the southeastern region and other parts of the United States. An attractive plant, particularly when flowering, kudzu vines can grow so extensively and become so heavy that large trees can be toppled by its weight.

Mississippi lies adjacent to Louisiana and Alabama and in close proximity to Florida. The coastal areas extending from Florida to Texas are adjacent to the Gulf of Mexico and the region is often referred to as the Gulf South. The entire Gulf South region is typified by warm subtropical climates, extensive wetland systems, and active international port systems – characteristics that make the states particularly vulnerable to new invasive species introductions. Researchers and state agency officials fear it is only a matter of time before the many nonindigenous species that have already created serious problems in Florida and Louisiana will spread to Mississippi and cause similar problems. In particular, Mississippi officials are concerned that some nonnative species, such as viral hemorrhagic septicemia virus (VHSV), a fish virus introduced to the Great Lakes and spreading south into the Mississippi River Basin, will adversely impact aquaculture, an important industry in the state. Likewise, there are concerns that species raised in aquaculture facilities, and the fish pathogens that sometimes infect them, may escape from the facilities and impact native species in freshwater lakes and streams.

Invasive species issues are often complicated, multi-disciplinary, and difficult to address. Overlapping regulatory jurisdictions by state agencies become even more complex when an invasive species issue crosses state lines. In these instances, jurisdictional issues between the states must be addressed for rapid response, eradication, or control efforts to proceed effectively. To begin to address these jurisdictional issues, the *Mississippi State Management Plan for Aquatic Invasive Species* was researched and written to complement the *State Management Plan for Aquatic Invasive Species in Louisiana*. Resemblances to the Louisiana management plan, with regard to strategies, objectives, and the structure of the Plan itself, were deliberate. Should an interstate Mississippi-Louisiana invasive species issue arise, it should be easier to coordinate efforts, due to the consistency in the states' respective management plans.

The *Mississippi State Management Plan for Aquatic Invasive Species* describes invasive species issues in Mississippi and proposes management actions to address these five objectives:

1. Coordinate all AIS management activities or programs within Mississippi and collaborate with regional, national, and international AIS programs;
2. Prevent and control the introduction/reintroduction of nonindigenous invasive species through education about species and pathways, targeting the general public (including schools), industries, user groups, government agencies, and nongovernmental organizations;

3. Eliminate locally established invasive species through monitoring, early detection, rapid response, and early eradication;
4. Control the spread of established invasive species through cooperative management activities designed to minimize impacts when eradication is impossible; and
5. Prevent the introduction of nonnative species, or the spread of existing ones, through legislation, regulation, and enforcement.

The overall purpose of this Plan is to prevent and control the introduction of new nonindigenous species into Mississippi; control the spread and impact of existing invasive species; and eradicate locally established invasive species wherever possible. It should also be stressed that increased coordination and communication of invasive species efforts is a priority for the MAIS Task Force, and is a primary recommendation for future actions.

This Plan focuses solely on aquatic invasive species in Mississippi, as opposed to all invasive species, including terrestrial species. With regard to plants, the Task Force decided to focus on those plants that are traditionally considered aquatic.

Participants in the invasive species planning process included state and federal agencies, universities and extension services, and research centers. Representatives of these entities are listed in Appendix A. Henry Folmar (MDEQ) and Phil Bass (currently at the US Environmental Protection Agency [EPA] Gulf of Mexico Program, but formerly at MDEQ) oversaw the Task Force and the planning process and assembly of this Plan, assisted by the Tulane/Xavier Center for Bioenvironmental Research (CBR), which wrote the Plan. Funding was provided by MDEQ, MDEQ's Coastal Impact Assistance Program (CIAP), the Mississippi Department of Marine Resources (MDMR), and the University of Southern Mississippi (USM). The Plan follows the guidelines of the national ANSTF, an intergovernmental organization that standardizes and approves state management plans nationwide.

This Plan was developed in association with Section 1204 of the National Invasive Species Act of 1996 (NISA), which specifically authorized the development of comprehensive state invasive species management plans and authorized federal funding for states with plans approved by the national ANSTF.

3 Geographic Scope of Plan

3.A Physiography and Soils

Mississippi is bordered on the north by Tennessee, on the east by Alabama, on the west (across the Mississippi River) by Louisiana and Arkansas, and on the south by a narrow coast that follows along the Gulf of Mexico. A small part of Louisiana on the east side of the Mississippi River borders Mississippi on the south.

Mississippi is entirely represented by relatively low-lying landscapes. The highest point is Woodall Mountain, a part of the foothills of the Cumberland Mountains, at an elevation of 806 feet (246 meters) above sea level. The lowest elevations are at sea level along the Gulf coast. The mean elevation of the state is 300 feet (91 meters) above sea level.

Mississippi occurs almost entirely within the area known as the Gulf Coastal Plain. The Gulf Coastal Plain is continuous to the east with the Atlantic Coastal Plain. The Gulf Coastal Plain is subdivided by the Mississippi River, i.e., areas to the east of the river are classified as the East Gulf Coastal Plain and to the west as the West Gulf Coastal Plain. The Mississippi River Alluvial Plain is narrow in southern Mississippi but widens from Vicksburg northward. The Mississippi Alluvial Plain includes the Delta region and consists of floodplains that extend to the foothills of the loess bluffs that follow the Alluvial Plain's eastern boundary. The Delta region extends from Louisiana and Mississippi north to southeastern Missouri and is characterized by largely silt and clay soils that have been deposited by floodwaters associated with the Mississippi River and associated tributaries.

A large area of northeast Mississippi includes a region of fertile black soils deposited during the old Mississippi Embayment of Cretaceous times and often referred to as the Black Belt region. Remaining coastal plain regions of the state include a range of soils types and elevations, i.e., the low elevation landscapes of water-deposited sediments bordering Mississippi Sound and the Gulf of Mexico as well as areas of higher elevations that occur further inland.

3.B Drainage Basins of Mississippi

The major drainage basins of Mississippi have been delineated and described in several different ways. Most authorities recognize approximately ten major drainage basins within the state, although they are sometimes defined in different ways. The US Geological Survey (USGS), for example, recognizes the North Independent Streams, Tennessee River, Yazoo River, Tombigbee River, Big Black River, Pearl River, South Independent Streams, Pascagoula River, Coastal Streams, and Mississippi River drainage basins. MDEQ recognizes a total of nine major drainage basins: North Independent Streams, Tennessee-Tombigbee River, Yazoo River, Pearl River, South Independent Streams, Big Black River, Pascagoula River, Coastal Streams, and Lower Pearl River drainage basins.

Figure 1 provides a map of the ten major drainage basins as defined by USGS. Of these ten drainage basins, two are much smaller than the remaining eight basins, and are not labeled (North Independent Streams and Tennessee River drainage basins). The South Independent Streams drainage basin is labeled on Figure 1 as the South West Mississippi Basin. Descriptions of the ten major drainage basins are as follows[1,2]:

3.B.1 North Independent Streams Basin

Major streams within this drainage basin include the Hatchie, Tuscumbia, Muddy, and Wolf rivers. This drainage basin consists primarily of small streams and medium streams that have been channelized, all of which flow to the Mississippi River on the western border of Tennessee. The basin drains an area of approximately 1,075 square miles of north-central Mississippi.

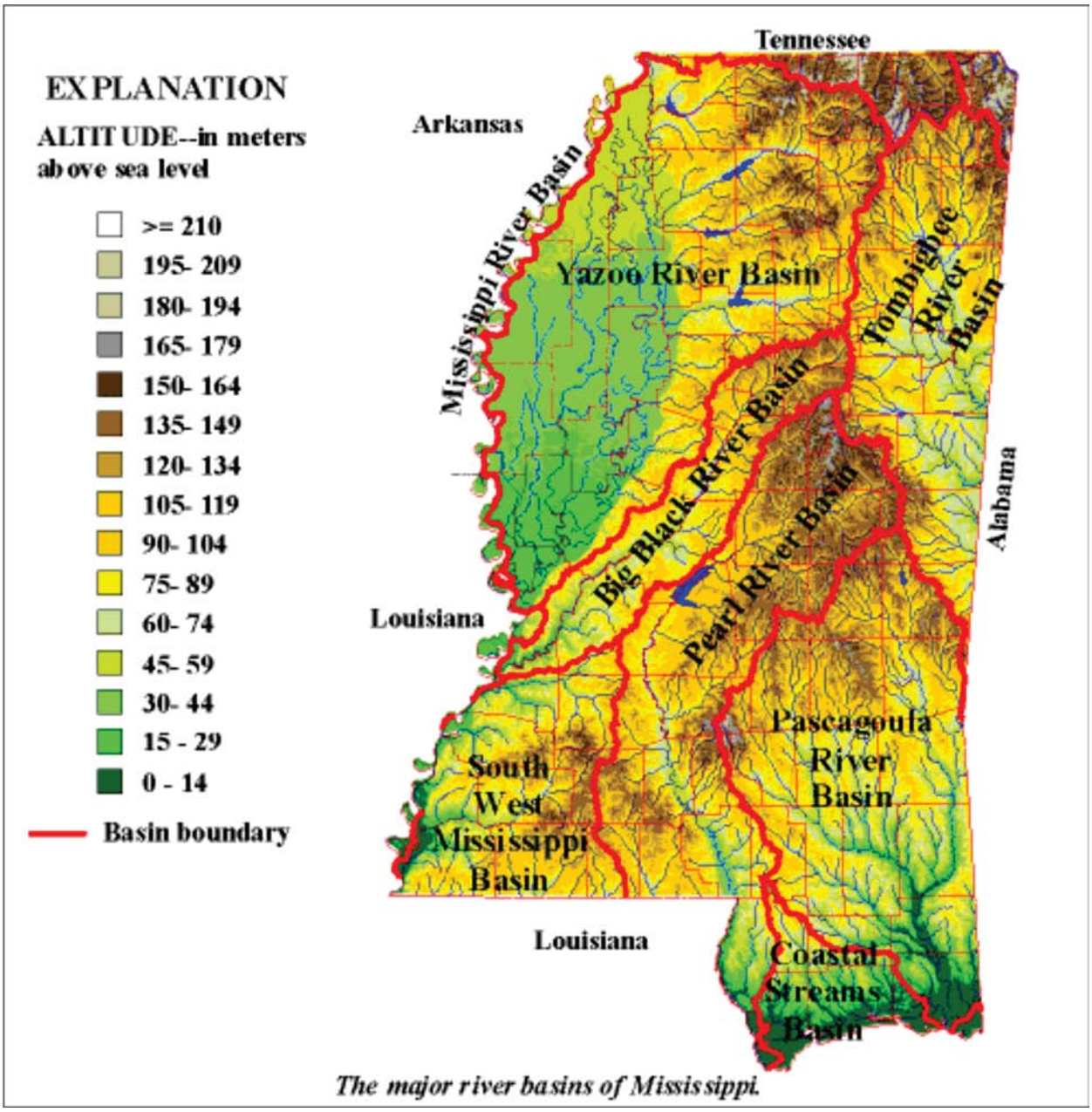


Figure 1. The ten major drainage basins within Mississippi, as defined by USGS. Invasive species often spread throughout the connected waterways within and throughout drainage basins. Map by USGS, 2008.

3.B.2 Tennessee River Drainage Basin

Located in the extreme northeastern corner of the state, this drainage basin includes the Tennessee River and small and medium stream categories. Small streams are categorized as drainage basins of less than 75 square miles and medium streams are categorized as drainage basins that do not exceed 1,000 square miles. These streams are unique within Mississippi due to their location in the fall line hills of northeast Mississippi. The Tennessee River barely enters Mississippi on its way north to an ultimate discharge in the Ohio River.

3.B.3 Yazoo River Drainage Basin

The Yazoo River is the largest river in this drainage basin; however, portions of the Big Sunflower, Tallahatchie, Yocona, Yalobusha, and Coldwater rivers are also located within this drainage basin. All the rivers of the basin eventually empty into the Mississippi River. A majority of the streams within this area have been channelized and/or impounded. This drainage basin is comprised of small, medium, and large streams and covers an area of about 13,400 square miles in northwestern Mississippi.

3.B.4 Tombigbee River Drainage Basin

The largest channels within this drainage basin include the Tombigbee River and associated Tennessee-Tombigbee Waterway. Many of the tributaries in this area have been altered by channelization. The Tombigbee River ultimately flows to the Mobile River and enters Mobile Bay in Alabama. This drainage basin consists of small streams, medium streams, and large streams. The basin covers an area of about 6,000 square miles in northeastern Mississippi.

3.B.5 Big Black River Drainage Basin

The Big Black River (largest stream in drainage basin) is located east and south of the Yazoo River and is less modified than many streams in the state, although most tributaries to the Big Black River in this drainage basin have been channelized. Headwaters of the Big Black River are located in north-central Mississippi, and the river flows in a southwestward direction to the Mississippi River. This drainage basin is comprised of small, medium, and large streams and covers an area of about 3,400 square miles.

3.B.6 Pearl River Drainage Basin

The Pearl and Yockanookany rivers are the largest stream systems in this drainage basin. Ross Barnett Reservoir, an impoundment of the Pearl River, is located in this drainage basin. This area is comprised of small, medium, and large streams and covers an area of about 7,800 square miles. The Pearl River discharges into the Gulf of Mexico.

3.B.7 South Independent Streams Basin

This drainage area is located in southwest Mississippi, and differs from many other basins because its streams and creeks do not flow into a single main stream within the basin. The Homochitto River is the major river of the basin, but it also includes Bayou Pierre, Coles Creek, Buffalo River, and the east and west forks of the Amite River. Streams in the northern portion of the basin drain into the Mississippi River, while those of the southern portion drain into Lake Maurepas and Lake Pontchartrain in Louisiana and ultimately to the Gulf of Mexico. This drainage basin consists of small, medium, and large streams and covers an area of about 4,300 square miles.

3.B.8 Pascagoula River Drainage Basin

This area includes major stream systems such as the Pascagoula, Leaf, and Chickasawhay rivers, all of which ultimately discharge to the Gulf of Mexico. A large portion of this drainage is free-flowing and is comprised of the following stream system types: small, small blackwater,

medium, medium blackwater, and large. It covers an area of about 8,800 square miles in southeastern Mississippi.

3.B.9 Coastal Streams Drainage Basin

The streams and creeks of this basin do not all flow into a single main stream, but most discharge directly into the Gulf of Mexico. The basin includes Bayou la Croix, Tuxachanie Creek, and the Biloxi, Little Biloxi, Wolf, Jourdan, and Tchoutacabouffa rivers. All of these rivers and associated tributaries are blackwater streams and have been intensely impacted by human activities. This area consists of small blackwater streams and medium blackwater streams and covers an area of about 1,545 square miles in extreme southern Mississippi.

3.B.10 Mississippi River Drainage Basin

This drainage basin, which is located along the channel of the Mississippi River, includes the largest river in the United States. In comparison with the relatively small sizes of the other nine drainage basins, the Mississippi River has a huge drainage area of greater than one million square miles.

3.C Land Cover

The Mississippi Gap Analysis Project (MS-GAP) began in 1996 as an effort to assess the distribution and conservation status of biodiversity in the state under existing land ownership and management regimes. A major objective of the project was to map vegetation cover types separation within the physiographic provinces. That project resulted in recognition of at least 50 natural land cover classes within Mississippi. These cover classes included a wide range of types, including various types of pine forest, mixed forest, deciduous forest, pasture, grassland, upland scrub/shrub, barren land, and other land. Figure 2, which is based on the MS-GAP project, provides a more generalized approach to mapping distribution of land cover types in the state.

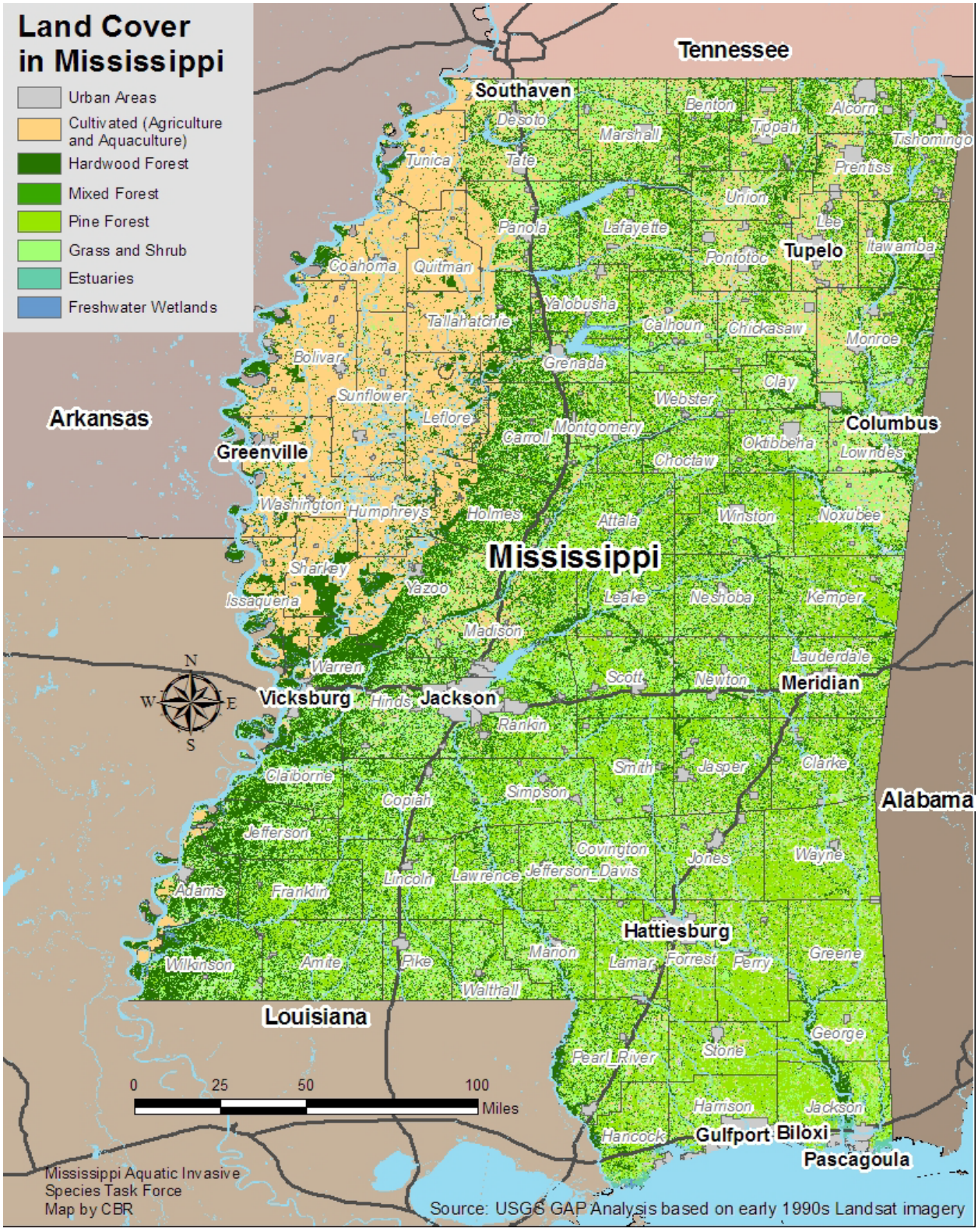


Figure 2. Map illustrating eight major land cover types in Mississippi. Map by CBR, 2007.

4 Problem Definitions

This chapter describes the scope of Mississippi's invasive species problem, in terms of pathways and media (how species arrived here), species and groups of species (which biota prove most problematic), and exacerbating circumstances (what other factors intensify this problem).

4.A Important Definitions Related to Invasive Species

It is important to define several terms that are used throughout the Plan. Each of these terms is defined in Section 11 (Glossary of Terms), but the following paragraph is an attempt to focus on the interrelationships among several of the terms.

A nonnative, or nonindigenous, species is defined as a species that has entered an ecosystem beyond its historic range.[3] The term "historic range" is defined as the area thought to have been occupied by an organism at the time of European colonization of North America. In some instances, a nonnative species may not have been present on the North American continent until during or after European colonization. In other cases, a nonnative species may have been present in some part of North America but not within the present boundaries of Mississippi. The concept of historic range, therefore, is used as a primary basis for distinguishing native species from nonnative species. For the purposes of this Plan, "nonnative species" and "nonindigenous species" are considered synonymous.

An invasive species is defined as a species that is nonnative (or alien) to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health.[4] For a species to be considered invasive, it must be a nonnative species introduced to an ecosystem in some manner, allowed to establish itself in the wild, achieve reproduction and increase in range and extent, and exert a negative impact or economic or ecologic effect. For the purposes of this Plan, an invasive species is always nonnative. In the rare instance of a native species causing economic or ecological harm or harm to human health, the species would be considered a nuisance species, not an invasive species. A nuisance species is one that threatens diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent upon such waters. For the purposes of this Plan, the terms "invasive species" and "nuisance species" will be considered synonymous when the species in question is nonnative. No native species are addressed in this Plan.

4.B Mechanisms of Introduction

4.B.1 Shipping

Shipping pathways, which play roles in numerous species translocations (and nearly all prior to the 20th century), are relevant to invasive species management because they offer preventative opportunities when an accidental introduction is at its most controllable stage. "Shipping" as a pathway refers not exclusively to hull fouling, ballast water, or packing materials (these phenomena are considered "media"), but rather to the network of waterways, shipping trends, and the port infrastructure through which waterborne vessels deliver and obtain cargo (including infested media) — and therefore may spread species into new habitats. Three major shipping pathways transect Mississippi: the Gulf Coast in the south, the Mississippi/Yazoo river system along the western border, and the manmade Tennessee-Tombigbee Waterway connecting the Tombigbee and Tennessee rivers in the northeastern quadrant of the state.

Mississippi's shipping industry generates $1.4 billion for the state (almost 3% of the gross state product) and directly or indirectly employs 34,000 Mississippians.[5] Sixteen public ports operate throughout the state (Figure 3): four along the Gulf Coast (Bienville, Gulfport, Biloxi, and Pascagoula), six along the Mississippi/Yazoo (Natchez/Adams, Claiborne, Vicksburg, Yazoo, Greenville, and Rosedale), and the remainder along the Tenn-Tom Waterway, including the ports of Lowndes County, Clay County, Aberdeen, Amory, Itawamba, and Yellow Creek.

Figure 3. Mississippi's main navigable waterways are the Mississippi River, Tennessee-Tombigbee Waterway and the Gulf of Mexico. The state is home to four Gulf ports and 12 inland ports. The four coastal ports handle bulk cargo, break-bulk cargo, and containerized cargo, arriving on barges or larger ocean-going vessels. The inland ports generally handle bulk and break-bulk cargo shipped on barges. Each type of cargo has its own invasive species implications. Map by CBR, 2007.

Three types of cargo flow through Mississippi's ports, each with an invasive species implication. The four coastal ports handle bulk cargo, break-bulk cargo, and containerized cargo (much of it refrigerated), arriving on barges or larger ocean-going vessels. The inland ports generally handle bulk and break-bulk cargo shipped on barges.

Bulk cargo is unpackaged cargo that is piled or pumped into a vessel's hold and handled in non-unitized mass, such as coal, petroleum, gravel, and grain. It may be solid, granular, pulverized, liquid, semi-liquid, or gaseous in form. Bulk cargo itself sometimes serves as media for species introduction—wood chips and plant matter may harbor insects, snails, slugs, and plant pathogens; gravel, grain, and fibers may harbor seeds and weeds[6]—but a more serious impact comes from heavy bulk cargo's need for more ballast water, which is one of the most problematic media of invasive species in shipping pathways.

Break-bulk cargo is loose cargo unitized into crates, cartons, boxes, bags, or staked pallets, which are stored in the hold and handled in a piece-by-piece manner. Examples may include textiles, retail merchandise, rubber, lumber, equipment, and any other unitized goods that are not containerized. Break-bulk cargos are often associated with species introduction because the varied nature of their unitization makes them permeable and penetrable by insects, seeds, etc. and the dunnage in which they are packed is susceptible to infestations (For more information about dunnage, please refer to 4.B.6 Media: Other, Dunnage).

Containerized cargo is packaged into boxcar-like containers, available in two standardized sizes, which are handled in a mass-production mode, regardless of contents. Starting in the 1960s, ports began a revolutionary movement toward this standardization at the expense of traditional ship-hold storage of break-bulk and bulk cargo. Even liquid and gas cargo may be containerized in special tank-fit units. While containerization of ships and port facilities requires massive changes of costly equipment, the savings in labor and increase in efficiency has more than offset the costs. Gulfport is Mississippi's premier containerized cargo port (and third busiest on the Gulf Coast), handling around 200,000 containers annually before Hurricane Katrina.[7] From an invasive species standpoint, containerization offers some benefits, because (1) the container itself often serves to contain not only its contents but hitchhiking organisms as well, preventing their release into the environment, and (2) containers use fewer wooden crates, burlap, grass, and other dunnage compared to equivalent quantities of traditional break-bulk cargo. For example, coffee used to be stored in burlap sacks piled in holds or containers, but now is more often blown into containers lined with plastic, a material less likely to harbor organisms than burlap. Additionally, a manifest is prepared for all contents of all containers no matter what their stage of shipment; this document may be used to identify those containers more likely to harbor introduced organisms. However, containers present the following problems:

- Containers are difficult to inspect because cargo must be fully unloaded and reloaded. It is the responsibility of the US Bureau of Customs and Border Protection, formerly the US Customs Service, to inspect containers. (Effective March 1, 2003, all border agencies in the United States Government, including the US Customs Service, were unified into one agency — the US Bureau of Customs and Border Protection [CBP]. The CBP is housed within the Department of Homeland Security.);
- Containers are usually not cleaned after each unloading;
- Full containers often sit idle for long periods of time on wharves near species-rich waterbodies, during which time organisms may enter, settle, and reproduce; and
- Because containerized cargo (unlike break-bulk cargo) is usually unloaded at destination ports rather than at entry ports, containers can release introduced species at numerous small interior points, rather than at major entry points such as New Orleans. In essence, containerization has partially reversed the geography of species introduction.

An entry port is a designated place where a ship may lawfully enter a country, and is where the paperwork is processed and customs inspections occur. A destination port, however, is where the cargo from a ship is actually unloaded. This distinction is of importance with regard to containerized cargo (as opposed to bulk cargo). Paperwork for these large containers is processed at the entry port, but the cargo containers are not actually opened until arriving at the destination port. It is at the numerous destination ports that potential nuisance organisms can be released.

Containerized shipments of used tires were the origin of the Asian tiger mosquito introduction in the late 1980s. Additionally, "at least 15 percent of the snails and slugs intercepted by Federal agriculture inspectors between 1984 and 1991 were in freight containers."[8]

Much of the cargo arriving to Mississippi ports, such as iron ore, sulphur, salt, sand, stone, and other bulk commodities, does not serve as a favorable media for living things and does not warrant special attention from invasive species managers. The major cargos that *may* serve as media for unwanted species are shown in bold type below, organized by the major cargos that have been reported as handled by selected Mississippi ports:

Aberdeen	synthetic slag, potash, bentonite clay, soybeans, **logs**, crude oil, diesel, gasoline
Bienville	twine, food products, coal, fabricated steel products, **lumber**, plastic resin, ferric sulphate, chemicals
Claiborne	**forest products**, **pulpwood**, feed grains, agricultural products
Clay	rock salt, soybeans, corn
Greenville	potash, rice, corn, wheat, grain feed ingredients, fertilizer, scrap
Gulfport	petroleum products, chemicals and products, **forest products**, **pulp and waste products**, sand, rock, stone, iron ore and scrap, non-ferrous ore and scrap, sulphur, clay, salt, paper products, iron and steel products, non-ferrous products, **wood products**, grain, processed grain, feed, meat - fresh, and frozen, **green fruit and other agricultural products**, machinery, equipment
Lowndes	caustic soda, chemicals, coal, aggregate, **wood chips / bark, forest products**, PVC powder, **wood pulp/fiber**, steel
Natchez/Adams	grain, **liner board**, **wood pulp, logs, plywood / lumber**, fertilizer, hydrate (alumina), activated alumina, liquid (caustic soda)
Pascagoula	steel, refrigerated meat, **wood pulp, liner board, lumber, plywood**, machinery and equipment, chemicals, bulk grains, natural rubber
Rosedale	steel coils, steel coil rods, soybeans, rice, aggregates (rock)
Yazoo	agricultural lime and rock, fertilizer, dry amitrate, liquid fertilizer, manufactured products, **wood chips, bark**
All other ports did not report major cargos. Source: Mississippi Department of Transportation. Mississippi Ports Online http://www.mdot.state.ms.us/ports/default.htm, visited May 30, 2006.	

Gulfport is Mississippi's busiest port and the state's premier connection with tropical regions. Created on undeveloped coastal land in 1887 (as opposed to Mobile and New Orleans, which developed because of their natural port advantages), Gulfport became in the early 20th century "the world's leading exporter of yellow pine,"[9] harvested to the point of depletion from the pine savannahs of southern Mississippi. Importation of bananas and other tropical fruit from Central America then became the port's forte, and with containerization and other technological improvements in the 1970s, Gulfport exploited its convenient position on the Gulf to grab the lucrative banana-importation business from the Port of New Orleans. Gulfport is now a top importer of bananas nationwide. The state-owned facility is critical to Mississippi's economy. It also represents, as all ports do, a potential pathway of species into the state. Because of Gulfport's relatively recent history, it has evaded the levels of accidental species introductions seen at the much older and bigger ports of Mobile and New Orleans. Nevertheless, the high level

of interaction with tropical regions and the large quantity of green fruit arriving to Gulfport make it a place of interest with regard to invasive species prevention.

The shipping pathway that puts Mississippi at greatest risk in terms of species introduction comes not from ports on Mississippi soil, but the state's terrestrial connections to neighboring states with even busier port systems. The confluence of waterways in adjacent Louisiana and sheer magnitude of waterborne shipping in that state have unintentionally made shipping the premier pathway for accidental species introductions to Louisiana. Texas, Louisiana, Mississippi, Alabama, and Florida together form the premier gateway of foreign shipping to America, making the sub-tropical Gulf Coast (with Mississippi positioned in the middle) that much more susceptible to accidental species introduction via shipping pathways. Invasive species such as Formosan termites, water hyacinth, and cogongrass first arrived by ship to either New Orleans or Mobile, but because of pathways *other* than shipping, all three species are now well established in Mississippi.

Thus, Mississippi must employ standard techniques and inspections to prevent unwanted species from arriving from the tropics or elsewhere via fruit importations, or from being transported within the state via wood chips or lumber on barges. But the greater challenge for Mississippi is to prevent unwanted species which arrived via shipping to *other* Gulf ports from invading Mississippi via the other pathways described in this Plan.

4.B.2 Boating

Recreational boating (see Figures 4 and 5) is a pathway by which invasive species may spread throughout Mississippi's waterways. By not thoroughly washing or rinsing boats and boat trailers, boaters can easily transport aquatic weeds, zooplankton, and mussels, particularly immature (veliger) stages, from one waterbody to another. In fiscal year (FY) 2010, more than 550,000 boaters, fishermen, and hunters registered with MDWFP. Mississippi is also at risk for invasive species introductions from boaters and fishermen from neighboring states with similar ecosystems and climates; the proportion of non-resident fishing licenses sold in FY 2010 (recreational and commercial) was about 15%. Non-resident boat registrations are included in the total boat registrations.[10]

Table 1. Mississippi Fishing License and Boating Registration in FY 2010.

License Type	Number Sold in FY 2010	Revenue
Recreational Freshwater Fishing (Resident)	276,750	$5,630,809
Commercial Freshwater Fishing (Resident)	658	$19,740
Recreational Freshwater Fishing (Non-resident)	46,567	$1,148,611
Commercial Freshwater Fishing (Non-resident)	31	$6,200
Total Freshwater Fishing Licenses	**324,006**	**$6,805,360**
Recreational Saltwater Fishing (Resident)	57,458	$574,580
Commercial Saltwater Fishing (Resident)	1,331	$117,865
Recreational Saltwater Fishing (Non-resident)	10,931	$243,330
Commercial Saltwater Fishing (Non-resident)	378	$85,610
Total Saltwater Fishing Licenses	**70,098**	**$1,021,385**
Boating (Resident)	NA	NA
Boating (Non-resident)	NA	NA
Total Boat Registrations	**156,300**	**$847,260**

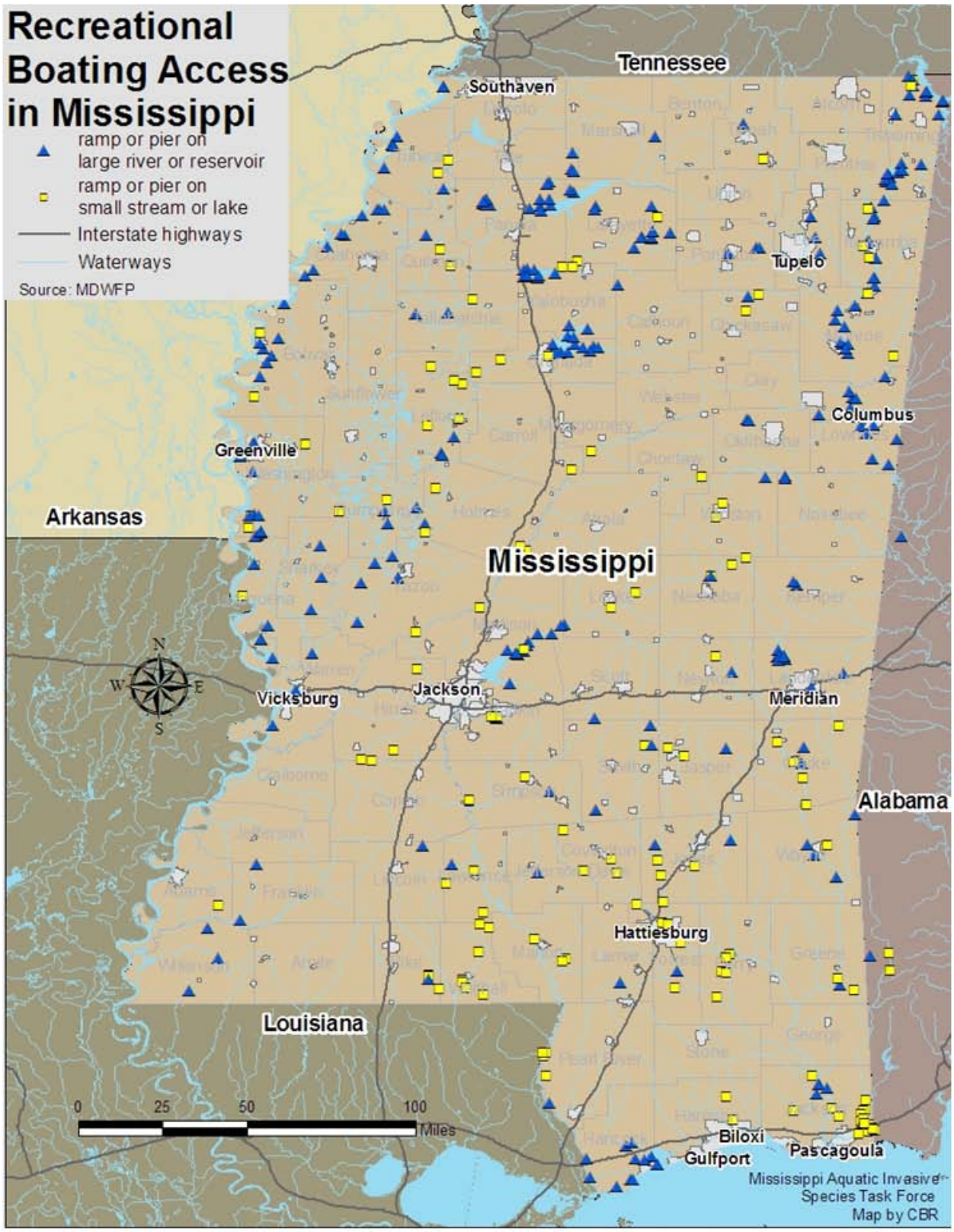


Figure 4. Mississippi's vast network of waterways supports both recreational and commercial fishing. The sportfishing industry brought $488 million to the state in 2006, providing over 5,000 jobs and generating over $28 million and $27 million in state and federal income taxes, respectively. Map by CBR, 2007.

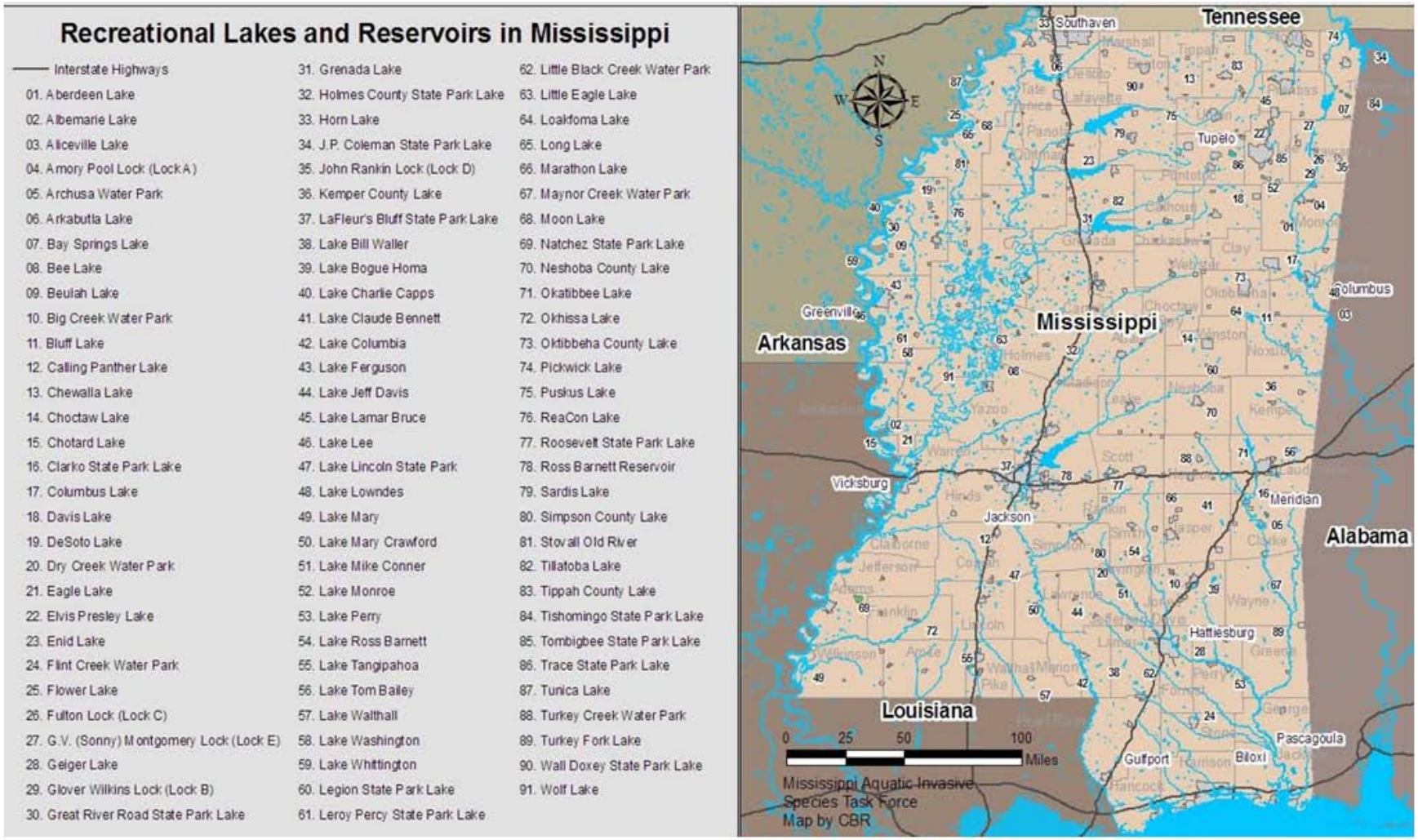


Figure 5. Mississippi has 91 recreational lakes and reservoirs. Recreational boaters who do not thoroughly rinse their boats after use could potentially transport an invasive species to the next body of water that they visit. Map by CBR, 2007.

The Gulf Coast is home to some of the most productive fisheries in North America. In 2006, Mississippi waters provided recreational opportunities to about 626,000 total anglers, of whom 81% were freshwater fishermen. The total economic impact of sportfishing to Mississippi in 2006 was estimated at over $488 million, providing over 5,000 jobs, and generating over $28 million and $27 million in state/local and federal income taxes, respectively.[11]

Commercial fishing license sales alone generated more than $229,000 in revenue in FY 2010. Combined with sportfishing, hunting, and recreational boating from both in-state and out of state, the total revenue generated by license sales in FY 2010 was more than $8.6 million.[12] Similar to recreational boating and fishing, the attraction of commercial fishermen to Mississippi from neighboring states increases the potential for an invasive species to become established in state and coastal waters. (For more information on fishing as a pathway for invasive species, see Section 4.B.8, Deliberate Introduction: Fishing.)

4.B.3 Natural Disasters

Hurricane Katrina made landfall on Monday, August 29, 2005, and devastated the Mississippi-Louisiana Gulf Coast. In addition to the multitude of tragedies caused by the storm, many invasive species concerns are surfacing, particularly regarding range expansions and/or potential introductions. Data are still being collected to determine the invasive species impacts from the storm, but some species of concern include Chinese tallow tree, cogongrass, Formosan termites, giant salvinia, and tilapia.

From an environmental standpoint, one primary impact from Hurricane Katrina was large-scale habitat disturbance. Hurricane force winds toppled many large trees, creating openings in forest canopy. Because it is a pioneer species, biologists are concerned that the Chinese tallow tree may capitalize on this opportunity for space in the canopy and quickly take the place of native trees. In some cases, natural resource managers fear that the use of construction equipment to cleanup hurricane debris may cause worse habitat destruction than the storm itself, by tearing up tracts of land and uprooting plants, thus allowing new species to encroach the areas. In some cases, the construction equipment, transporting hurricane debris, dirt, or mulch produced from fallen trees, may be the source of new introductions. In Louisiana, cogongrass is being spread in this manner, and this has been a well-documented pathway for fire ants as well. Formosan termites may also be spread from New Orleans to Mississippi and other adjacent states through the transport and dumping of infested wood from demolished homes, fallen trees, or ground-up debris sold as mulch.

In summer 2005, prior to Hurricane Katrina, a giant salvinia infestation was discovered in the lower Pascagoula River system. Wildlife officials believed the infestation was too large to be eradicated from the river.[13] After the storm, most of the giant salvinia was gone, and officials from the Mississippi Department of Marine Resources (MDMR) have been surveying other parts of the drainage to determine if the salvinia was pushed further upriver by the storm surge, or if the influx of saltwater from the Gulf of Mexico was enough to kill it. To date, 13 sites in the Pascagoula Drainage are being monitored and treated for giant salvinia[14] (see Section 4.C.1.b.i, Giant Salvinia).

A few aquaculture facilities in Mississippi have open ponds or tanks that may have been impacted by storm surge, flooding, elevated levels of salts in rainfall, or some other sort of damage. Nonnative, cultured fish species, such as tilapia, may have escaped from the ponds during the flood period. It has been reported that an Australian red claw crayfish grower suffered a total kill of the crop, with the damage caused by saltwater rain from the storm. Australian red claw crayfish begin to suffer at 5 ppt salinity with complete mortality at occurring 18 ppt salinity. (For more information on tilapia and Australian red claw crayfish, see Section 4.C, Species of Concern). Further assessment is required to determine the impacts of Hurricane Katrina on invasive species in Mississippi.

4.B.4 Transportation Corridors

There are 2,459 miles of railroad in Mississippi and 26 railroad companies (Figure 6). In 2005, over 12 million tons of freight carried on over 170,500 rail carloads originated in Mississippi and terminated outside of the state, while over 18 million tons of freight carried on over 215,800 rail carloads originated outside of the state but terminated in Mississippi. The major commodities originating in Mississippi and shipped by rail were chemicals (27%), lumber and wood products (26%), and pulp and paper products (19%).[15]

Mississippi has 10,974 miles of state-maintained roads, and 74,408 miles of Mississippi roads are maintained by local, county, and other agencies[16] (Figure 6).

Mississippi has four international airports. These include the Gulfport Biloxi International Airport, Jackson-Evers International Airport, Stennis International Airport (in Bay St. Louis), and Trent Lott International Airport (in Pascagoula).

Mississippi has four commercial shipping waterways within and bordering the state. These include the Gulf Coast, the Mississippi River, the Yazoo River, and the Tombigbee River (and associated Tennessee-Tombigbee Waterway).

Invasive species may be introduced or spread through transportation corridors such as highways, railroads, airports, and navigable waterways and their associated rights-of-way. Cogongrass is an example of an invasive species that spreads along highway rights-of-way, migrating from Mississippi to Louisiana by exploiting the disturbed soils shouldering the Interstate 10 corridor. Its continued expansion is partially due to the transport of dirt and soil containing cogongrass tubers to new, uninfested locations.

It is interesting to note that Formosan termites have expanded their range through railroads and railroad ties by infesting one tie to the next. Instances of termite range expansion also have been documented when old, infested railroad ties were transported to a new, uninfested location, frequently for use in gardening and landscaping. In these examples, the railroads served both as the pathway and as the media for invasive species introductions.

4.B.5 Media: Ballast Water

Ballast is weight stored in the hold of a ship to prevent capsizing when its cargo load is light. Sea water is often used as ballast for large ocean-going vessels, which discharge the ballast water in anticipation of new cargo. Discharging ballast water into new maritime environments has been shown to introduce new species, some of which have become invasive. Because of invasive species concerns, some regions require mandatory ballast water exchange, in which ships must discharge their ballast in the open ocean and take on new ocean water ballast before coming to port. Although no known introductions of invasive species have occurred directly to Mississippi via ballast water discharges, it may only be a matter of time before such an introduction.

The National Invasive Species Act of 1996 (NISA) originated as the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 (NANPCA). NISA expired in September 2002 and was considered for reauthorization in Congress in the 2005-2006 session. Senate Bill 725, the National Aquatic Invasive Species Act of 2007 (NAISA) that would have reauthorized NISA, was read twice and referred to the Committee on Environment and Public Works on March 1, 2007. Unfortunately, NAISA did not become law.

Figure 6. Transportation corridors are a pathway for the spread of invasive species. The cleared shoulders alongside interstates are prone to invasion by weeds such as cogongrass. Another example is the Formosan termite, which has spread through railroads by infesting one railroad tie after another. Map by CBR, 2007.

NISA did not require ships traveling along US coastlines within US waters to either exchange or treat their ballast water unless they were destined for the Great Lakes. Because most ships that travel the Gulf of Mexico never leave US waters, the Gulf never benefited from NISA's strongest features. Ships operating outside the US waters were not required to exchange or treat their ballast water, although they were encouraged to do so, but were required to submit a statement as to whether they had or had not exchanged or treated their ballast water.

According to NISA, ships entering US waters from outside the Exclusive Economic Zone (EEZ) are not required to perform ballast water exchange, though reporting is mandatory. NISA, however, designated the Gulf of Mexico as a "sea" instead of an "ocean," thus exempting the Gulf from ballast water reporting regulations.[17] Because of this exemption, ballast water reporting for ships entering Gulf of Mexico ports has traditionally been low.

When the US Coast Guard (USCG) tightened ballast water regulations in 2004, the new regulations imposed monetary penalties for reporting violations and required ballast water management practices, some of which were formerly voluntary. Currently, all ships entering US waters from outside the EEZ must either:

- Perform complete ballast water exchange;
- Retain ballast water onboard; or
- Utilize an alternative, USCG-approved method of ballast water treatment before entering US waters.

USCG believes "defining mid-ocean ballast water exchange as taking place at least 200 [nautical miles] from shore allows more vessels to conduct exchange and simplifies enforceability."[18] This rule supercedes earlier regulations which restricted exchange to areas that were at least 200 nautical miles offshore *and* deeper than 2,000 meters (6,562 feet).[19] Despite the NISA exemption for the Gulf of Mexico, the new USCG rule applies to all ships entering US waters, including the Gulf of Mexico, from outside the EEZ, but for the following exemptions: crude oil tankers engaged in coastwise trade; Department of Defense, USCG, and armed service vessels; and vessels that operate solely in one USCG Captain of the Port (COTP) zone.[20] The COTP is designated by the USCG Commandant to direct USCG law enforcement activities within a designated area of responsibility. A COTP enforces regulations for the protection and security of vessels, harbors, and waterfront facilities; anchorages; bridges; safety and security zones; and ports and waterways.

Despite these regulations, risk remains for species introduction through ballast water exchange. Researchers estimate that at least 7,000 species of marine life are transported around the world everyday, and ballast water arrives in the United States at a rate of 2 million gallons per hour.[21] Oil tankers are exempt from the above rules, as are military vessels and passenger ships with ballast water treatment systems.[22] Also, the new exchange requirement does not include coastwise trade, meaning that vessels traveling from the Caribbean to Gulf ports along continental coastlines will not be required to perform ballast exchange.

One of the few regional studies on this issue was conducted in 1998 by Battelle Memorial Institute (Battelle) for EPA's Gulf of Mexico Program. Battelle attempted to approximate the volume of ballast water discharged at five major ports in the Gulf of Mexico: Houston, Lower Mississippi, Gulfport, Mobile, and Tampa. In 1996, at the Port of Gulfport, Battelle estimates that the total ballast water discharge from ocean-going vessels was 17,830 metric tons. This equates to approximately 4.7 million gallons per year, or about 536 gallons per hour. [23]

4.B.6 Media: Other

Fouling organisms, such as barnacles, mussels, sponges, coelenterates, annelids, algae, and seaweeds, can attach to vessels, dry docks, and drilling platforms. The worldwide transportation

of vessels and infrastructure sometimes carries fouling species across oceans, a trip they normally would not survive if drifting on their own. The potentially high biological diversity of fouling organisms on ships led Godwin to describe ocean vessels as "biological islands" for organisms living in ports and estuaries.[24]

Dunnage is any loose packing material used to support and protect cargo from movement, moisture, contamination, or other damage. Dunnage can be made of wood, straw, plastic, Styrofoam, jute and other fibers, rice matting, tarpaulins, or bags. *Floor dunnage* protects moisture-sensitive cargo such as coffee, tea, and tobacco from water that may accumulate in the cargo hold. *Lateral dunnage* fills gaps between cargo. *Interlayer dunnage* is placed between cargo layers to prevent contamination of underlying cargo from top cargo. *Top and side dunnage* protects cargo against moisture, condensation, and contamination at the top and sweating side walls of the cargo hold.[25] Dunnage is a more likely media for invasive species than the cargo itself, or the dunnage may itself be an invasive species.
Some problematic dunnage materials include:

- Wooden pallets or crates
- Jute coverings
- Paper
- Straw
- Matting
- Squared lumber
- Planks or boards

Several invasive species in Mississippi and the Gulf South arrived via dunnage. The premier example is the Formosan termite, which was introduced through infested wooden pallets (floor dunnage) during World War II. Another example is cogongrass, accidentally introduced to Mobile, Alabama, when it was used as a packing material in shipping crates. Now spreading across the Gulf South, cogongrass can be found in over half of Mississippi's 82 counties. The red imported fire ant, known for its painful sting and aggressive behavior, was introduced in dunnage and ballast soil to Mobile in the 1930s, and quickly spread throughout the southern United States by transport of nursery stock and relocation of construction and landscaping equipment.[26] Crates used for break-bulk cargo also serve as media; 11% of the mollusks intercepted by inspectors in the late 1980s arrived on crates.[27] Tropical plywood piled high in riverside warehouses awaiting shipment may also offer infestation opportunities

4.B.7 Introduction: Aquaculture

Species are introduced to new environments either accidentally or deliberately. Accidental introductions arrive through pathways such as those listed in the previous sections. Deliberate (or intentional) introductions are purposely brought in by humans, usually for economic gain and with little consideration for how the species may affect natural ecosystems. Deliberate introductions occur in the context of the aquaculture, agriculture, and fishing industries; aquarium and pet industries; gardening and landscaping; and others.

Aquaculture is a major industry in Mississippi, and the state leads the nation in farm-raised catfish production, raising channel catfish (*Ictalurus punctatus*), blue catfish (*Ictalurus furcatus*), and channel catfish X blue catfish hybrids. According to Mississippi State University (MSU) researchers, as reported by the Mississippi Farm Bureau (MFB), "in 2003, state farm production value of catfish was estimated at $255 million. In 2000, our catfish industry generated about 7,000 jobs for a total of $102 million in wages… These figures represent jobs directly associated with the production and processing of catfish and do not include the many jobs created in local business that support the industry."[28] In 2010, there were 994 catfish farms in the United States,

totaling approximately 115,100 acres and generating $402.5 million in sales revenue. Mississippi's catfish industry comprised about 64,000 acres (about 56% of the US total acreage), and generated over $217.7 million in sales (about 54% of the US total).[29]
The Mississippi counties with the most catfish pond acres are Humphreys, Leflore, and Sunflower, but at least four other counties have more than 1,000 acres of catfish ponds.[30]

Other cultured species in Mississippi include freshwater prawns, tilapia, hybrid striped bass, and Australian red claw crayfish. Tilapia, due to their cold intolerance are raised in tanks, with the producers located primarily in southern Mississippi. Freshwater prawn production is ongoing during the summer primarily in the Delta region and southern Mississippi. One facility in Jackson County currently raises Australian red claw crayfish.[31]

While some of these species, such as catfish, are native to Mississippi and provide tremendous economic benefit, some nonnative species, including tilapia, may pose a threat to natural resources if the species escape cultivation. Tilapia can out-compete native fish for food and habitat and may also alter ecosystems and food webs. In addition, although catfish are native, sometimes Asian carp species are introduced to the aquaculture ponds as a biocontrol for snails, parasites, and aquatic plants.[32] If these "biocontrol species" escape cultivation, the natural environment may be adversely impacted.

4.B.8 Introductions: Fishing

The popularity of freshwater fishing puts the freshwater fisheries most at risk from invasive species introductions; therefore commercial fisheries and marine sportfish will not be included in this section of the Plan.

Fish Stocking for Sportfishing — According to the American Sportfishing Association, in 2006, the total economic impact of freshwater sportfishing to Mississippi was over $375 million.[33] Some popular fish species are deliberately stocked by MDWFP to ensure larger numbers for sportfishing. Some stocked species are nonnative, but few are considered invasive. On the contrary, most are regarded as beneficial and commercially valuable, such as striped bass (*Morone saxatilis*), which is native to some parts of southeastern Mississippi but has been stocked in other waterbodies in the state. Striped bass inhabit pelagic habitats of large reservoirs that are seldom occupied by native species and help control gizzard shad (*Dorosoma cepedianum*) to produce a prey of more suitable size for native species.[34]

The USGS Nonindigenous Aquatic Species database reports hybrid striped bass, striped bass, white bass, wiper, smallmouth bass, green sunfish X bluegill hybrid, sauger, walleye, rainbow trout, tench, yellow perch, and landlocked Atlantic salmon as being stocked in Mississippi for sportfishing. Of these species, hybrid striped bass, green sunfish X bluegill hybrid, rainbow trout, sauger, and striped bass have been reported as established species.

MDWFP, however, reported that they do not stock white bass, smallmouth bass, green sunfish X bluegill hybrid, sauger, rainbow trout, tench, yellow perch, or landlocked Atlantic salmon in the state of Mississippi.[35] These species, if stocked in the state, represent stockings by entities other than MDWFP. MDWFP data for 2010 state stockings indicate that, of the 2.48 million sport fish stocked in Mississippi, a total of 248,200 were hybrid striped bass.[36]

MDWFP has been stocking Mississippi lakes and streams since 1963; prior to 1963, the US Fish and Wildlife Service (USFWS) stocked public waters of the state because Mississippi did not own or operate its own fish hatchery.[37] Table 2 provides the number of fish stocked in public waters by MDWFP since 1963.

Table 2. Total Number of Fish Stocked in Mississippi Public Waters, 1963-2010.*

YEAR	NUMBER	YEAR	NUMBER	YEAR	NUMBER	YEAR	NUMBER
2010	2,480,527	1998	3,032,552	1986	4,059,860	1974	3,475,300
2009	2,461,475	1997	3,668,808	1985	2,161,920	1973	4,493,450
2008	2,193,079	1996	1,739,533	1984	2,834,748	1972	546,148
2007	1,749,826	1995	1,886,564	1983	3,318,264	1971	784,357
2006	3,983,609	1994	1,827,903	1982	2,504,480	1970	108,574
2005	1,823,031	1993	1,744,601	1981	3,125,015	1969	214,679
2004	2,945,017	1992	1,789,204	1980	2,366,717	1968	95
2003	2,152,504	1991	4,397,364	1979	3,467,413	1967	4,000
2002	1,460,099	1990	5,699,997	1978	3,221,268	1966	No Data**
2001	2,890,512	1989	2,291,539	1977	3,748,254	1965	No Data**
2000	3,232,706	1988	6,146,027	1976	3,176,800	1964	50,000
1999	2,254,987	1987	2,995,431	1975	4,699,133	1963	207,500
TOTAL = 115,414,870							

*Data provided by MDWFP.[38]
**No data are available for the years 1965-66.

It should be noted that Mississippi State Law 49-7-80 states, “No person shall stock, place, release or cause to be released into any of the public waters of the state any aquatic species without first obtaining a permit from the Mississippi Department of Wildlife, Fisheries and Parks.” It is also illegal to sell game fish for any purpose other than for stocking private fish ponds. Mississippi State Law 49-7-87 states,“The Department of Agriculture and Commerce may issue a permit to the owner of a private pond to sell fish grown or cultivated for stocking purposes only under such regulations as the Department of Agriculture and Commerce may deem necessary.”

These laws are necessary and important because accidental introductions could occur through deliberate fish stocking. Though the fish stocks themselves might not be invasive, the water used to transport them could be contaminated with invasive plants, invertebrates, or viruses. Fish stocks should be carefully inspected for such biological contaminants before relocation to a new waterbody. Fish stocking by unqualified individuals increases the chance of biological contamination. In addition to acting illegally, these individuals are less likely to adhere to regulations and standards regarding transport methods and equipment. Though there are no data to report on the magnitude of illegal attempts to start new fisheries, Carlton (2001) states that these attempts may be a significant source of introductions.[39]

A hazard analysis and critical control point (HACCP) program can be used to assess and minimize the risk of introducing aquatic invasive species when transporting and stocking live fish. USFWS Southeast Region can provide HACCP materials and training to interested parties.[40] The MAIS Task Force will evaluate the HACCP program and will work with USFWS to obtain training for interested Mississippi agencies.

Baitfish Introductions — Live bait also pose an invasive species risk. When anglers discard live bait or the bait’s packing material into a waterbody, they may inadvertently introduce an invasive species to that waterbody. These actions are sometimes referred to as “bait bucket releases” or “bait bucket dumps.” Anecdotal evidence indicates that this ostensibly small pathway may in fact contribute significantly to the invasive species problem. In some parts of the United States, discarded earthworms intended as bait may be causing significant changes in forest plant compositions.[41]

The fathead minnow (*Pimephales promelas*), a common baitfish species, is not generally regarded as invasive, but its widespread range in Mississippi and other parts of the United States is most likely due to numerous bait bucket dumps.[42]

4.B.9 Introductions: Horticulture

As accessed August 12, 2011, the USGS Nonindigenous Aquatic Species database reports a total of 39 exotic species (and four native species) for Mississippi. Sixteen species were reported by USGS as "collected" and the remaining 23 species were classified as "established." The USGS Nonindigenous Aquatic Species database uses the status term of "collected," but that does not necessarily provide adequate information to assess status of a species under field conditions. It is suspected that at least some of the "collected" species are actually "established" in Mississippi.

Of the 23 exotic plant species listed as established, we believe that three species should be excluded from the Plan for the reason that they are not aquatic species: Oriental lady's thumb (*Polygonum caespitosum*), field sow thistle (*Sonchus arvensis*), and barnyard grass (*Echinochloa crusgalli*). Oriental lady's thumb and field sow thistle are weedy nonindigenous species that are of widespread occurrence in upland habitats over much of eastern North America. Although either species can be found in a seasonal wetland habitat, neither one is found in aquatic habitats. Barnyard grass is less clear cut, although we believe it should also be excluded from the Plan. Barnyard grass is of widespread occurrence on moist soils of upland fields, waste places, and roadside ditches, although it also occurs in floodplains, river bottoms, and seasonally wet habitats. Barnyard grass will tolerate poor drainage and flooding. It is normally absent, however, from sites having standing water for periods of a month or longer.

A recent increase in interest has made water gardening one of the fastest growing sectors of the gardening and nursery industry, and sales of aquatic plants are greater than ever. This means that the sale of aquatic invasive plants is on the rise. Since there were no specific data on invasive plant sales at nurseries and watergarden stores in the Gulf South, CBR (at Tulane and Xavier universities in New Orleans) conducted an informal survey in 2003 of selected nurseries in the New Orleans metropolitan area. The surveyed businesses included two national home improvement stores, a national pet and aquarium store, and two locally owned nurseries, one of which specializes in aquatic plants and water gardens.

Although some invasive plant species were found at the nurseries, such as parrot feather, Japanese and Chinese privet, and Brazilian waterweed, several common plant species that CBR expected to find were not available. Some merchants expressed willingness to order the plants. CBR also found discrepancies in the naming of plants, which could confuse buyers who prefer native species.

University of Minnesota researchers Maki and Galatowitsch investigated the long-range transport of aquatic invasive plants through the water garden trade. They placed 40 orders with vendors across the United States, for a total of 681 individual plants, for plant species typically used by water gardeners. To determine whether current regulations are effective in preventing the sale of aquatic nuisance plants, they placed orders for species classified as noxious weeds under federal law and as prohibited exotic species under Minnesota law. Once the plants arrived, they were grown in a greenhouse for 5 weeks. The results were as follows:

- Federally listed noxious weeds and Minnesota-regulated plants were obtained in 92% of the orders requesting those species, including purple loosestrife and curly pondweed;
- Only one of 13 vendors informed the customer that he could not sell the plants because of regulations;
- Ninety percent of all purchases contained a plant species that was not specifically ordered, some of which (10%) contained banned or regulated plants, such as hydrilla, purple loosestrife, giant salvinia, or curly pondweed;
- Forty-one percent of the orders contained seeds of both ordered and unordered plants.
- Fifteen percent of the orders contained misidentified plants; and

- Other unintended organisms received were several invertebrates (snails) and some vertebrates, including two fish.[43]

4.B.10 Introductions: Agriculture

In general, agricultural commodities in Mississippi are nonnative but not invasive. Many of the most commercially important agricultural products are nonnative plants and animals including cotton, soybeans, corn, cattle, and rice. In 2000, the market value of these and other agricultural commodities (both plant and animal) was approximately $3.1 billion.[44]

Insects are the invasive pests most commonly associated with nonnative agricultural crops. Some examples include:

- The Mexican boll weevil, a cotton pest that has caused an estimated $14 billion in damage to the cotton industry since its accidental introduction from Mexico in the 1890s;[45]
- The sugarcane borer, a moth whose larvae bore into the sugarcane stalks causing plants to weaken or die. The invasive red imported fire ant is a predator of the sugarcane borer and, therefore, is favored by sugarcane farmers; and
- The sweet potato weevil, an insect whose larvae bore into and tunnel through sweet potatoes, damaging the crop and rendering it unusable.[46]

Although these insects are not aquatic and are thus beyond the scope of this Plan, it should be recognized that they cause extensive damage to important crops. USDA and the Mississippi Department of Agriculture and Commerce (MDAC) have extensive resources to control or eradicate these agricultural pests. Regarding the spread of invasive insect pests, such as the Asian long-horned beetle expanding its range within the United States, USDA has rapid response plans already in place.

4.B.11 Introductions: Aquarium and Pet Industry

Aquarium Release — The majority of plant and animal species sold in aquarium and pet stores are nonnative. These sales of nonnative species represent a "deliberate pathway," by which more than 2,000 fish species are introduced to the United States every year, primarily from Central America, South America, Africa, and southeast Asia.[47] To become invasive, the species must be released or escape, establish itself in the wild, reproduce and spread, and exert a negative impact or economic or ecological effect. Aquarium releases usually occur when an aquarium or pet owner no longer wishes to care for his or her pet; the owner chooses to be "humane" and releases the pet into a waterbody. This is sometimes referred to as "aquarium dumping."

There is a national effort sponsored by the Pet Industry Joint Advisory Council, USFWS, and the National Oceanic and Atmospheric Administration (NOAA) Sea Grant Program called "Habitattitude" (www.habitattitude.net) to encourage responsible disposal of unwanted fish and plants. Several states have used "Pet Amnesty Days" to encourage pet owners to bring unwanted pets to collection centers for safe disposal instead of releasing them into the wild.

Figure 7. Habitattitude is a national effort sponsored by the Pet Industry Joint Advisory Council, USFWS, and the NOAA Sea Grant Program.

Many nonnative fish and plants have been introduced to the United States through suspected aquarium dumping. According to USGS, "at least 185 different species of exotic fishes have been caught in open waters of the United States, and 75 of these are known to have established breeding populations. Over half of these introductions are due to the release or escape of aquarium fishes."[48]

Misidentified Aquarium and Pet Store Species — In March 2000, the Louisiana Department of Agriculture and Forestry (LDAF) discovered that the East Baton Rouge Science Resource Center, a public school entity, was using "golden apple snail" as part of an elementary school ecology project. The snails were obtained from a local pet store that sold them under the name *Pomacea bridgesi*, sometimes known as the spiketop apple snail, the Brazilian apple snail, or the albino mystery snail. However, David Robinson, Ph.D., a Plant Protection and Quarantine National Identifier with USDA's Animal and Plant Health Inspection Service (APHIS), confirmed the species to be *Pomacea canaliculata*, the channeled apple snail, an invasive species and a potential threat to the rice industry. After that discovery, LDAF surveyed 32 pet stores in Louisiana and found that 31% carried *P. canaliculata* or a closely related species under generic common names such as golden apple snail, apple snail, or mystery snail. Only one store used scientific names, but used an incorrect one for the snail species.[49] This case study illustrates the potential pathway of invasive species introductions through aquarium and pet stores, a problem exacerbated by the frequent misidentification of species by vendors.

Live aquatic plant sales are problematic as well. Hundreds of online aquarium supply websites sell thousands of nonnative plant and animal species. Many of these plants are exotics known to be invasive. A common example is the submerged aquatic plant "Anacharis," otherwise known as Brazilian waterweed. Despite the establishment of this invasive plant in 33 states,[50] it is frequently recommended as "an ideal aquatic plant for beginners" and "an excellent oxygen producer for all types of freshwater aquariums."[51] A few stores will list the states that the plant cannot be shipped to, but it is very rare for a retailer to offer an explanation as to why the plant cannot be shipped to a particular state.

Other invasive species commonly for sale on-line include water hyacinth, parrot feather, various apple snails only identified to the genus *Pomacea*. Websites also offers a fish identified as the Texas cichlid, *"Herichthys cynoguttatus"* [sic], also called the Rio Grande perch or Rio Grande cichlid.[52] Ichthyologist and Rio Grande cichlid expert Martin O'Connell, Ph.D., confirmed that the fish on one website is the Rio Grande cichlid and noted that although there is some debate over whether this species belongs in the genus *Herichthys* or the genus *Cichlasoma*, the misspelled specific epithet on the website could lead to further confusion.[53] The Rio Grande cichlid is established and becoming invasive in Louisiana's Lake Pontchartrain and the connected New Orleans drainage canals. Dr. O'Connell is concerned that the Rio Grande cichlid may expand its range and spread to Mississippi via bait dumping, aquarium dumping, or simply through waterways shared by Mississippi and Louisiana.

Solutions to these problems include education (such as signage at marinas and piers warning against aquarium dumping), internal pet industry education and self-regulation, and, as a last resort, state regulation. The Mobile District of the US Army Corps of Engineers (USACE) has posted "Stop Aquatic Hitchhikers" signs at all the Corps boat ramps along the Tennessee-Tombigbee Waterway. MDMR has also posted similar signs at all public boat ramps in the coastal area. These signs inform the public of the dangers of spreading harmful plants, animals, and other organisms that can "hitch a ride" on clothing, boats, and other items used in the water. Although these signs do not specifically address "aquarium dumping," they are a useful tool in educating the public on the dangers of spreading harmful plants, animals, and other organisms.

4.B.12 Introductions: Other

Fur Industry—Historically, native mammals, including muskrat, beaver, wild mink, fox, and bobcat, have been trapped for fur in the Gulf South. In the 1930s, fur interests and others introduced nutria to Louisiana, primarily to offer a new fur resource to the state, and secondarily as a biocontrol for the invasive plant water hyacinth. Although legend says that Tabasco Sauce tycoon E.A. McIllhenny was responsible for the escape of 20 nutria held at Avery Island, recently discovered documents indicate that fur trappers or growers deliberately released nutria at several other locations in coastal Louisiana in the 1930s and 1940s.[54]

Until about 15 years ago, nutria harvesting was so profitable that harvests exceeded one million individuals every year between 1961 and 1980, when the price per pelt hovered between $7 and $8. During the late 1970s and early 1980s in Louisiana, nutria fur harvests were a $15 million per year industry. In 1988, a few years after the price of nutria fur peaked, and the number of animals harvested annually fell, landowners began noticing an increase in the nutria population and in damage to vegetation occurring on their properties.[55]

A variety of factors contributed to the decline of the nutria market, including a series of mild winters in Europe and Russia, previously the largest importers of nutria furs; an overproduction of ranch mink, which lowered the price of mink fur; a saturation of the fur market among people most likely to purchase fur coats; and an increased preference for leather coats, particularly for women. Contrary to popular belief, the animal rights movement caused, at most, a minor impact on this decline. Despite concerted efforts to increase demand, the demand for nutria never rebounded.[56]

Over the last 20 years, this South American rodent has become one of the Gulf South's most notorious invasive species, wreaking ecological havoc on native wetland vegetation and contributing to coastal erosion problems. (For more information on nutria, see Section 4.C.4.a.i).

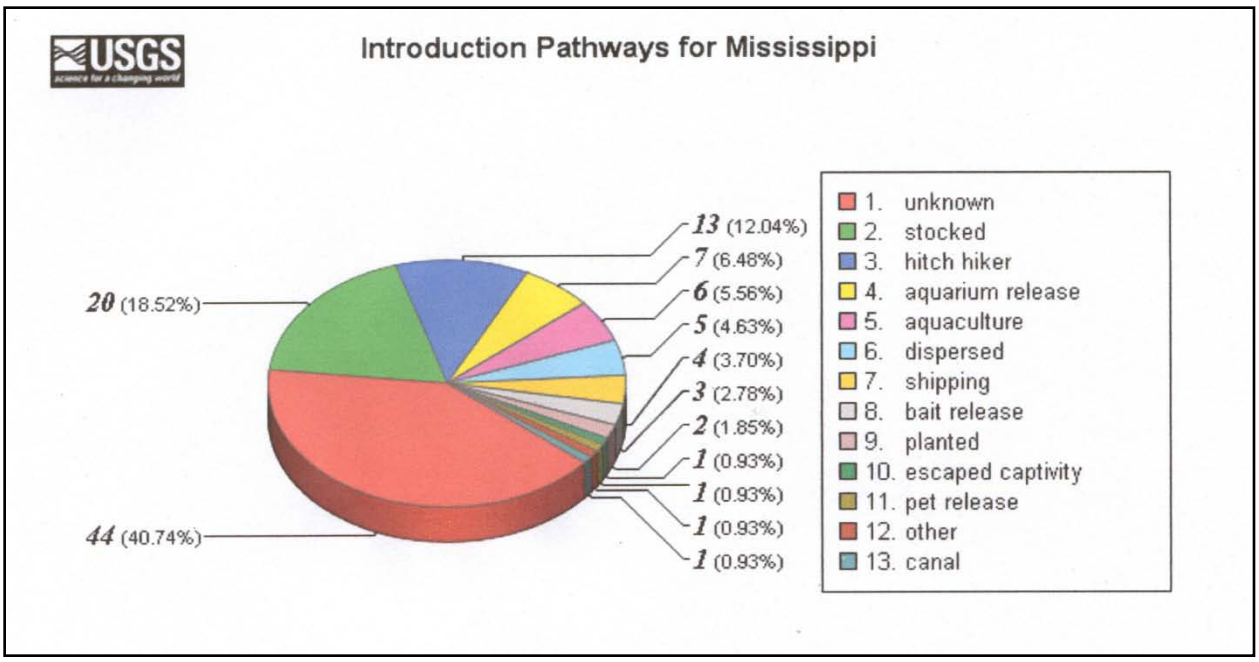
Cultural Traditions—For the purposes of this Plan, "cultural traditions" are defined as traits associated with the ethnic or religious identity of a people beyond the influence of economics (which is covered by the sections on agriculture, fishing, shipping, boating, etc.). Nationally, there are a number of examples. In 1997, a Buddhist group purchased 2,500 fish from a pet store in New York's Chinatown and released them in a New Jersey pond. Some Buddhists believe that setting animals free is an act of compassion that will be rewarded with good karma.[57] Similar cultural pathways may exist in Mississippi.

It is not the intention of the MAIS Task Force to condemn these cultural traditions, as they play important roles in the acculturation of recently arrived refugees and immigrants. Indeed, European charter groups indulged liberally in the introduction of species from their homelands upon their initial arrival. Nevertheless, the possibility of a genuinely harmful species arriving and spreading via this pathway cannot be overlooked by agencies charged with the protection of the greater public good. Management actions that assess the risk level of such introductions and propose reasonable and appropriate responses if the risk level is significant would be of interest to Mississippi's invasive species efforts.

4.B.13 Summary of Species Introduction Pathways for Mississippi

USGS, as part of its Nonindigenous Aquatic Species program, has prepared a graph based on introduction pathways (Graph 1). USGS lists the introduction pathways as follows:

1. Unknown
2. Stocked
3. Hitch hiker
4. Aquarium release
5. Aquaculture
6. Dispersed
7. Shipping
8. Bait release
9. Planted
10. Escaped captivity
11. Pet release
12. Other
13. Canal



Graph 1. Introduction pathways for Mississippi as defined by USGS.

4.C Species of Concern

Aquatic species are organisms living primarily in a water environment. Usage commonly refers to aquatic plants such as water hyacinth and salvinia, fish, and invertebrates, but also includes mammals such as nutria. Aquatic species of concern are nuisance aquatic species that are potentially harmful to environments in which they are not native.

4.C.1 Plants

Aquatic invasive plants of Mississippi are placed in two categories in this Plan: 1) Extensively Established Species, or 2) Locally Established Species or Species of Potential Concern. Aquatic invasive plants found in five or more of the ten drainage basins spanning Mississippi and adjacent areas were categorized as "Extensively Established Species." Those that occur in three to four drainage basins were categorized as "Locally Established Species," and plants found in two or fewer drainage basins were listed as "Species of Potential Concern." The following distribution maps show only "officially" reported locations and may not depect all known infested areas. This lack of distribution information clearly illustrates the need for increased efforts toward mapping AIS infestations.
Also, it is important to note that this method of categorization emphasizes distribution in the state rather than density in a particular location. One plant species sparsely distributed throughout seven drainage basins may be listed as "extensively established," whereas another species could be extensively established in only one drainage basin but listed only as a "species of potential concern."

Also, note that not all nonnative plants listed by USGS as present in Mississippi appear in this section. Only those plants generally recognized as the most problematic, regardless of establishment, are described below. (Please see Section 13.B for a complete list of all known aquatic invasive plants in Mississippi.)

4.C.1.a Extensively Established Species

According to USGS, the following aquatic plants occur in five or more drainage basins in Mississippi:

4.C.1.a.i Water Hyacinth (*Eichhornia crassipes*)

Water hyacinth was first introduced to the United States as an ornamental plant at the World's Industrial and Cotton Centennial Exposition in New Orleans in 1884 and 1885. A South American native, water hyacinth frequently clogs bayous and canals, impedes boat traffic, slows water currents, and blocks light to native submerged aquatic vegetation (SAV), which degrades water quality and harms wildlife. Known for its beautiful flowers, water hyacinth can be found in many of Mississippi's drainage basins, including the Black Warrior-Tombigbee, Mobile Bay-Tombigbee, Middle Tennessee, Pearl, Pascagoula, and Yazoo[58] (Figure 8).

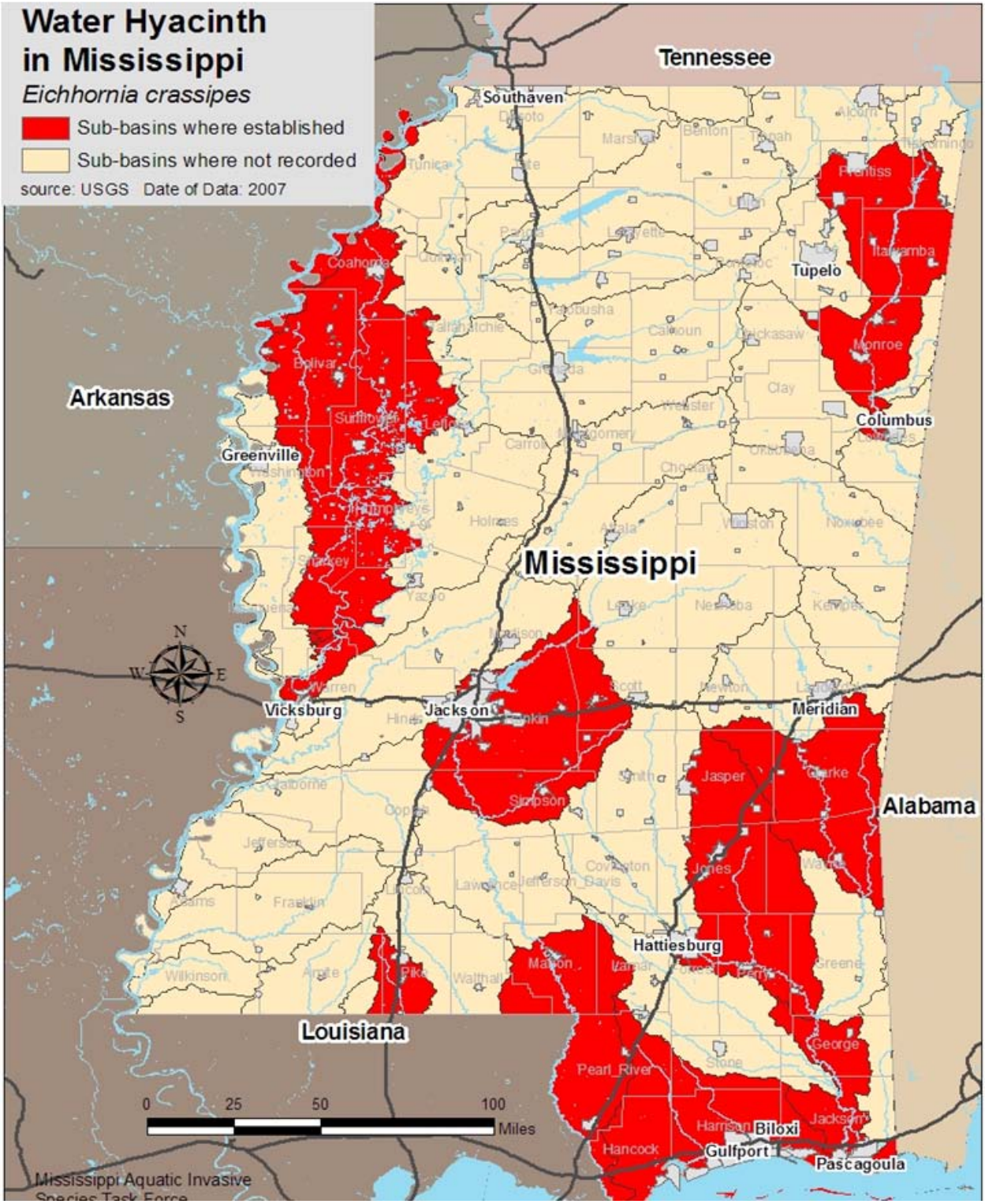


Figure 8. Distribution of water hyacinth in Mississippi aggregated by drainage basin. Water hyacinth was first introduced to the United States as an ornamental plant at the World's Industrial and Cotton Centennial Exposition in New Orleans in 1884 and 1885. Map by CBR, 2007.

4.C.1.b Locally Established Species or Species of Potential Concern

According to USGS, the aquatic invasive plants in the following sections occur in three to four drainage basins in Mississippi.

4.C.1.b.i Giant Salvinia (*Salvinia molesta*)

Giant salvinia (Photo 1) is a free-floating, rootless plant that reproduces quickly; under ideal conditions, giant salvinia can double its biomass every 7 to 10 days. It chokes bayous and canals, and can cover large portions of lakes and reservoirs, degrading water quality, harming wildlife, and impeding boat traffic.[59]

Photo 1. Giant salvinia (*Salvinia molesta*).

(A) Giant salvinia completely covers a waterway in the Pascagoula drainage in Mississippi.
(B) Close-up of giant salvinia.

Photo credits: MDMR

Salvinia molesta was probably intentionally introduced to the United States as an aquarium plant, and, in fact, has been linked to several aquatic plant nurseries. The plant was probably kept in an aquarium until overgrowth occurred, at which point the aquarium contents were dumped into a local stream or pond.[60] Giant salvinia expands its range through reproduction, wind transport, and boaters and fishermen who do not rinse their gear.

Giant salvinia first appeared in Mississippi in 1999 when its presence was reported in Moselle in a 0.25-acre pond and an adjacent ditch. The owner of the pond released four plants in 1998, causing the infestation. After repeated chemical treatments, giant salvinia has not reappeared at this location. In August 2004, a population was discovered in Petal, Mississippi, in a large marshy bottomland lake system. In September and October 2004, personnel from MDWFP and MDAC chemically treated the plants but did not eradicate them.[61] In 2005, the MDAC Bureau of Plant Industry (BPI) applied for a USDA permit to release the salvinia weevil (*Cyrtobagous salviniae*) as a biological control agent. In 2005 and 2006, several shipments of the salvinia weevil were released at ths site. In September 2007, Dr. Daniel Flores, an entomologist with the USDA Biocontrol Laboratory in Edinburg, Texas, visited the site and reported that the salvinia weevils were well established. A large decrease in giant salvinia coverage was observed.[62]

A third infestation of giant salvinia was discovered in the lower Pascagoula River System in the summer of 2005. Prior to Hurricane Katrina, state wildlife officials believed the infestation was too large to attempt eradication with herbicides. Instead, they had planned to post “Stop Aquatic Hitchhikers!” signs at boat ramps, warning boaters to clean off their boats and trailers, as well as brochures for placement at fishing camps. The state also investigated the possibility of introducing salvinia weevils as a biological control method, because weevils have been successful at experimental sites in Texas and Louisiana[63] (Figure 9).

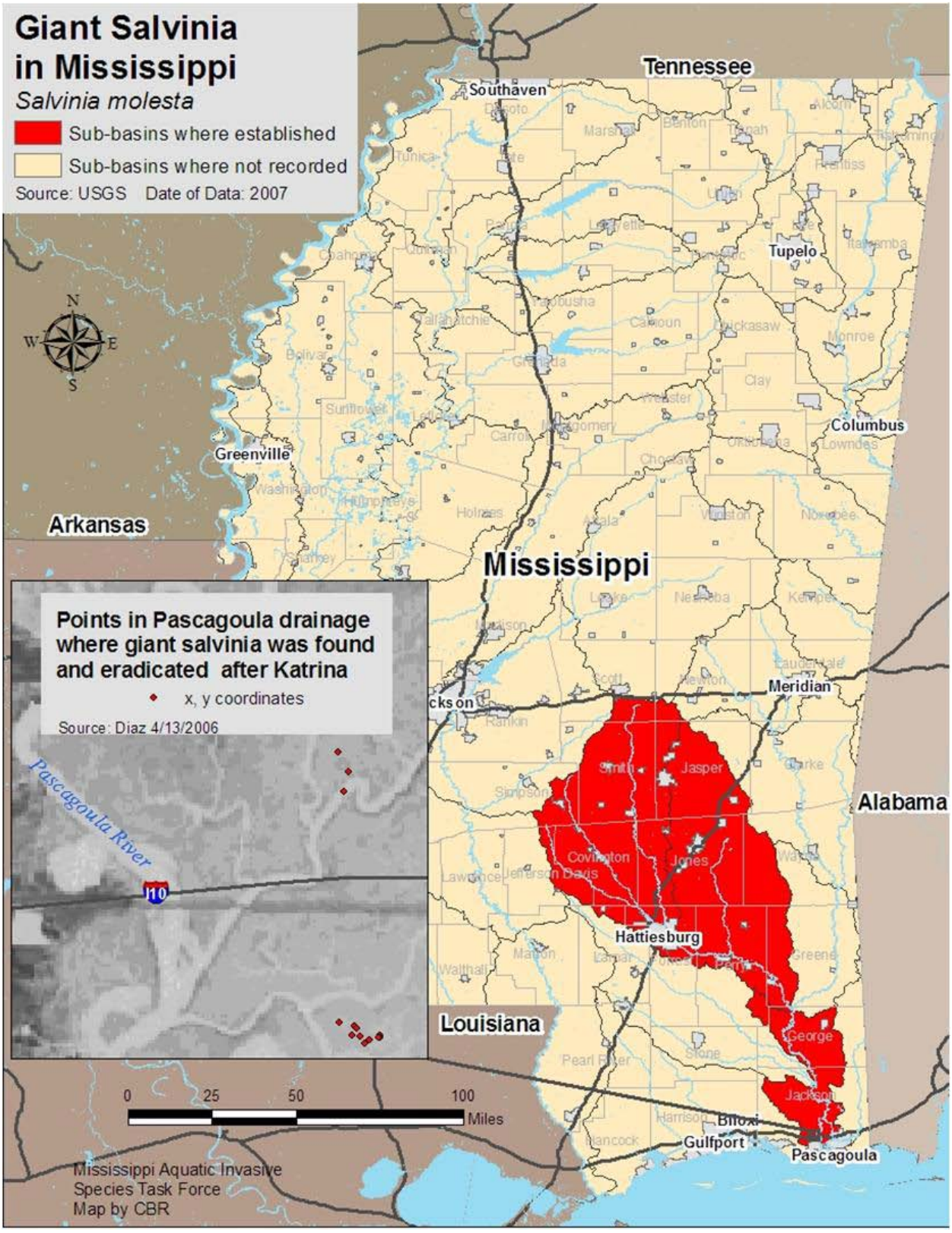


Figure 9. Distribution of giant salvinia in Mississippi aggregated by drainage basin. Inset: giant salvinia was found and eradicated at these locations after Hurricane Katrina. It is unknown whether storm surge killed off most of the giant salvinia or whether it was pushed further inland. Map by CBR, 2007.

After Hurricane Katrina, state wildlife officials revisited the site of the giant salvinia infestation, only to find that most of the plant was gone. MDMR has been surveying other parts of the drainage, because it was unknown if the saltwater forced upriver by the storm had killed the giant salvinia, or if the storm surge simply pushed the plant further upriver. Thirteen sites are now being monitored within the Pascagoula drainage basin, some of which contain giant salvinia populations, though they are much smaller than the infestation in the Pascagoula drainage basin before the storm. The sites with giant salvinia are being treated with chemical and manual extraction methods.[64]

4.C.1.b.ii Common Salvinia (*Salvinia minima*)

This Central and South American native has been cultivated in the United States since the 1880s for water gardens. Researchers believe *Salvinia minima* spread beyond cultivated areas into Florida's St. Johns River in 1928, probably when a water garden flooded, but possibly from an intentional release. USGS reports that common salvinia was first found in Mississippi in 1999 in a tributary of the Upper Leaf River near Hattiesburg. At the time, a recently landscaped lake was the suspected source of introduction. In 2002, infestations were found at Stennis Space Center and at St. Catherine Creek National Wildlife Refuge. Common salvinia continues to spread in Mississippi, as seen by the 2004 discoveries in Lake Tangipahoa at Percy Quin State Park in Pike County, and infestations in Aberdeen and Columbus lakes in the Tennessee-Tombigbee Waterway[65] (Figure 10).

A floating fern, common salvinia is also sometimes called "water spangles" or "water fern." *Salvinia minima* prefers slow-moving freshwaters such as bayous, cypress swamps, marshes, and ponds and lakes. Common salvinia forms thick mats on the water surface, up to almost 25 centimeters (10 inches) deep in some instances. These mats shade and crowd-out native plants, degrading habitat for fish and birds and negatively affecting water quality.[66]

The USDA Agricultural Research Service, in cooperation with the National Park Service, is experimenting with the Florida salvinia weevil (*Cyrtobagous salviniae*) as a form of biocontrol for common salvinia.[67]

4.C.1.b.iii Water Lettuce (*Pistia stratiotes*)

Water lettuce is a floating plant resembling a head of lettuce with thick green leaves. A perennial, water lettuce infestations impede boat traffic, swimming, fishing, and other recreational activities. It degrades water quality for native vegetation and adversely affects fish and bird populations.

Some experts believe the plant is native to Africa and was introduced in ballast water by early explorers (there are records of *Pistia stratiotes* in Florida as early as 1765). Though this plant is on the Federal Noxious Weed List, water lettuce is still available through aquarium suppliers and on the internet.[68]

In Mississippi, this species has been reported in the following drainage basins: Yazoo, Big Black-Homochitto, and Pearl[69] (Figure 11).

4.C.1.b.iv Eurasian Watermilfoil (*Myriophyllum spicatum*)

Eurasian watermilfoil, also called spike watermilfoil, aggressively outcompetes native vegetation and degrades water quality for fish and birds. *Myriophyllum spicatum* prefers slow-moving waters, such as ponds, lakes, bayous, shallow reservoirs, streams, and low-energy rivers, but also grows in flowing waters. Dense growths often impede water recreational activities, such as boating, swimming, and fishing.[70]

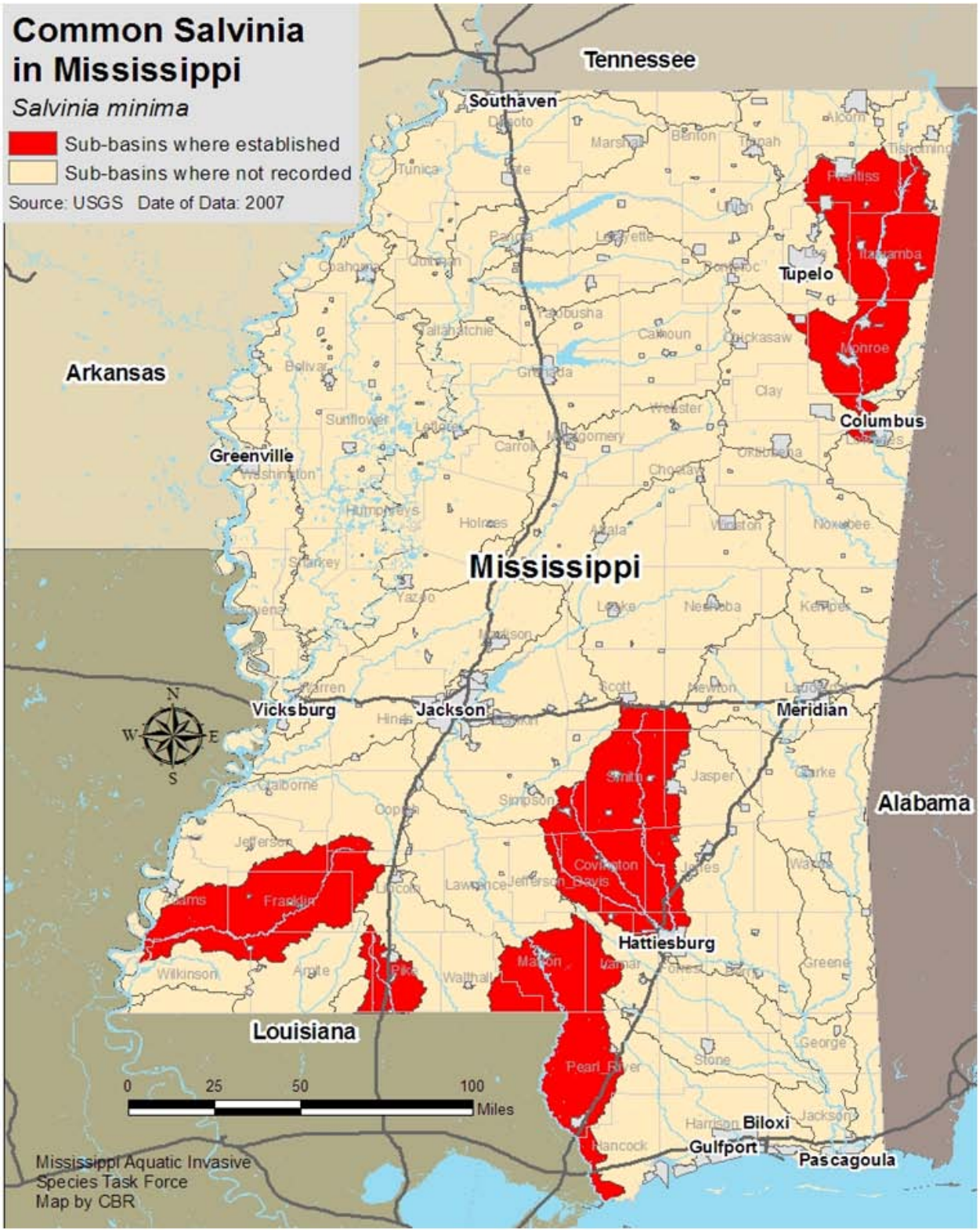


Figure 10. Distribution of common salvinia in Mississippi aggregated by drainage basin. USGS reports that common salvinia was first found in Mississippi in 1999 in a tributary of the Upper Leaf River near Hattiesburg. At the time, a recently landscaped lake was the suspected source of introduction. A floating fern, common salvinia is also sometimes called “water spangles” or “water fern.” Map by CBR, 2007.

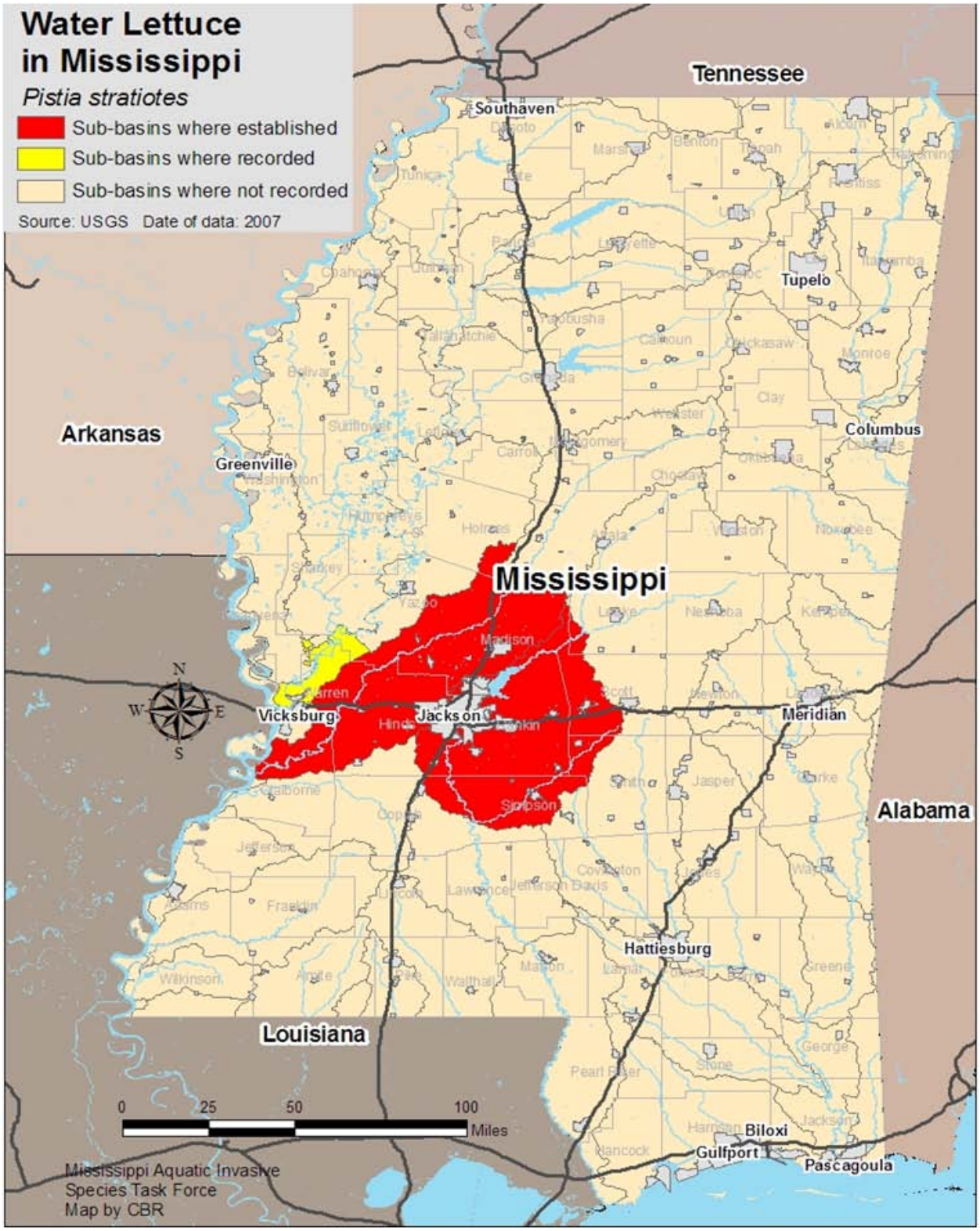


Figure 11. Distribution of water lettuce in Mississippi aggregated by drainage basin. Some experts believe the plant is native to Africa and was introduced in ballast water by early explorers (there are records of *Pistia stratiotes* in Florida as early as 1765.) Though this plant is on the Federal Noxious Weed List, water lettuce is still available through aquarium suppliers and on the internet. Map by CBR, 2007.

Myriophyllum spicatum was first recorded in the United States in Washington, DC, in 1942, possibly an intentional introduction by federal authorities. Its rapid spread throughout the country may derive from its use as packing material for baitworms sold to fishermen. Today, the most common pathway is vegetative fragments attached to boats and boat trailers. Eurasian watermilfoil is still sold by some pet stores and on the internet as an aquarium plant. Some introductions may be due to aquarium releases.[71]

In Mississippi, this species has been recorded in the following drainage basins: Black Warrior-Tombigbee, Mobile Bay-Tombigbee, Middle Tennessee-Elks, and Lower Tennessee[72] (Figure 12). Twenty-five percent of the lower lake in Lock D in the Tennessee-Tombigbee Waterway is covered with Eurasian watermilfoil, and coverage on Lock D is about 10%.[73]

4.C.1.b.v Hydrilla (*Hydrilla verticillata*)

Originally from Asia, hydrilla is a rooted, aquatic plant that inhabits both deep and shallow waters. In shallower areas, hydrilla forms thick mats that impede boat traffic and swimming. It adversely affects water quality by shading out native vegetation, lowering dissolved oxygen concentrations, and can result in fish kills.[74]

It is believed that hydrilla was first discarded from a home aquarium or possibly was planted in canals in Miami and Tampa, Florida. Accidental introduction through boating, usually when attached to a boat or trailer, is the primary pathway spreading hydrilla into new areas. Hydrilla is not as prevalent in Mississippi as in neighboring states Louisiana and Alabama. However, one infestation in particular is reported in eastern Mississippi in the Tombigbee River (Figure 13), the result of an infestation in the Aliceville Reservoir in Alabama. Hydrilla has been found in all lakes along the Tennessee-Tombigbee Waterway and the Mobile District Corps of Engineers has posted "Stop Aquatic Hitchhiker" signs at all Corps boat ramps along the waterway. Hydrilla coverage is extenstive in Lock C.[75] USGS reports other hydrilla populations in drainages shared between Mississippi and its neighbors Louisiana and Alabama, so hydrilla may soon become a bigger concern in Mississippi.[76]

In 2005, about 100 acres of hydrilla were discovered in Ross Barnett Reservoir near Jackson, Mississippi (Figure 13). The Pearl River Valley Water Supply District contracted with a commercial chemical applicator to spray the hydrilla with Aquathol K in fall 2005 and apply granular Sonar in spring 2006. Approximately $60,000 was spent on these control efforts.[77] In 2007, another area of hydrilla was discovered in the Ross Barnett Reservoir (Figure 13).

4.C.1.b.vi Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife (Photo 2) is an invasive plant introduced from Europe in the 1800s as an ornamental plant. It also may have arrived in the northeastern United States in ship ballast. Purple loosestrife stalks can grow up to 9 feet tall, and just one mature purple loosestrife plant can produce an estimated 3 million seeds annually. Seeds are prone to wind, animal, and water dispersal. Purple loosestrife stands disrupt wetland ecosystems by displacing native wildlife, affect agriculture by clogging irrigation systems, and destroy grazing pastures by replacing range grasses.[78]

An easy-to-grow plant with attractive purplish-magenta flowers, purple loosestrife can be purchased in many plant nurseries, garden stores, and over the internet. Some nurseries claim to sell only sterile loosestrife plants, but these claims have often proven false.[79]

Photo 2. Purple loosestrife (*Lythrum salicaria*).

Photo credit: Plant Conservation Alliance through the National Park Service.

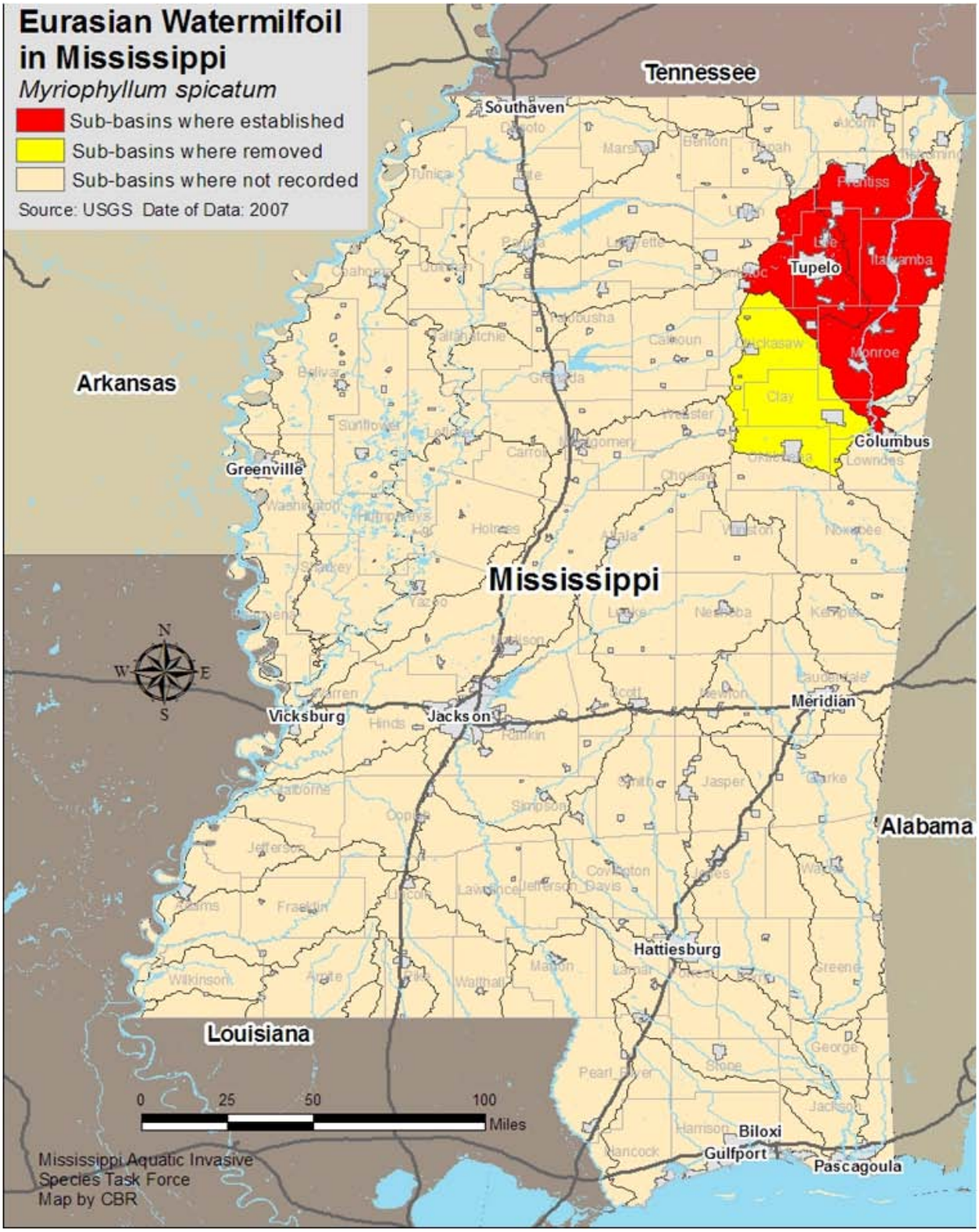


Figure 12. Distribution of Eurasian watermilfoil in Mississippi aggregated by drainage basin. *Myriophyllum spicatum* was first recorded in the United States in Washington, DC, in 1942, possibly an intentional introduction by federal authorities. Eurasian watermilfoil is still sold by some pet stores and on the internet as an aquarium plant. Some introductions may be due to aquarium releases. Map by CBR, 2007.

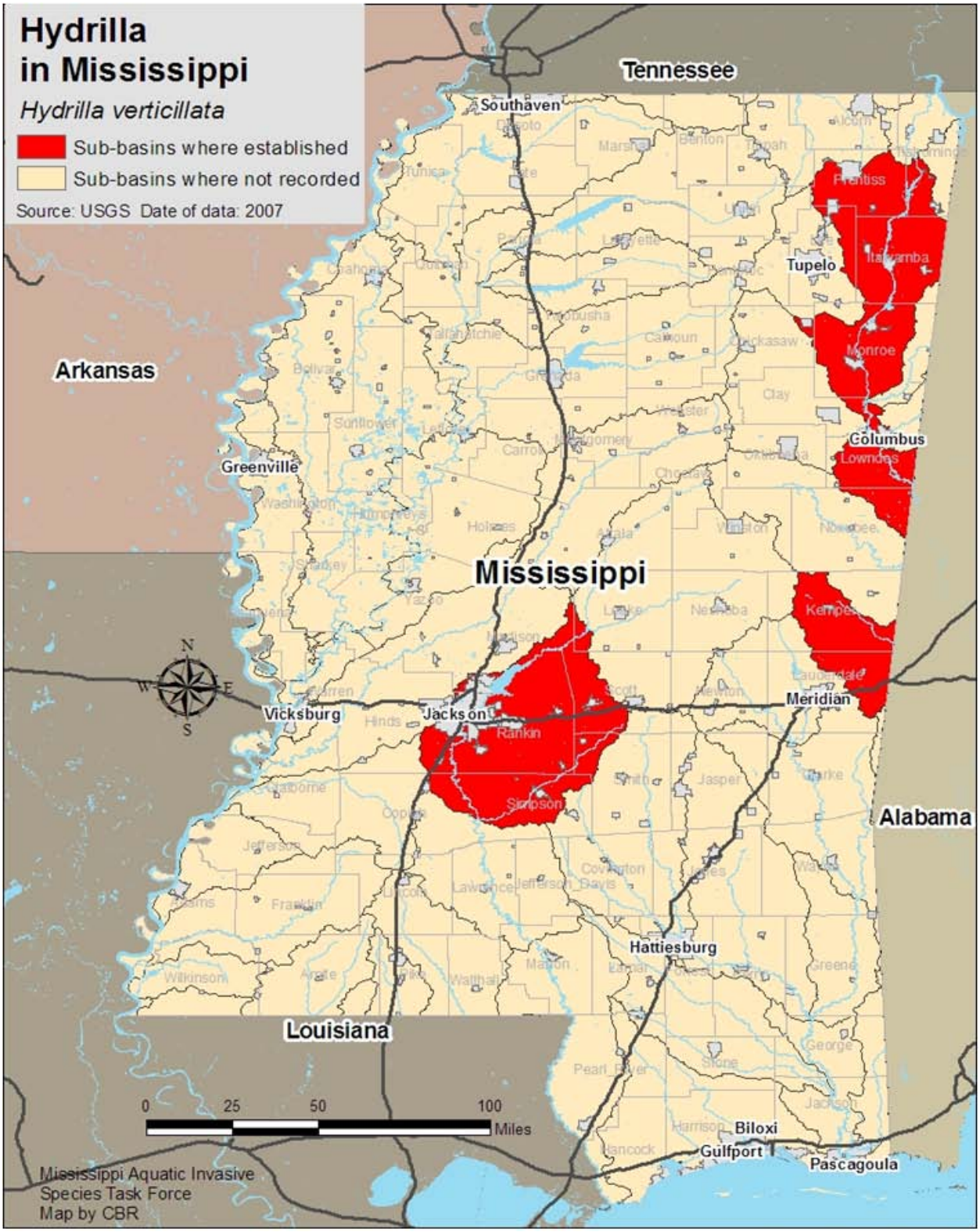


Figure 13. Distribution of hydrilla in Mississippi aggregated by drainage basin. It is believed that hydrilla was first discarded from a home aquarium or possibly was planted in canals in Miami and Tampa, Florida. Accidental introduction through boating, usually when attached to a boat or boat trailer, is the primary pathway spreading hydrilla into new areas. Map by CBR, 2007.

USGS reports the presence of purple loosestrife in three drainage areas in Mississippi: the Pearl River drainage basin, which also spans into Louisiana; the Hatchie-Obion drainage basin, which Mississippi shares with Tennessee; and the Middle Tennessee-Elks drainage basin, which is shared with Tennessee and Alabama[80] (Figure 14). USGS also reports the presence of purple loosestrife in Arkansas, though not in a drainage area that borders Mississippi. Alternatively, NationalAtlas.gov reports purple loosestrife in the following counties in the following years: Alcorn (1992), Grenada (1987), Attala (1987), Scott (1969), and Rankin (1991) (Figure 14). These five counties correspond to the following drainages: Hatchie-Obion, Yazoo, Big Black-Homochitto, and Pearl. Also, the University of North Carolina's herbarium records indicate a specimen was collected from Alabama's Mobile County, in the Pascagoula drainage, in 1970.[81]

4.C.1.b.vi Torpedo Grass (*Panicum repens*)

Native to Australia, this plant frequently colonizes stream banks and shorelines.[82] Though its exact date of introduction in unknown, it was first collected in 1876 near Mobile, Alabama.[83] Torpedo grass can form extensive monocultures that may even extend into a waterbody, forming a thick mat of vegetation. Present along the Gulf and South Atlantic coasts from North Carolina to Florida to Texas (Figure 15), it is resistant to drought, and can grow in a variety of soils, though it does best in moist environments. Also sometimes called "quack grass" or "bullet grass," this species displaces native grasses, including important marsh grasses. Additionally, floating vegetative mats may interfere with water flow in ditches or canals or limit recreational use of a lake or pond.[84]

4.C.1.b.vii Wild Taro (*Colocasia esculenta*)

Wild taro was initially introduced to North America in association with the slave trade, but spread when USDA promoted it as a substitute for potatoes in the early 1900s. Wild taro forms dense growth stands in riparian zones and displaces native vegetation.[85]

Many species of taro are sold at garden stores as ornamental plants. *Colocasia esculenta* has been reported in the Mobile Bay-Tombigbee drainage basin in Mississippi and along the shores of the Ross Barnett Reservoir near the Natchez Trace Parkway[86] (Figure 16).

4.C.1.b.viii Peruvian Watergrass (*Luziola peruviana*)

Peruvian watergrass is a South American native that was introduced to the United States within the last 10 years, but the details of its introduction are unknown. In Louisiana's Vermilion Parish, rice and crayfish farmers have reported the plant's presence in some of their rice fields. In addition to interfering with crop production, this fast-growing plant can form thick, rooted mats and clog canals and other waterways. The only other known location of Peruvian watergrass in the United States is near Pensacola, in Florida's Escambia County. Wildlife managers speculate that the plant spread from Florida to Louisiana via the Intracoastal Waterway, possibly attached to a boat traveling through the shipping corridor.[87] Currently there are no known occurrences of this species in Mississippi.

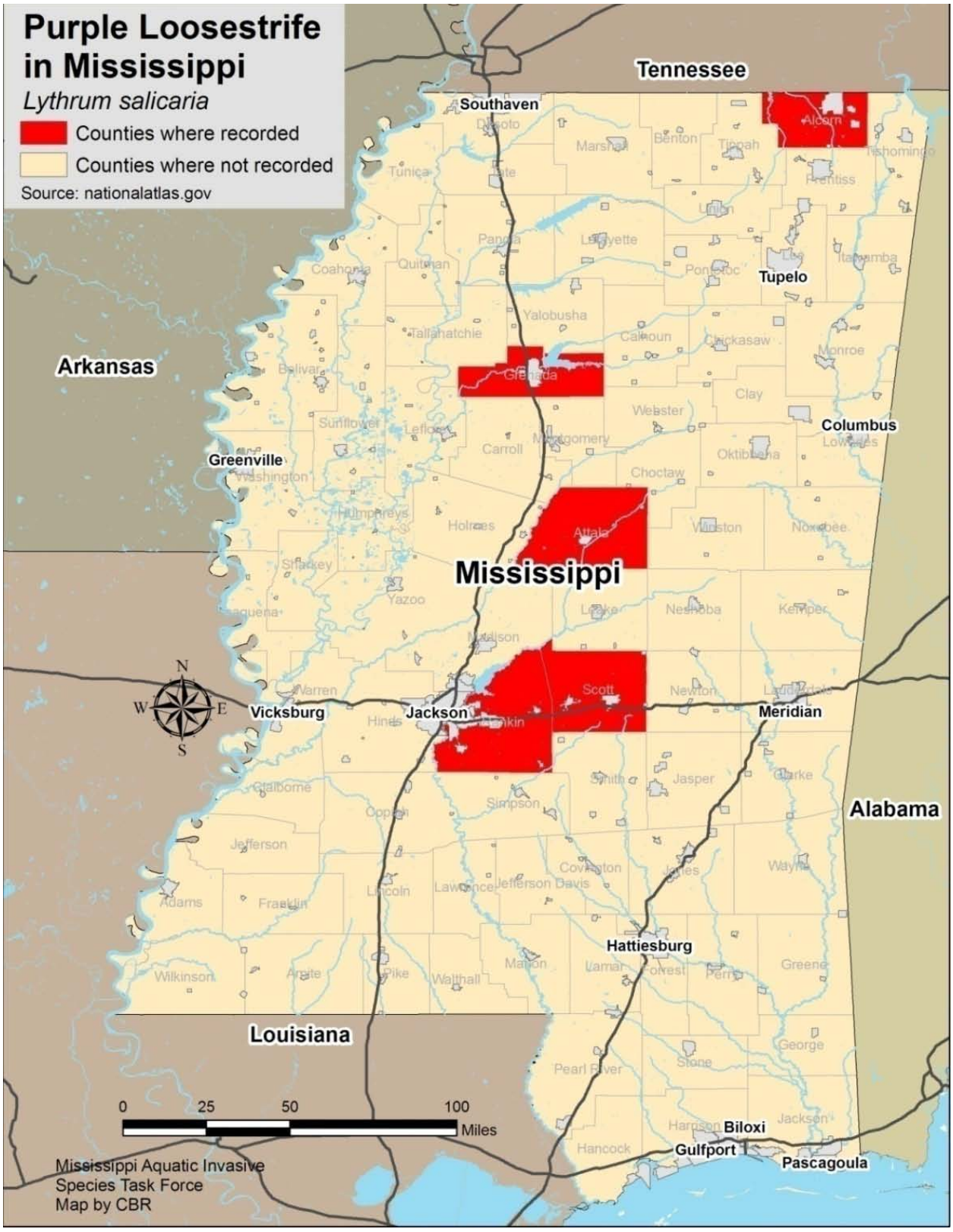


Figure 14. Distribution of purple loosestrife in Mississippi aggregated by county. *Lythrum salicaria* was introduced from Europe in the 1800s as an ornamental plant. It also may have arrived in the northeastern United States in ship ballasts. Purple loosestrife is sold as an ornamental by many plant nurseries, but its seeds are also spread by wind, water, and animals. Map by CBR, 2007.

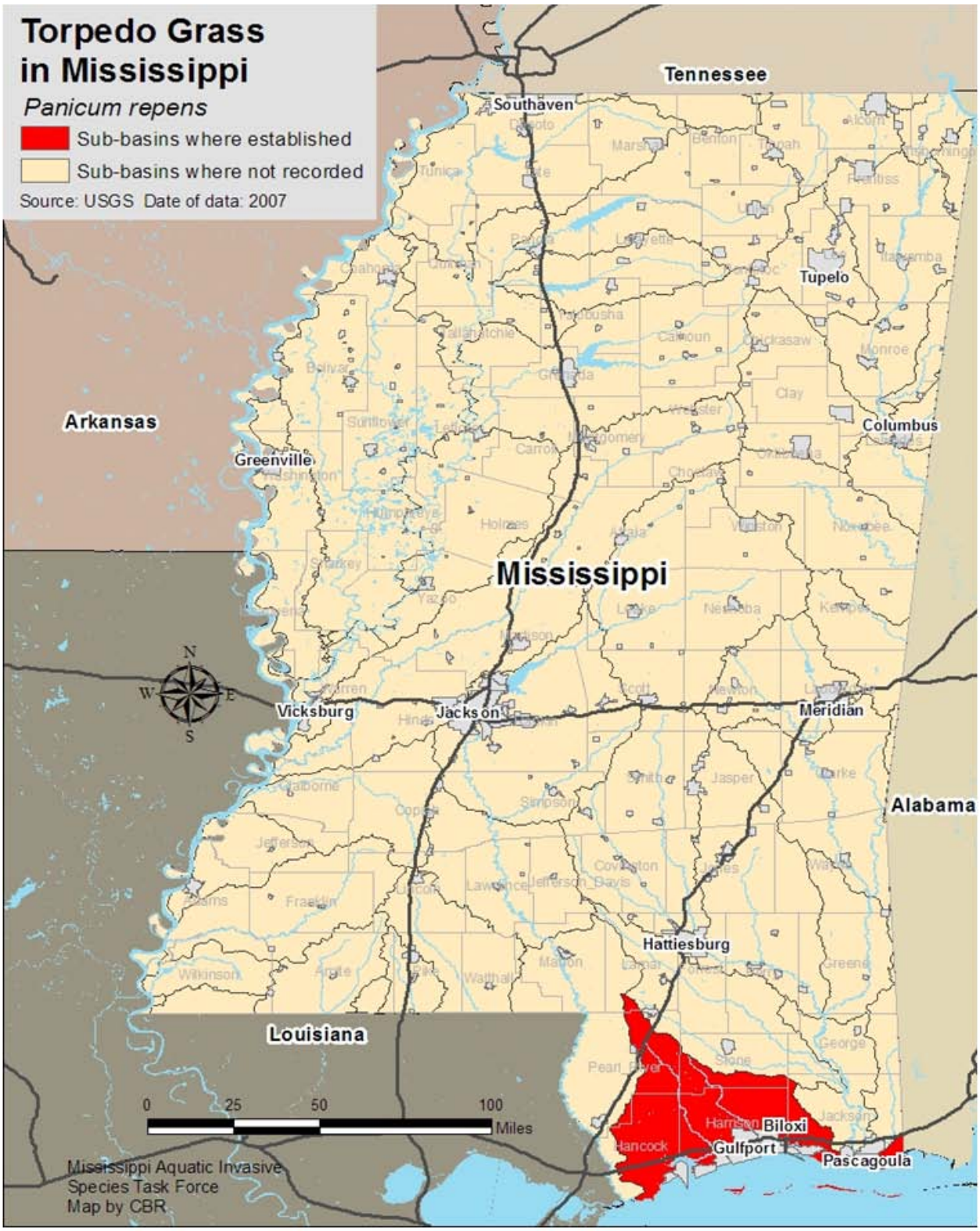


Figure 15. Distribution of torpedo grass in Mississippi aggregated by drainage basin. Though its exact date of introduction is unknown, torpedo grass was first collected in 1876 near Mobile, Alabama. Map by CBR, 2007.

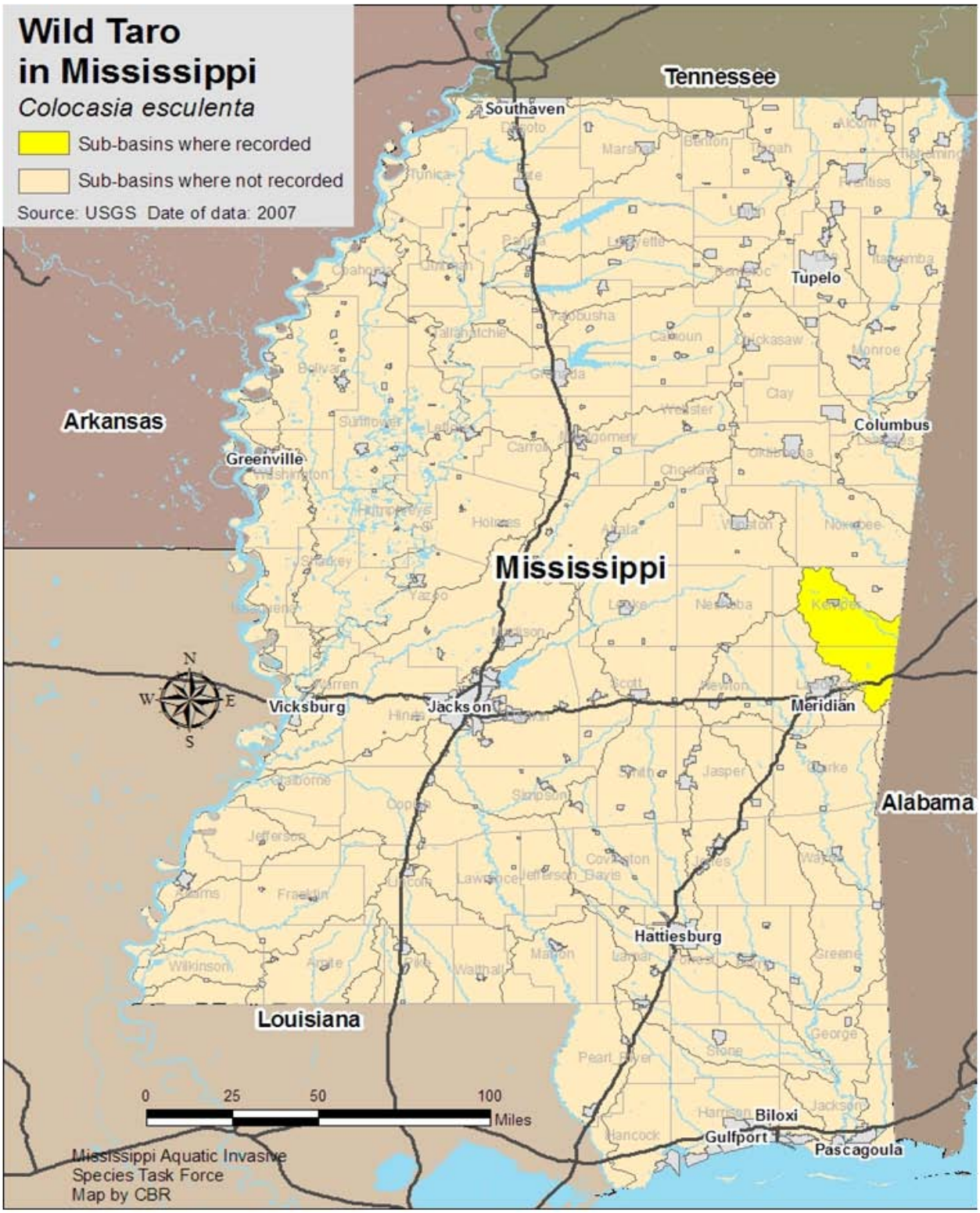


Figure 16. Distribution of wild taro in Mississippi aggregated by drainage basin. Wild taro was initially introduced to North America in association with the slave trade, but spread when USDA promoted it as a substitute for potatoes in the early 1900s. Map by CBR, 2007.

4.C.1.b.ix Brazilian waterweed (*Egeria densa*)

Brazilian waterweed has been introduced worldwide through the aquarium trade. The plant is marketed widely as a good oxygenator plant for aquaria and has become established over a major part of the Gulf Coast and Atlantic Coast regions, in addition to other parts of the United States. It is likely introduced to new areas by boat trailers and downstream dispersal of plant fragments. Dense stands of Brazilian waterweed may restrict water movement, trap sediment, and cause fluctuations in water quality. Severe infestations may impair recreational uses of a waterbody including navigation, fishing, swimming, and water skiing. The USGS Nonindigenous Aquatic Species database indicates that the species is established in the Lower Mississippi drainage basin. A range map on the Flora North America website[88] suggests that the species is heavily established in states to the east of Mississippi and to the west of the Mississippi River but that it is minimally established in Mississippi. Available information suggests, however, that it is a species having a potential for greater establishment in Mississippi in the future.

4.C.2 Finfish

Invasive fishes of Mississippi are placed in two categories in this Plan: 1) Extensively Established Species, and 2) Locally Established Species or Species of Potential Concern.

4.C.2.a Extensively Established Species

4.C.2.a.i Common Carp (*Cyprinus carpio*)

Common carp were introduced to the United States so long ago, and are so widespread that they are commonly mistaken as an indigenous species. Records of the earliest common carp introductions are sketchy, but this freshwater fish was certainly introduced to the United States from Asia at least by 1877, and possibly as far back as the 1830s. In 1877, the US Fish Commission began stocking this fish throughout the United States for food purposes. In addition to deliberate stockings, *Cyprinus carpio* escaped cultivation from fish farms and spread into wild water bodies. More recently, use of juvenile common carp as baitfish has resulted in additional introductions. Also known as German or European carp, mirror carp, leather carp, and koi, common carp have been introduced through the aquarium and water garden trade. Koi are more colorful variations of common carp that are sometimes kept as pets. It must be noted that only a small portion of common carp introductions have resulted from this pathway.[89]

Cyprinus carpio is a freshwater fish but is able to withstand brackish waters in its native range. Its nonnative range in the Gulf of Mexico is not limited by temperature; the Gulf of Mexico region's temperate waters are suitable habitat for this fish. An omnivore, *Cyprinus carpio* will consume both zooplankton and phytoplankton and will frequently disturb bottom sediments while feeding. The increased turbidity and dislodging of plants disturb habitat for native species that require rooted vegetation and clear waters. Common carp also adversely impact native fishes by consuming fish eggs and larvae.[90]

Most abundant in man-made waterbodies, common carp are also plentiful in waters polluted by sewage and agricultural runoff.[91] Common carp are widely distributed throughout Mississippi.

4.C.2.a.ii Grass Carp (*Ctenopharyngodon idella*)

Grass carp were first imported to the United States in 1963 for Arkansas and Alabama aquaculture facilities, where they served to control vegetation (including invasives) in fish ponds. The fish first escaped from cultivation into the White River in 1966 from the Fish Farming Experimental Station in Stuttgart, Arkansas. Grass carp were also legally and illegally stocked in many rivers, streams, and reservoirs to control unwanted submerged vegetation. Known also as white amur, grass carp were first reported in the Mississippi River in the early 1970s. Its rapid spread throughout adjacent United States waterways, coupled with continued deliberate stockings for biological control, allowed this fish to establish in 45 states (Figure 17). In Mississippi, according to USGS and the Gulf States Marine Fisheries Commission, grass carp are established in: the Mississippi River; Washington, Tunica, Humphreys, and Sunflower counties; the Yazoo River drainage; Coles Creek; and some parts of the Leaf River.[92] Also, according to

MDEQ biologists Beiser and Folmar (2006), this species has been observed "in virtually every one of the state's river basins with the exception of the Tennessee-Tombigbee."[93]

Grass carp can have serious detrimental effects on riverine, limnetic, and littoral ecosystems. They decrease available habitat and food, and change macrophyte and phytoplankton community composition, ultimately altering an ecosystem's food web. According to Nico et. al (2006), "although grass carp are often used to control selected aquatic plants, these fish sometimes feed on preferred rather than on target plant species."[94] Several researchers have noted that in high numbers, grass carp can eliminate all macrophyte aquatic vegetation. Grass carp also may carry and transmit parasites and diseases to native fishes.[95]

Although several states allow pond owners to stock grass carp in their ponds for biological control of unwanted plants, some states only permit the stocking of triploid-certified (sterile) grass carp. While Mississippi allows the stocking of both diploid (fertile) and triploid carp in ponds, MDWFP fisheries biologists only recommend the stocking of triploid grass carp. In addition, all grass carp stocked into state lakes and reservoirs for weed control by MDWFP are from eggs that have been subjected to a triploid inducing process. When it becomes feasible, MDWFP hopes to use 100% certified triploid grass carp in its stocking programs.[36] See Section 13.H.1 for additional information on this species.

4.C.2.a.iii Silver Carp (*Hypophthalmichthys molitrix*)

Hypophthalmichthys molitrix is native to eastern Asia, particularly China, and naturally occurs in temperate and primarily freshwaters. This species was first introduced to the United States around 1973 for phytoplankton control in aquaculture ponds, and as a food fish. Earliest reports indicate that a private fish farmer imported silver carp into Arkansas in the early 1970s, but by the mid-1970s, silver carp were being stocked in private and public ponds as well as municipal sewage lagoons. By the 1980s, silver carp were found in natural waterbodies (Figure 18).[96]

In Mississippi, silver carp have been reported in the Mississippi River, the Yazoo River, Butler Lake, Bogue Phalia (Yazoo drainage basin), and the coastal area.[97]

Unlike grass carp, silver carp are planktivorous fishes that sometimes also consume detritus.[98] This could present an ecological threat to native mussels and fish larvae, organisms which are also filter-feeding planktivores. In addition to the threat to native fish and shellfish, silver carp also can be physically dangerous to fishermen and boaters. Silver carp have a tendency to leap out of the water, possibly when startled by boat motors or other noises. "Flying" carp can land in boats, and some significant injuries to fishermen and boaters have been documented. See Section 13.H.2 for additional information on this species.

Photo 3. Silver Carp (*Hypopthalmichthys molitrix*), jumping after being startled by boat.

Photo credit: USGS

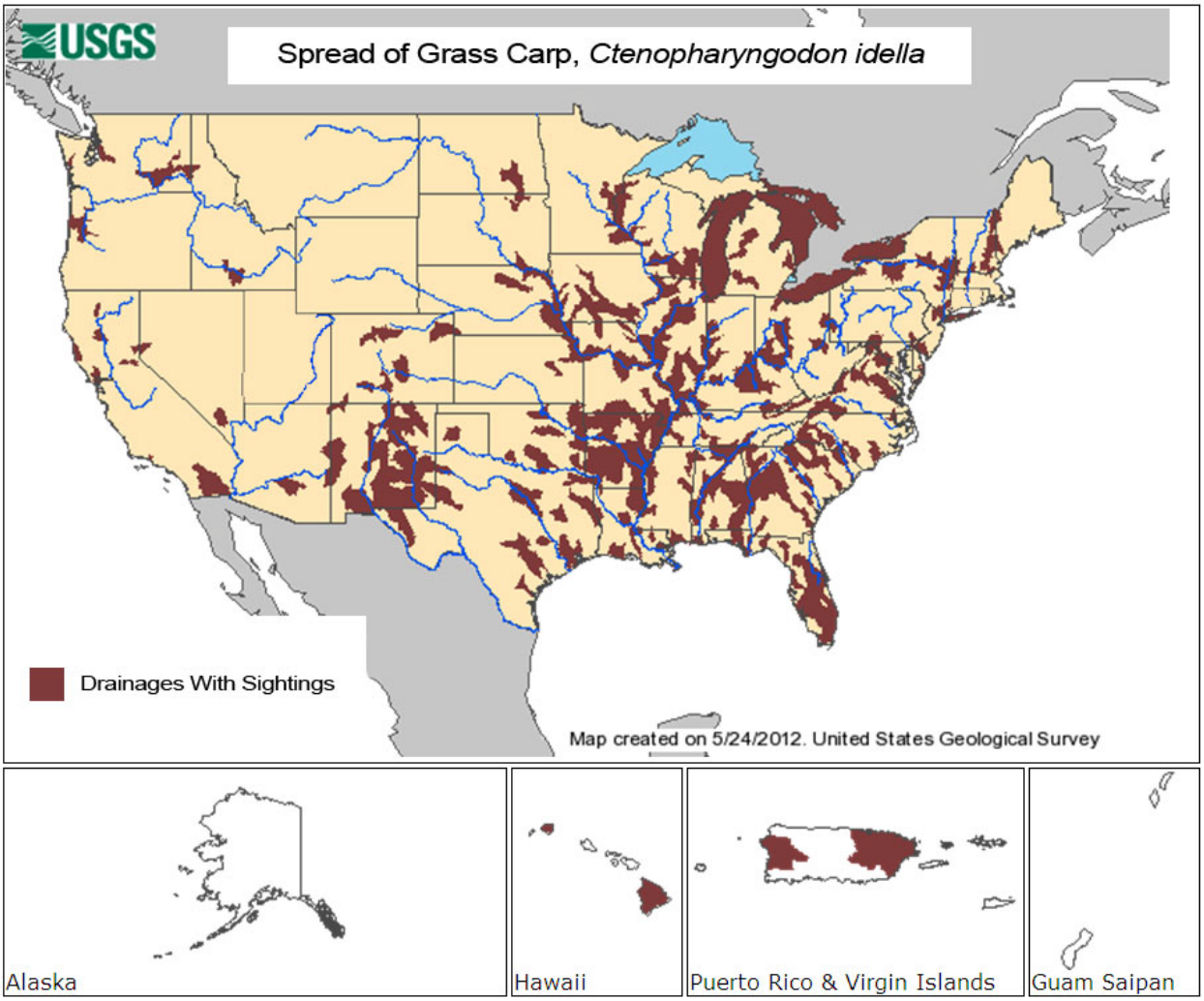


Figure 17. Grass carp were first imported to the United States in 1963 for Arkansas and Alabama aquaculture facilities, to control vegetation (including invasives) in fish ponds. The fish first escaped into the White River in 1966 near Stuttgart, Arkansas, and were first reported in the Mississippi River in the early 1970s. Its rapid spread throughout adjacent waterways, coupled with continued deliberate stockings for biological control, allowed this fish to establish in 45 states. In Mississippi, grass carp have been observed in almost every drainage basin. Map adapted from USGS, 2012..

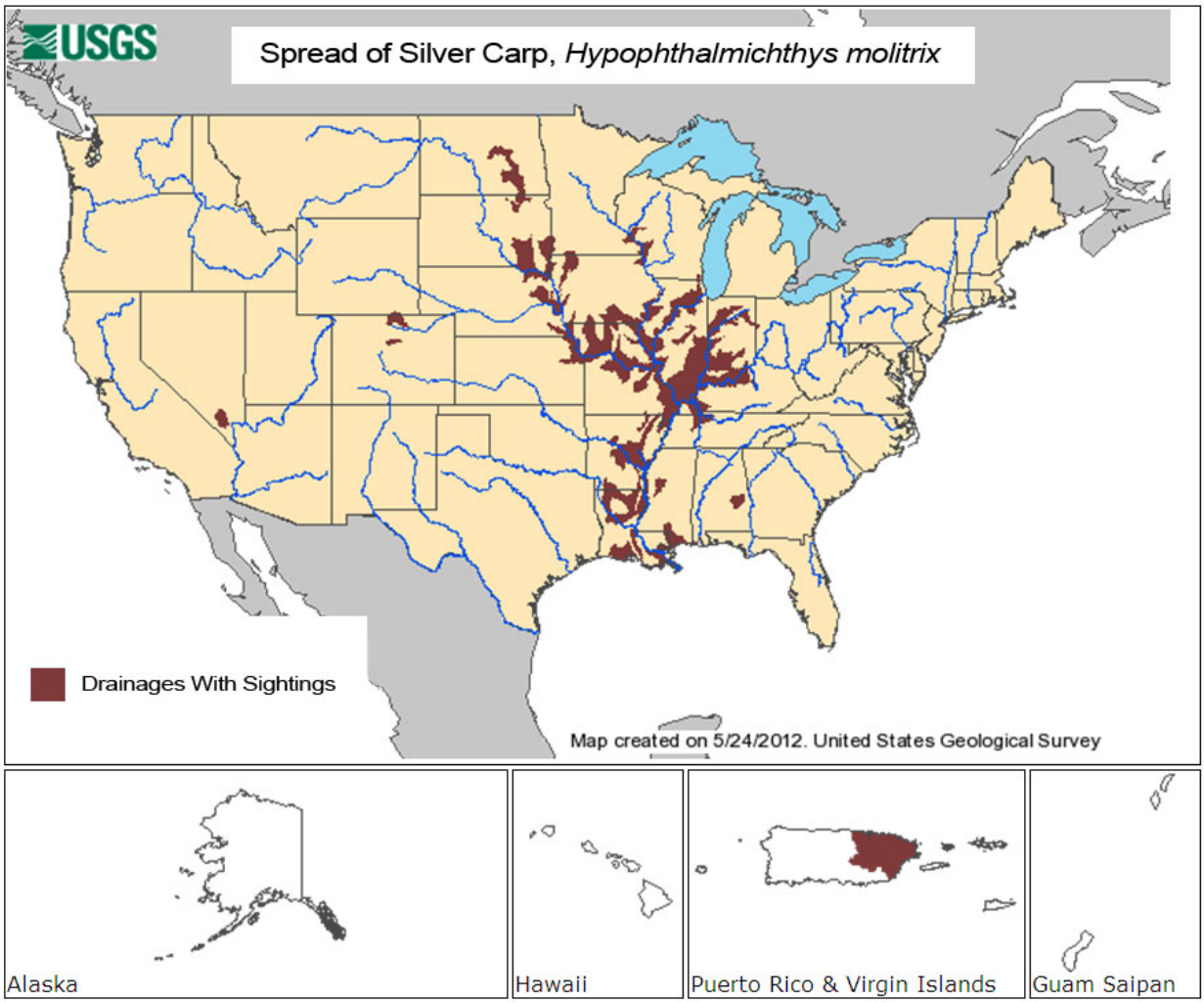


Figure 18. Native to eastern Asia, silver carp were first introducted to the United States in Arkansas in the early 1970s for phytoplankton control in aquaculture ponds and for human consumption. In Mississippi, silver carp have been reported in the Mississippi River, the Yazoo River, Butler Lake, Bogue Phalia (Yazoo Basin), and the coastal area. Map adapted from USGS, 2012.

4.C.2.a.iv Bighead Carp (*Hypophthalmichthys nobilis*)

Similar to the silver carp, bighead carp were introduced to the United States by a private fish farmer in Arkansas in the early 1970s, who sought to use them with other herbivorous fish to improve water quality and increase production in his aquaculture ponds. Probably the result of an escape from such aquaculture facilities, bighead carp began to appear in open waters in the early 1980s. In Mississippi, bighead carp have been found in the following locations: the Mississippi River, Pascagoula River, Yazoo River, Black Bayou (Yazoo drainage basin), Skillikalia Bayou (Yazoo drainage basin), Steele Bayou (Yazoo drainage basin), Little Sunflower River, Six Mile Lake, Butler Lake, Lower Sardis Lake, and more[99] (Figure 19).

As recently as March 2007, bighead carp were collected from the Tombigbee River, which drains to the Mobile River and then to the Gulf of Mexico. Collection dates are from 2004, 2005, and 2007, and specimens ranged in size from 4 kg to 25 kg. No evidence of reproduction has been found. The Tennessee-Tombigbee Waterway is the suspected source of the fish; the Tennessee-Tombigbee Waterway connects the Mobile River basin with the Mississippi River basin. If bighead are now established in the Tombigbee River, this may be the first known population of bighead carp established outside of the Mississippi River basin.[100]

Both the bighead carp and the silver carp are filter feeders; bighead carp prefer zooplankton, while silver carp are primarily phytoplanktivorous. In waters with low levels of zooplankton, though, bighead carp will consume phytoplankton and detritus. In large numbers, bighead carp can deplete zooplankton populations, which could reduce native zooplanktivorous species and threaten existing food webs.[101] See Section 13.H.3 for additional information on this species.

4.C.2.a.v Tilapia (*Tilapia* spp., *Oreochromis* spp., and *Sarotherodon* spp.)

"Tilapia" is a general name given to many related fish species from the genera *Tilapia*, *Oreochromis*, and *Sarotherodon*. Tilapia were native to Africa and parts of the Middle East but have been widely translocated throughout the world in the tropics.[102] They are strictly warmwater fish but can grow in brackish waters; some species can tolerate seawater. Tilapia are a popular fish for aquaculture and are the third most commonly cultured fish group in the world, after carps and salmonids.[103] The United States is the world's largest importer of tilapia, but domestic aquaculture is limited—primarily by the cold-intolerance of the fish. About 17 million pounds of tilapia were grown in the United States in 2005 and about 75% of that production was derived from indoor, water-reuse culture systems.[104] Tilapia are the most widely cultured nonnative fish in Mississippi.

In addition to competing with natives, most tilapia species are aggressive toward other fish. Tilapia are omnivores, consuming detritus, algae, phytoplankton, zooplankton, insects, vascular plant fragments, small fish, and crustaceans. Several tilapia species are established in parts of Florida, Texas, and Alabama,[105] and USGS reports that a breeding population of Nile tilapia (*Oreochromis niloticus*) has been established since the late 1990s in Robinson Bayou in the Pascagoula drainage basin in Mississippi, probably the result of an escape from a nearby tilapia aquaculture facility (Figure 20).[106]

Some question whether tilapia truly pose a threat to wildlife if they escape cultivation. Though tilapia have wide salinity tolerances, historically they have not been cold-tolerant. According to Greg Lutz, an aquaculture specialist at the Louisiana State University AgCenter, "growth is generally limited at water temperatures below 70 ºF, and most tilapia become severely distressed at 65 ºF. Death begins to occur at 60 ºF, with few surviving temperatures below 50 ºF for any period of time."[107] However, the establishment and survival of a breeding population of tilapia for almost a decade in southern Mississippi indicates that the fish may become a threat to native fish and other wildlife. See Section 13.H.4 for additional information on this species.

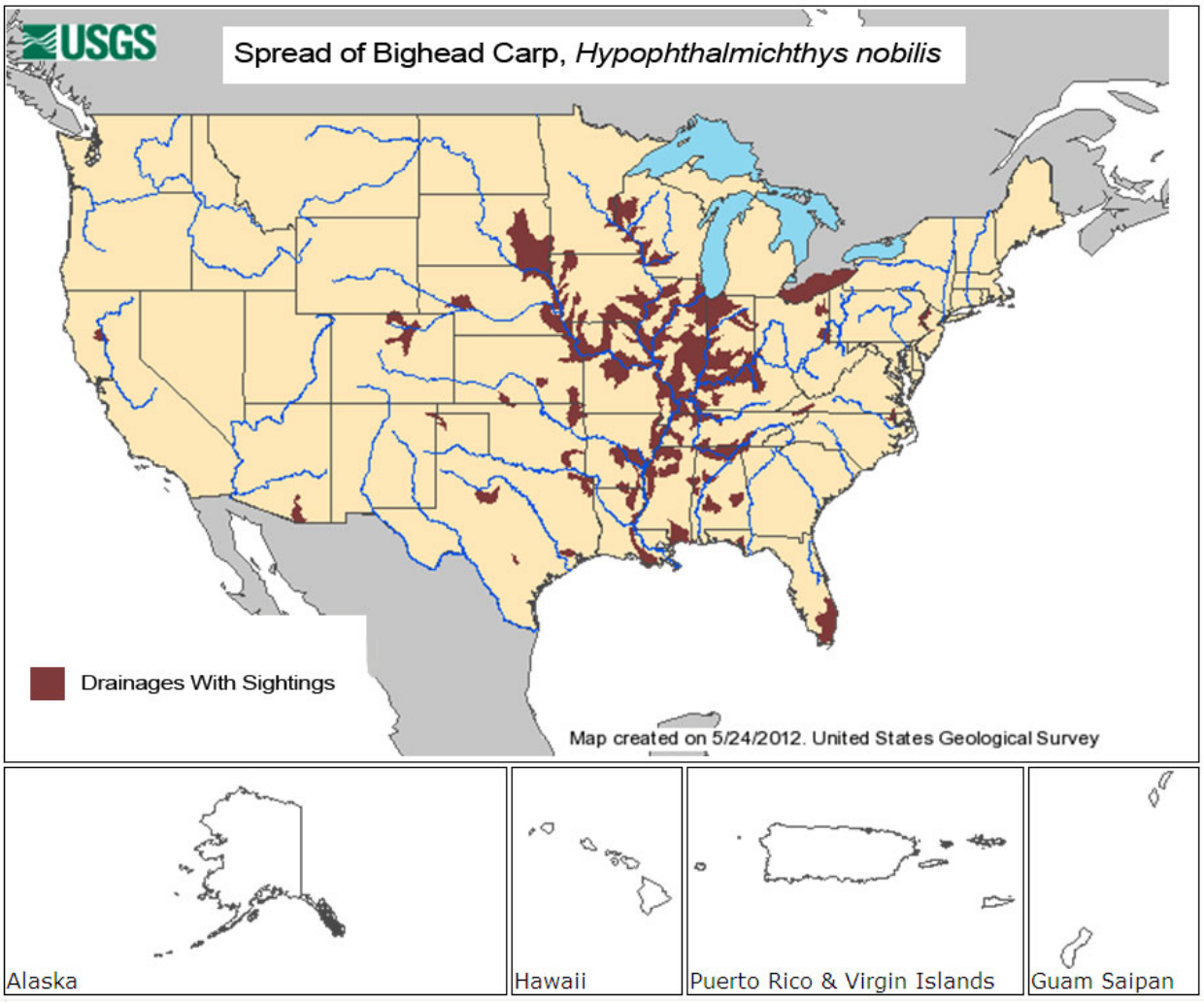


Figure 19. Bighead carp, a zooplanktivore from Asia, was introducted by fish farmers to improve water quality and increase production in aquaculture ponds. Bighead carp have been observed in at least ten Mississippi waterbodies. Map adapted from USGS, 2012.

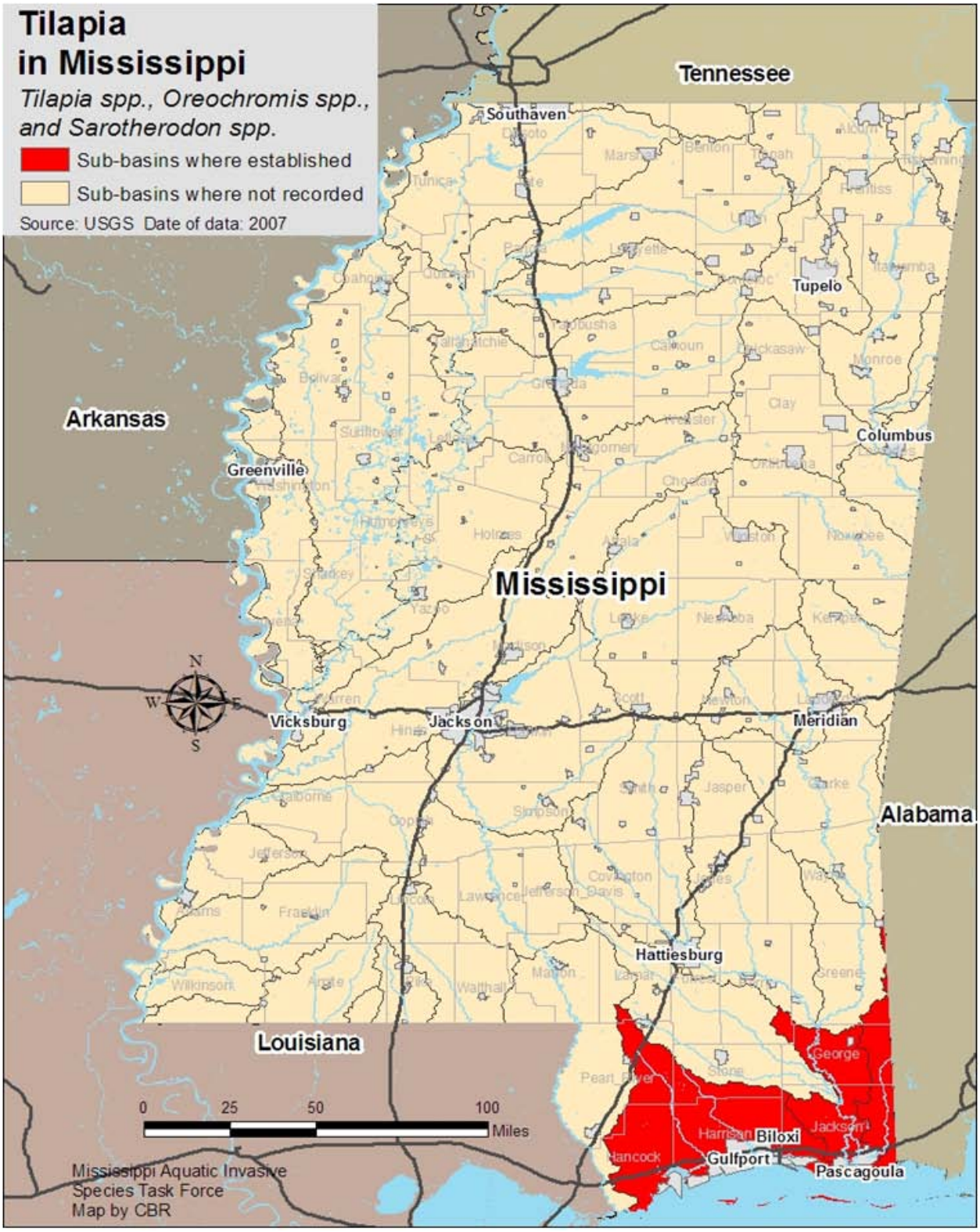


Figure 20. Distribution of tilapia in Mississippi aggregated by drainage basin. It should be noted that this map does not include tilapia that are raised as an aquaculture species, only established breeding populations in the wild. Map by CBR, 2007.

4.C.2.b Locally Established Species or Species of Potential Concern

No known established populations exist in Mississippi for the following fish species, but the MAIS Task Force identified them as species of concern in neighboring areas.

4.C.2.b.i Black Carp (*Mylopharyngodon piceus*)

Recent black carp collections from the Red River in Louisiana have sparked concern among fisheries managers that this species may soon become established in natural ecosystems. Also known as the snail carp, Chinese black carp, black amur, Chinese roach, or black Chinese roach, the black carp is a freshwater fish native to China, parts of eastern Russia, and possibly northern Vietnam. A bottom-dwelling mollusk eater, black carp also are known to eat freshwater shrimp, insects, and crayfish. In large numbers, black carp could threaten native shellfish and mollusks, including snails and mussels, some of which may be endangered. Black carp host many parasites and flukes, not to mention bacteria and viruses, which may infect commercially valuable sportfish, food fish, or threatened and endangered species.[108]

The first introduction of black carp to the United States, in the early 1970s, was as an accidental specimen in imported grass carp stocks sent to a private fish farmer in Arkansas. The second introduction in the 1980s was deliberate: the carp were imported both as a food fish and as a biocontrol for yellow grubs at aquaculture facilities.[109] The only known introduction of black carp to open waters occurred in 1994 when high waters flooded an aquaculture facility near the Missouri River. An estimated 30 black carp, along with thousands of bighead carp, escaped into the Osage River.[110] According to USFWS, if black carp became established in large lakes or river systems, "eradication and/or control of black carp [would be] nearly impossible and they would likely become permanent members of the fish community."[111]

On March 26, 2003, Illinois fisherman Jim Beasley caught the first recorded black carp from open waters in Horseshoe Lake, Alexander County, Illinois. The carp measured 78.3 centimeters long (30.8 inches) and weighed 5.8 kilograms (12.8 pounds). Horseshoe Lake is located a few miles from the Mississippi River, which periodically floods into the lake. River floodwaters last entered Horseshoe Lake in May 2002. This particular black carp specimen was determined to be triploid (sterile), leading managers to believe it escaped from a commercial aquaculture facility. The Illinois Department of Natural Resources is working with commercial fishermen in Horseshoe Lake to determine if there are any other black carp in the lake.[112]

In April and May 2004, two black carp specimens, one of which was 43 inches long, were caught in the upper Atchafalaya River/lower Red River region of Louisiana. Researchers felt that the Arkansas Osage River population was too far removed from these two Louisiana specimens to explain their origin and suspected a new source, possibly an escape from an aquaculture facility permitted by the Louisiana Department of Wildlife and Fisheries to evaluate triploid black carp effectiveness for snail control. Preliminary tests indicate the two black carp specimens may be diploid, indicating that they may be reproducing in open waters. The commercial fisherman who caught the carp reported that he had been catching "strange-looking grass carp in this area for over 8 years."[113]

Although there are no known black carp populations in Mississippi, two states adjacent to Mississippi and two states upriver—Arkansas and Louisiana, and Illinois and Missouri, respectively—have collected black carp from their waters. This species is of concern to the MAIS Task Force, and it may become necessary to start a black carp monitoring program.

Effective November 19, 2007, USFWS added all forms of live black carp (*Mylopharyngodon piceus*), gametes, viable eggs, and hybrids to the list of injurious fish under the Lacey Act. By this action, the Service prohibits the importation into or transportation between the continental United States, the District of Columbia, Hawaii, the Commonwealth of Puerto Rico, or any territory or possession of the United States of live black carp, gametes, viable eggs, and hybrids. Live black carp, gametes, viable eggs, and hybrids can be imported only by permit for scientific, medical,

educational, or zoological purposes, or without a permit by federal agencies solely for their own use. Interstate transportation of live black carp, gametes, viable eggs, and hybrids currently held within the United States will be allowed only by permit. Interstate transportation permits may be issued for scientific, medical, educational, or zoological purposes.[114] See Section 13.H.5 for additional information on this species.

4.C.2.b.ii Vermiculated Sailfin Catfish (*Pterygoplichthys disjunctivus*)

The vermiculated sailfin catfish (Photo 3) is native to South America and the Amazon Basin. Also called "suckermouth armored catfish" due to the thick plates on their heads and bodies and sucker-like mouths, these catfish also have a large, spiny, sail-like dorsal fin. Probably introduced to the United States as an aquarium fish, it is now established in central Florida and parts of North Carolina. Specimens have been collected from Washington State and Mississippi. A single specimen was found in the Pearl River at the I-20 Bridge in 1992 (Figure 21). The environmental impacts of this fish are still unknown, but fisheries biologists speculate that it may be adversely affecting the food web due to its benthic grazing.[115]

Photo 4. Vermiculated sailfin catfish (*Pterygoplichthys disjunctivus)*.
Photo credit: USGS.

4.C.2.b.iii Lionfish (Pterois voltans)

The Gulf of Mexico is now home to the Indo-Pacific lionfish (*Pterois voltans*). This popular aquarium pet with a bold appearance and venomous "mane-like" spines first escaped into Florida's Atlantic waters in 1992 as a result of Hurricane Andrew. In years since, these highly prolific super-predators have spread as far North as New York as far South as Venezuela. Scientists now consider lionfish to be the first non-native fish species to establish successful breeding populations along the U.S. East Coast and Caribbean Sea.[174]

In 2011 this invasion reached the Northern Gulf of Mexico. Lionfish have been recently sighted in Alabama, Louisiana and Texas waters. Fisheries biologists anticipate that it is only a matter of time before these fish are discovered off the coast of Mississippi as well.[173]

Photo 5. Lionfish (*Pterois voltans)*.
Photo credit: AquaValley.ca

These voracious top-carnivores are harmful because they consume up to 60% of their body weight every day and have few, if any, natural predators. Females can produce up to two million free-drifting eggs per year. These exotic invaders have been linked to drastically reduced reef fish populations in the Caribbean and are considered a significant threat to the ecology and economy of the Gulf Coast region.[175]

MDMR's Artificial Reef and Aquatic Invasive Species Programs are working together with the National Park Service-Gulf Islands National Seashore, the U.S. Fish and Wildlife Service, Gulf States Marine Fisheries Commission and conservation officials from neighboring states to confront these "lions of the deep".[173]

Planned activities include development of an interagency strike force for early detection and rapid response to new lionfish invasions as well as public outreach and education activities.[173] While there is no technology that can completely stop this exotic invader, it is hoped that a proactive and coordinated approach will help reduce lionfish numbers and preserve our native fish populations.

4.C.3 Mollusks

Mollusks of Mississippi are placed in two categories in this Plan: 1) Extensively Established Species, and 2) Locally Established Species or Species of Potential Concern.

4.C.3.a Extensively Established Species

4.C.3.a.i Zebra Mussel (*Dreissena polymorpha*)

The zebra mussel, native to the Black, Caspian, and Azov seas, was first discovered in North America in 1988 in Lake St. Clair, near Detroit, probably the result of a release of veligers (larvae) in ballast water. In subsequent years, zebra mussels quickly spread throughout the Great Lakes, down the Mississippi River, and up its tributaries, including the Ohio, Tennessee, Cumberland, and Arkansas rivers.[116]

In Mississippi, zebra mussels are established in the Mississippi River at mile 537 at the Warfield Point Revetment, the Mississippi River at mile 433 at Entergy's Baxter-Wilson Plant just south of Vicksburg, the Mississippi River at mile 363.5 at Natchez, and in 2002 were found in the Mississippi Sound between Cat Island and Gulfport.[117] There are unconfirmed reports that zebra mussels are established on the locks of the Tennessee-Tombigbee Waterway, and MDEQ biologists have collected zebra mussels from "river connected oxbows well south of Natchez"[118] (Figure 22). In addition to other environmental problems, zebra mussels are notorious biofoulers and colonizers of water intake/outtake pipes at industrial facilities located along rivers.

On the federal level, USACE performs periodic zebra mussel monitoring surveys at locks and other structures during dewatering or when gates are removed for maintenance. The USFWS 100th Meridian Initiative aims to prevent the westward spread of zebra mussels by trailered boats. The USFWS Southeast Region is working to implement an outreach program aimed at boaters visiting locations of confirmed or potential zebra mussel sightings.[119] In 2012, the USFWS Southeast Region will be supporting a risk assessment for zebra mussels throughout the Tennessee-Tombigbee Waterway. The risk assessment will include matching environmental tolerances, confirming environmental tolerances under laboratory conditions, growth and survival, and matching with environmental data in the Tennessee-Tombigbee Waterway.[120]

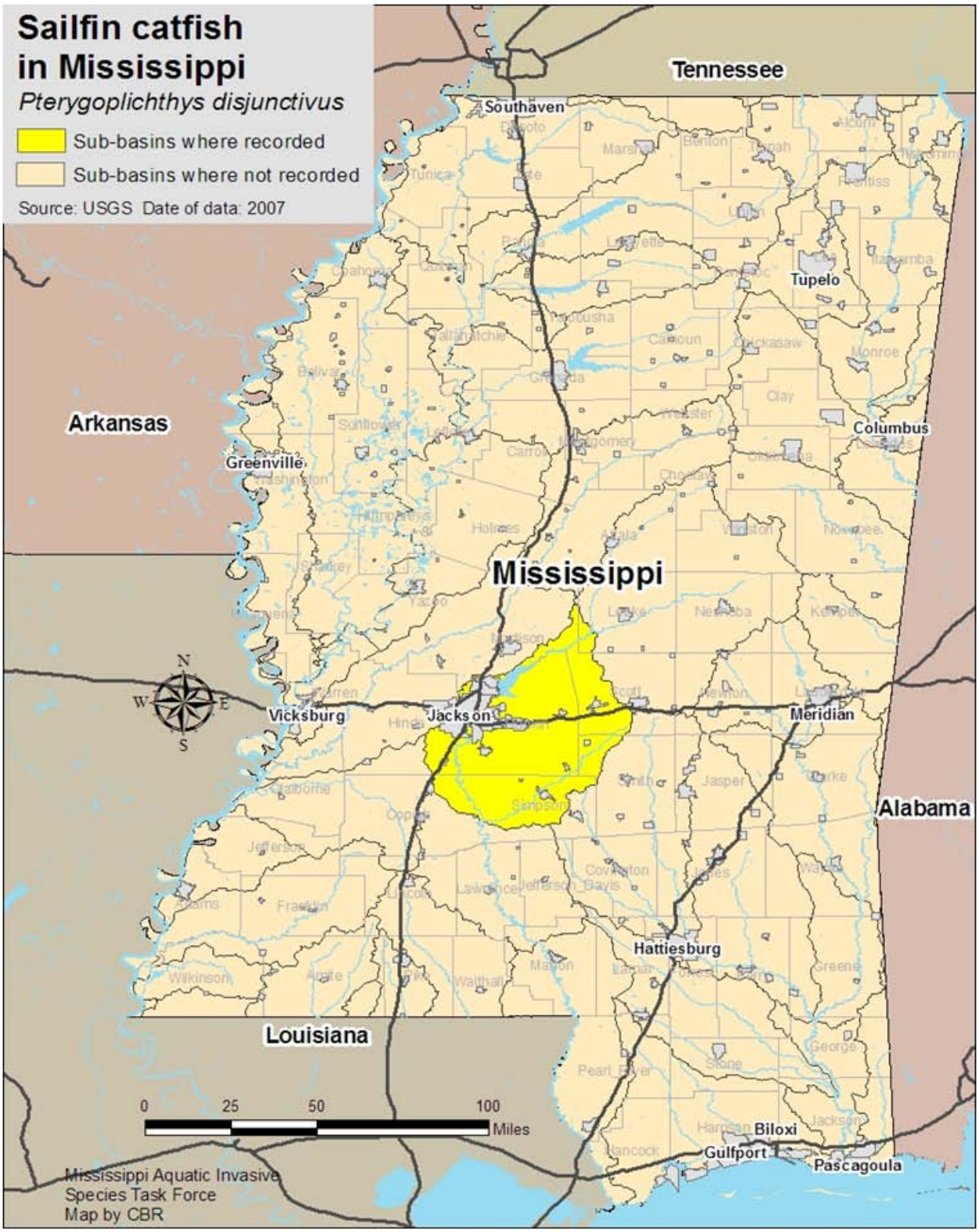


Figure 21. Distribution of vermiculated sailfin catfish in Mississippi aggregated by drainage basin. Also called "suckermouth armored catfish" due to the thick plates on their heads and bodies and sucker-like mouths, these catfish have a large, spiny, sail-like dorsal fin. Map by CBR, 2007.

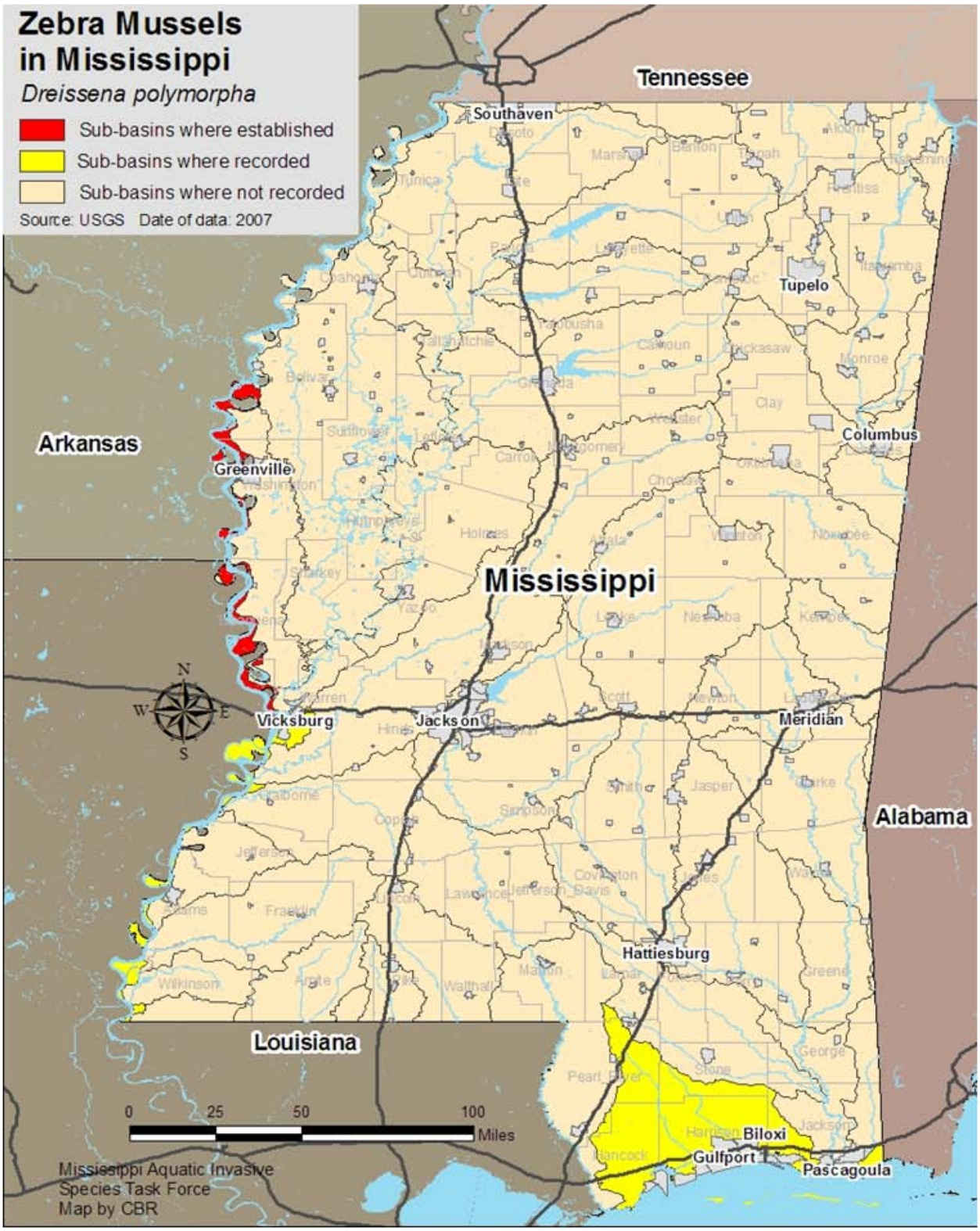


Figure 22. Distribution of zebra mussels in Mississippi aggregated by drainage basin. The zebra mussel, native to the Black, Caspian, and Azov seas, was first discovered in North America in 1988 in Lake St. Clair, near Detroit, probably the result of a release of veligers (larvae) in ballast water. In subsequent years, zebra mussels quickly spread throughout the Great Lakes, down the Mississippi River, and up its tributaries. Map by CBR, 2007.

Zebra mussel infestations, while costly to industry and public works, have not been as widespread in the lower Mississippi River as elsewhere in the United States, primarily due to current speed and water temperature. In the spring, when zebra mussel veligers are most abundant, snowmelt raises the stage of the river, which steepens its gradient and thus increases its velocity. The rapid current prevents many veligers from attaching to hard substrates in the river. Consequently, the larvae are swept to the Gulf of Mexico and die in saline waters. In the late summer and early fall, the river lowers and loses velocity. As water temperature rises, zebra mussels expend energy to prevent overheating, causing them to decrease their consumption and subsequently starve to death.[121]

4.C.3.b Locally Established Species or Species of Potential Concern

4.C.3.b.i Green Mussel (*Perna viridis*)

The green mussel is native to the Indo-Pacific region, from the Persian Gulf to the South China Sea. It was introduced to the Gulf of Mexico around 1990 when larvae were transported in ballast water to Trinidad. Green mussels subsequently appeared in Venezuela in 1993, and in the United States in 1999, when underwater divers performing maintenance work at a power plant in Tampa Bay, Florida, discovered the mussels clogging the inside of cooling water intake tunnels. According to Benson et al. (2001), "phylogenetic comparisons between known *Perna* species and species collected from Tampa Bay indicated that the Tampa Bay specimens were most closely related to *Perna viridis* acquired from Trinidad."[122] As of December 2002, the range of *Perna viridis* in the United States was confined to Tampa Bay and the Gulf of Mexico between Johns Pass and Charlotte Harbor in Florida, but in February 2003, live mussels were found on the Atlantic Coast of Florida, from St. Augustine to New Smyrna Beach. In addition, the green mussel is spreading north and west. Researchers from the Smithsonian Environmental Research Center (SERC) found a *Perna viridis* specimen on a fouling plate in Pensacola, Florida. SERC believes recreational boaters probably transported the mussel.[123] Georgia Department of Natural Resources officials and researchers at the University of Georgia recently found green mussel specimens in Georgia waters, near Brunswick and Tybee Island at the mouth of the Savannah River.[124]

Green mussels prefer warm estuarine environments. The lower limit of the green mussel's salinity tolerance is 16 ppt and researchers have shown that *P. viridis* can survive in turbid waters.[125] Researchers are concerned that as filter feeders, green mussels will impact the availability of phytoplankton for native species and increase water clarity in previously turbid waters.[126] In addition to ecological impacts, *P. viridis* is a known biofouler of boats and submerged infrastructure such as bridges, seawalls, docks, and buoys. Like the zebra mussel, the green mussel can interfere with industry and power plant activities by clogging cooling-water intakes and outflow pipes. Tampa Bay area oyster beds have recently been invaded by *P. viridis*, which attach to and suffocate native oysters. Florida's oyster reefs consist of the species *Crassostrea virginica*, which is also commercially valuable to Mississippi's seafood industry. In the invaded Tampa Bay area oyster reefs, up to 90 percent of the dead oysters were killed recently, meaning that the oyster was still attached to the shell and normal predation was probably not a factor. Researchers suspect that the green mussel may be having a negative effect on commercially important oyster beds in Florida.[127]

Recreational boat traffic and commercial shipping lanes between Florida (particularly Tampa Bay and Pensacola) and Texas could serve as a pathway for *P. viridis* into Mississippi waters. If introduced, *P. viridis* could become established in Mississippi coastal waters.

4.C.3.b.ii Island Apple Snail (*Pomacea insularum*)

The island apple snail is a large freshwater snail native to South America. It was first found on the Texas Gulf Coast in mid-2000. This species is similar to the Florida apple snail (*Pomacea paludosa*), but it possesses a more prominent apex, a much more deeply incised suture and tends to grow to a larger size. It is capable of tolerating a broad range of salinities. Initially this species was identified as the channeled apple snail (*Pomacea canaliculata*), but genetic testing

has proven that the species collected in Florida, Georgia and Texas are in fact island apple snails. This species is mainly herbivorous, usually feeding on macrophytes and occasionally on the eggs and juveniles of other snails. In Hawaii and parts of Asia, these snails have become a serious pest in rice fields. These snails can also host a parasitic rat lungworm that can infect humans.

Island apple snails have been found in Alabama in Lake Munson, Lake Brantley, and in Spring Hill Lake near Mobile, as well as many locations in Florida. This species has also been reported in the Alabaha River in Georgia; American Canal and Mustang Bayou in Texas, and in 2006 in the Veret Canal in Gretna, Louisiana.[128] Riecke[129] stated that this species has been collected from Hide-A-Way Lake, Picayune, Pearl River County, Mississippi. They have likely been present at this location for approximately 10 years. Measurement of genomic DNA content confirms that the Hide-A-Way Lake population is a match with *Pomacea insularum*. Recently an additional population, thought to be this species, was collected from Wood Lake subdivision in Picayune, Mississippi. Homeowners have stated that they have seen the pink egg masses typical of this genus for 3 to 4 years. Identification of this population is currently being confirmed by Jenn Bernatis at the University of Florida.

On September 12, 2001, MDAC adopted an Emergency Apple Snail Regulation.[130] This regulation was adopted to prevent the introduction and spread of the destructive plant-eating apple snails of the family Ampullariidae. The regulation prohibits the movement of live forms of these snails at any stage of development into and within the state of Mississippi.

Apple snails have been introduced into Mississippi through the pet trade, and they have been found in several pet stores in Mississippi. They are typically sold under the names “mystery snail,” “golden apple snail,” “ivory mystery snail,” and “black mystery snail.” These apple snails are likely *Pomacea bridgesii*, the only apple snail species within Ampullaridae allowed for importation or interstate commerce by the USDA APHIS permit system. However, to prevent the introduction of unwanted apple snails, BPI has requested that any pet store selling these snails cease selling them and destroy them.

4.C.3.b.iii Japanese Mystery Snail (*Bellamya japonica*)

The Japanese mystery snail has been established in the United States since the late 1800s, but the record from a single site on McKinney Bayou (August 2007), north of Hollywood, Tunica County, Mississippi, is the first report from the lower Mississippi basin. A follow-up study was conducted in September 2007 by Dr. Jan Hoover and others from the USACE Engineer Research and Development Center in Vicksburg, Mississippi. Photographs and specimens have been identified by several outside authorities (Doug Shelton, Rob Dillon, and Jay Cordiero), and voucher specimens have been deposited with the Mississippi Museum of Natural Science. Additional specimens will be deposited with the Smithsonian. A journal article describing the collection of this species is pending.[131] Dr. Hoover reported in July, 2012 that over time, the population has increased to densities of 1-15 snails/ m^2 and spread out slightly within the same watershed.[171]

4.C.4 Mammals

Mammals of Mississippi are placed in two categories in this Plan: 1) Extensively Established Species, and 2) Locally Established Species or Species of Potential Concern.

4.C.4.a Extensively Established Species

4.C.4.a.i Nutria (*Myocastor coypus*)

Nutria, or coypu, are herbivorous, rodent-like aquatic mammals deliberately introduced to Louisiana from Argentina between 1900 and 1940 for fur farming. Some nutria were released into the wild, and others were used as biocontrol for invasive water hyacinth. A prolific breeder, nutria reach sexual maturity at just 4 months of age, and females are able to breed within 48 hours of

giving birth to a litter. Nutria young are precocial (capable of a high degree of independent activity from birth) and can swim and eat vegetation shortly after birth. [132]

Nutria exacerbate coastal erosion by digging into thin soils and eating roots of marsh vegetation. As the vegetation dies, the fine-grained, denuded soils become more vulnerable to erosion, eventually forming expanding holes in the marsh called "eat-outs." With the exception of alligators, nutria have no natural predators in the United States; populations were kept in check for decades only by fur trappers motivated by a healthy demand for nutria pelts. After the price of nutria pelts plummeted in the late 1980s, populations exploded. Wildlife managers estimate that several million nutria inhabit the Gulf Coast region today. For more information on nutria harvests for fur, see the "Fur Industry" section under Section 4.B.12.

Nutria are not distributed throughout Mississippi. The USGS Nonindigenous Aquatic Species database for invasive aquatic species, however, provides documentation that they are established in a total of 18 of the 82 counties of Mississippi: Adams, Bolivar, Claiborne, Coahoma, Desoto, Hancock, Harrison, Holmes, Issaquena, Jackson, Jefferson, Leflore, Stone, Tunica, Warren, Washington, Wilkinson, and Yazoo.

4.C.4.b Locally Established Species or Species of Potential Concern

No locally established invasive mammals currently warrant inclusion in this Plan.

4.C.5 Other

"Other species" are those of other taxonomic groups that the Task Force decided are important and problematic, but do not fit into any of the above categories. Other species are placed in two categories in this Plan: 1) Extensively Established Species, and 2) Locally Established Species or Species of Potential Concern.

4.C.5.a Extensively Established Species

None to date.

4.C.5.b Locally Established Species or Species of Potential Concern

4.C.5.b.i Australian Spotted Jellyfish (*Phyllorhiza punctata*)

The Australian spotted jellyfish, native to the South Pacific Ocean, was introduced to the Caribbean probably between the 1950s and 1970s, but was not noticed in the northern Gulf of Mexico until June 2000, when the *Phyllorhiza punctata* population exploded.[133] *P. punctata* was likely transported from Australia to the Caribbean through the Panama Canal, either as polyps in ballast water or attached to the hull of a ship. Transport of this species to the northern Gulf of Mexico may have occurred when an eddy spun off of the Loop Current, which carries tropical water from the Caribbean to the Gulf of Mexico.[134]

In summer 2000, when *P. punctata* populations were at their greatest, commercial fishermen, researchers, and environmental managers feared this species might have a significant impact on commercially valuable fisheries, specifically shrimp, menhaden, anchovies, crabs, and red snapper. Shrimpers complained that the gelatinous creatures were clogging their nets. Every summer, larval fish and eggs, particularly for those species mentioned above, are carried by tides to estuaries close to shore. In 2000, the jellyfish blocked the entrances to these estuaries. *P. punctata* is a filter-feeding omnivore that will consume every living organism smaller than a few millimeters across. Each jellyfish can filter up to 50 cubic meters of water and eat approximately 2,400 fish and shellfish eggs on a daily basis.[135] According to Harriett Perry, director of the Fisheries Section of the Gulf Coast Research Laboratory in Mississippi, "You really have two problems in terms of commercially important fish. First, the jellies are ingesting the larvae and eggs of these commercially important species, and then the fish larvae must compete with these incredibly efficient jellies for the same food source."[136]

Though the spotted Australian jellyfish population explosions of 2000 have not occurred since, USGS reports that "yearly re-occurrence of medusae in waters east of the Mississippi River and the maintenance of a population west of the Mississippi River in Terrebonne Bay, Louisiana, suggest that populations have become established in the northern Gulf of Mexico."[137] Numerous specimens of spotted Australian jellyfish were reported from the Indian River Lagoon in Florida in 2001[138]. Graham et al. (2003) reported that thousands of medusa were present in south Louisiana waters west of the Mississippi River in 2003, and they were seen in Galveston Bay, Texas, in June 2006[139]. The yearly reoccurrence of medusa in waters east of the Mississippi River and the maintenance of a population west of the Mississippi River in Terrebonne Bay, Louisiana, suggest that populations have been established already in the northern Gulf of Mexico.

4.C.5.b.ii Giant Malaysian Prawn (*Macrobrachium rosenbergii*)

Commercial production of the tropical giant Malaysian prawn (Photo 4) has been the subject of research and commercial enterprise in the United States for several decades. This species is native to the tropical Indo-Pacific region of the world. Basic production techniques were developed in the late 1950s in Malaysia, and in the United States, Israel, and several Asian countries during the last three decades. *Machrobrachium rosenbergii* is tolerant to a wide temperature range, and it can tolerate low dissolved oxygen levels with a minimum of stress. Due to its ability to survive in a variety of environmental conditions, and due to increased demand for seafood at low costs, *M. rosenbergii* is thought to be a desirable aquaculture species.[140] Production of freshwater prawns in Mississippi requires a permit from MDAC.

In 1984, the MSU Mississippi Agricultural and Forestry Experiment Station (MAFES) initiated an extensive research program to develop and evaluate management practices for the establishment of a commercial freshwater prawn industry. Research and on-farm demonstration projects to date have proven that this could be a profitable enterprise in Mississippi. The availability of juveniles, once a major limitation to the establishment of the industry, is no longer a constraint with at least one supplier located in Mississippi. Although the commercial production of prawns is currently limited in the state, the potential is real and it appears to be only a matter of time before commercial prawn production is a viable component of the Mississippi aquaculture industry.[141]

Photo 7. Giant Malaysian prawn (*Macrobrachium rosenbergii*). Photo credit: Southeastern Regional Taxonomic Center/ South Carolina Department of Natural Resources.

In 2001, while surveying for nonindigenous fish species, a team of researchers in Mississippi found 40 giant Malaysian prawn specimens in Simmons Bayou, Mississippi, between the months of May and November. In four consecutive months of sampling, the researchers found juvenile giant Malaysian prawns, indicating there may be some spawning in the wild. Simmons Bayou receives effluent from an aquaculture facility.[142]

There are no known adverse impacts of this species on natives in Simmons Bayou; however, *M. rosenbergii* are known to be resistant to and a carrier of white spot virus, and could potentially displace and threaten native and commercially valuable shrimp and other aquatic species.[143]

4.C.5.b.iii Australian Red Claw Crayfish (*Cherax quadricarinatus*)

Australian red claw crayfish (Photo 5) are native to northern Australia, but were introduced to the United States in the late 1980s for research as a potential aquaculture species. Compared with native crayfish, *Cherax quadricarinatus* have a larger potential size, yield more meat, can grow in a wide temperature range (23 ºC to 31 ºC), are non-aggressive, and can spawn several times per year. *C. quadricarinatus* can also tolerate relatively low levels of dissolved oxygen.[144]

Like some other cultured species, there is a possibility of escape from captivity and establishment in local waters. According to the Southern Regional Aquaculture Center (SRAC), "red claw are excellent climbers and escape from tanks if the water level is near the tank top or if equipment such as air line tubing or heater cords extends over the sides of the tank."[145]

Prior to Hurricane Katrina, one producer in Jackson County, Mississippi, was licensed to raise Australian red claw crayfish in ponds. The facility was heavily damaged by the storm, and the producer reported that 100% of the crayfish were killed by saltwater rainfall during the hurricane.[146] Currently, there are two facilities in Mississippi licensed by the state to raise Australian red claw crayfish—the producer in Jackson County and another in Union County. The facility in Jackson County applied for a permit for Australian red claw crayfish and has resumed production.[147]

Photo 8. Australian red claw crayfish (*Cherax quadricarinatus)*.
Photo credit: Missouri Department of Conservation

Another potential problem with farm-raising Australian red claw crayfish is that, according to SRAC, due to the light blue color and red claws, many juvenile Australian red claw crayfish being produced in the southeastern United States are being sold in aquarium/pet stores as an ornamental species.[148] Aquarium dumping is a well-documented pathway for invasive species introduction and could result in this species becoming introduced and established in US waters.

4.C.5.b.iv Asian Tiger Shrimp (*Penaeus monodon*)

Asian tiger shrimp (Penaeus monodon), native to SE Asia, Australia and the Philippines has been found recently in Mississippi and could pose a threat to waters native shrimp species.[172]

Photo 5. Asian Tiger Shrimp (*Penaeus monodon)*.
Photo credit: MDMR

Commercial shrimp fishermen reported landing fifteen Asian tiger shrimp from Mississippi waters in 2011. Tiger shrimp were captured in the Mississippi Sound near Pascagoula, Bellfountaine Point, Round Island , East of Cat Island, South of Horn Island and near the Chandeleur Islands. The other two recorded Mississippi Sound sightings occurred near Pascagoula in 2009.[173] Since 2006, tiger shrimp have also been found in the waters of Louisiana, Alabama, Florida and the Carolinas.

These exotic shrimp are presumed to have escaped from aquaculture facilities in the Caribbean and carried here by ocean currents. Although no tiger shrimp are being raised commercially in the United States, past aquaculture facilities have operated in Texas, Alabama, Florida and South Carolina. Potential environmental threats from exotic shrimp introductions include diseases, aggression toward native shrimp and competition for food and habitat.

Asian tiger shrimp can easily be identified by the distinctive black and white "tiger" striping pattern on the shell and their large size compared to native shrimp. These giant crustaceans can grow to more than 10 inches long and weigh more than half a pound.[172]

4.C.6 Microorganisms

4.C.6.a Human Pathogens

West Nile virus is one of the many examples of viruses, bacteria, and other disease-causing microbes that qualify as invasive species. Despite their acknowledged importance, the MAIS Task Force decided not to address these microorganisms in this Plan. The Task Force decided that the management measures that are already in place through various other governmental health organizations, such as the Centers for Disease Control and Prevention, could address these disease-causing agents. The Task Force chooses to allocate scarce state and federal resources toward the prevention and control of invasive species that agencies focused on human health cannot address.

4.C.6.b Fish Pathogens

Movement of live fish and ballast water as part of global commerce provides opportunities for transfer of fish pathogens outside their native range. Some of these pathogens pose significant risks to cultured and wild fish within Mississippi. Nonindigenous fish pathogens may directly impact fisheries or aquaculture through morbidity and mortality associated with pathogen infection. Indirect impacts may also occur as an effect of regulatory actions to reduce the risk of introducing pathogens into the state or to eradicate the disease when discovered within the state. For example, catfish aquaculture is a regional industry involving considerable interstate transport of juvenile and food-sized fish among farms in Alabama, Arkansas, Louisiana, and Mississippi. State or federal regulations restricting interstate or intrastate movement of catfish could cause significant economic hardship to fish farmers. Likewise, MDWFP relies on reciprocal agreements among various states to provide certain sportfish for stocking public waters. Regulations to reduce risk of spreading nonnative fish pathogens could also affect those activities. The three diseases described below are listed as notifiable by the Office International des Epizooties (OIE). In the United States, suspect cases must be sent to a USDA-approved fish disease diagnostic laboratory for confirmation. If the case is confirmed as a notifiable disease, the diagnostician must promptly notify the state veterinarian and appropriate USDA-APHIS Veterinary Services officials. Confirmed diagnoses usually trigger eradication efforts, which may cause severe economic losses to aquaculturists.

Three fish viruses—spring viremia of carp virus (SVCV), koi herpes virus (KHV), and viral hemorrhagic septicemia virus (VHSV)—are recognized as nonnative to the United States and of potential concern to wild and captive fish stocks. These viruses do not cause disease in humans and have no zoonotic significance. SVCV and KHV disease are of concern in Arkansas, Florida, and other states that have significant aquaculture industries involving cyprinid fishes grown for bait or ornamental purposes. Channel catfish are considered susceptible to VHSV and, as such, VHSV is of special concern in Mississippi. These viruses have not been detected in fish in Mississippi.[149]

The MAIS Task Force decided not to address these fish pathogens in the Plan at this time. Regulatory and policy activities regarding VHSV are in flux, and fish health specialists are working with aquaculture representatives from Alabama, Arkansas, Louisiana, and Mississippi to develop a strategic plan for reducing risks of introducing and spreading the disease within these states. The MAIS Task Force recommends that the MIAIS Council consider amending this Plan in future updates to address introductions of nonnative fish pathogens, especially for VHSV. The need for amendments to address this issue should be clear in the next few years. If amendments are enacted, the issue will need to be reevaluated.

4.C.6.b.i Spring Viremia of Carp Virus (SVCV)

SVCV is a rhabdoviral disease mainly of common carp (*Cyprinus carpio*). The disease has been reported throughout Europe and in many countries in the Middle East and Asia. Reports of the disease in Europe date to the Middle Ages.[150] The disease has recently been reported in wild and cultured fish in South and North America, with reports in the United States from North Carolina, Wisconsin, Illinois, Missouri and Washington.[151] Common carp, including its color variant koi, is the main species affected by SVCV, but other species that can sustain natural infections include, but are not limited to, grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*), bighead carp (*Hypophthalmichthys nobilis*), and goldfish (*Carassius auratus*). Species that can be experimentally infected include northern pike (*Esox lucius*), pumpkinseed sunfish, (*Lepomis gibbosus*), zebra danios (*Brachydanio rerio*), and golden shiners (*Notemigonus crysoleucas*). The disease is spread primarily by direct contact with infected fish and via feces, urine, and gill mucus from infected fish. Water or mud from environments harboring infected fish may also transmit the virus and mechanical vectors, such as birds or fish culture equipment, may also be significant in the spread of the disease. Transmission over wider geographical areas is primarily through movement of infected live fish. There are no antiviral treatments or commercial vaccines for SVCV, and prevention is best accomplished through biosecurity measures such as testing and quarantine of susceptible fish obtained from outside sources.[152] Disease outcome is highly temperature-dependant with greatest losses occurring at water temperatures less than 20 ºC. High summer temperatures in Mississippi may prevent permanent establishment in the state.[153]

4.C.6.b.ii Koi Herpes Virus (KHV)

KHV is a highly contagious herpes virus that may cause significant morbidity and mortality in common carp and koi.[154] Goldfish and other fish in the cyprinid family are not susceptible to KHV and do not act as carriers of the virus. The first outbreak of KHV disease was reported in 1998 in Israel. Since then, the disease has been confirmed in the United States, Europe, and Asia. The virus is spread by direct contact with infected fish, with fluids from infected fish, or with water or mud from environments harboring infected fish. Susceptible fish that are exposed may become infected and either develop the disease and die or become carriers of the virus. Introductions over wider geographical areas are primarily through movement of infected live fish. There is no known treatment for KHV. Control measures include testing, quarantine, and use of appropriate biosecurity measures when obtaining any susceptible fish from outside sources. If KHV is detected, the affected culture system should be depopulated, followed by disinfection of all materials and systems that have contacted infected fish.[155]

4.C.6.b.iii Viral Hemorrhagic Septicemia Virus (VHSV)

VHSV is an important rhabdoviral disease of fish that has historically been considered the most serious viral disease of salmonids reared in freshwater in Europe.[156] It has recently become associated with marine species and, in 2005, a highly virulent, easily transmissible strain of VHSV (Type IVb) was identified as the cause of fish kills in the Great Lakes region of the United States and Canada.[157] USDA-APHIS issued a federal order in November 2006 (modified May 2007) placing restrictions on importation and interstate transportation of 34 affected fish species to prevent movement and accidental transmission of the virus. All states bordering the Great Lakes, some of which are also in the Mississippi River Basin, were declared affected regions.[158] Among fish species considered susceptible to VHSV (Type IVb) are several important sport and commercial fishes in Mississippi, including black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), brown bullhead (*Ameiurus nebulosus*), channel catfish (*Ictalurus punctatus*), largemouth bass (*Micropterus salmoides*), pumpkinseed sunfish (*Lepomis gibbosus*), rock bass (*Ambloplites rupestris*), smallmouth bass (*Micropterus dolomieu*), and walleye (*Sander vitreus*).[159] The virus is spread by direct contact with infected fish and with fluids from infected fish. Fish-eating birds and contaminated fish culture equipment can also be mechanical vectors of VHSV. The primary vector for large-scale transmission is movement of live fish and fish products, leading many states within the Mississippi River Basin to modify fish transportation and bait laws to help reduce the risk of spreading VHSV. Treatments for VHSV do not exist; control measures include testing, quarantine, and use of appropriate biosecurity measures when obtaining any

susceptible fish from outside sources. High summer temperatures in Mississippi may prevent permanent establishment in the state.[160]

4.D Exacerbating Circumstances

Factors such as lack of communication, legal loopholes and shortfalls, and geographical conditions complicate Mississippi's aquatic invasive species problems. These and other exacerbating circumstances are documented here.

Lack of Communication and/or Cooperation Among State Agencies — Task Force members recognize the lack of a single "point person" or agency for the public to contact with questions about invasive species. In addition, overlapping or unclear jurisdictions can create "turf wars" between state agencies, which can result in delays responding to invasive species occurrences and control efforts.

Lack of Education, Knowledge, and Concern or Ignorance of Existing Laws — This major problem is described by examples offered by Task Force members:

- "The vast majority of the boating and fishing public appear to be ignorant of the problem with invasive exotic species. Therefore, they do not exercise relatively easy measures to prevent the spread of these exotics;"
- "Many of those involved with the aquarium, landscaping, and garden pond hobbies do not appear to recognize the problems with invasive species. This includes both consumers and merchants;"
- "Previous education efforts by USDA have not made enough of an impact, so international travelers continue to carry prohibited articles, which harbor exotic pests;"
- "This [invasive species issue] is still a 'back burner' issue for most of the general public and many people in related and affected industries;" and
- "The public is generally aware of the negative impact of some invasives (i.e., Formosan termites, fire ants, hydrilla) but is not aware of how their actions could lead to the next problem."

Lack of Laws or Enforcement of Existing Laws — Gaps and loopholes in existing federal laws weaken their effectiveness. Another common problem is the lack of enforcement of federal laws governing the aquarium trade and sale of aquatic plants. Mississippi has no formal state inspection program to ensure that banned or invasive plants and animals are not being sold in plant nurseries and aquarium/pet stores.

Lack of Effective Alternatives to Biological Control of Pests in Aquaculture Facilities — Black carp (*Mylopharyngodon piceus*) are used for biological control of snails that carry a trematode that may infect commercially valuable catfish crops in aquaculture facilities. To date, black carp are the most effective way to curb incidences of parasites infecting the catfish. Research to find an alternative method of controlling the snails is ongoing for the purpose of reducing, and eventually eliminating, the use of black carp to control the snails. Aquaculturists should be educated and encouraged to use alternatives whenever possible.

Lack of Funding — Funds shortfalls for education, prevention, and control projects also contribute to Mississippi's invasive species problem. One Task Force member stated, "Government funding for invasive species detection has been spotty, with high-profile species and certain geographical areas (e.g., exotic fruit flies in Florida and California) receiving the lion's share, while smaller states desiring to survey for lower-profile species receive minimal dollars, if any."

Tropical Storms and Hurricanes — Tropical storms and hurricanes serve as natural dispersion mechanisms for invasive species, especially aquatic plants. Storms can also disturb habitats, making them more vulnerable to an invader. Winds and floodwaters, during the tropical storm

season beginning June 1 and lasting through November 30, or at other times during the year, can transport seeds and plant fragments to new areas, potentially over long distances.

Other exacerbating circumstances and concerns raised by the Task Force members include:

Competing Interests — Control of invasive species may require the use of herbicides or pesticides, and/or host removal, trapping, animal depopulation, etc., some of which are opposed by certain advocacy groups.

Limited Detection Technology — Detecting the presence or absence of invasive species in an area usually relies on costly and time-consuming field surveys. Technologies to sense their presence remotely on a broader scale are available, but fail to consistently and directly detect target species in a variety of environments. For certain invasive plants (kudzu, water hyacinth, weed infestations in agricultural areas), multispectral and hyperspectral aerial and satellite imagery have proven useful in detection. Aerial surveys have been used to map marshland "eat-outs" to provide information on nutria distributions, and handheld thermal imagers have been used to find Formosan termite infestations inside structures. These approaches are mostly still in testing phases and have not been deployed operationally. Accurate and timely detection and mapping of invasive species remains a challenge.

Lack of Control Alternatives — Sometimes when confronting a new pest or disease, basic research has not been done to identify alternate effective control measures. Industries may be faced with using only one control method, which could be the use of another nonnative species for biological control.

Aversion to Implementing Chemical Control — Among the general public, there can be resistance to the use of chemical control methods because of fears that the application of the chemical may result in harm to the environment or to non-target species, or harm to human health. Some pond owners would prefer to use grass carp (*Ctenopharyngodon idella*) as a biological control method rather than use approved aquatic herbicides. Using nonnative species such as grass carp for biological control can result in a new set of invasive species problems, however.

Lack of Data — Information on invasive species in Mississippi is difficult to find on the internet, in scientific journals, and other sources, in large part because the research has not yet been done or published.

Fines Viewed as "Cost of Doing Business" — Economic gains in the smuggling and sale of species often outweigh monetary fines imposed by governments trying to prevent species introductions. Smugglers have little incentive to follow import regulations, and commercial smuggling of prohibited products in maritime containers is occurring more frequently. Some traders in invasive species view fines simply as a cost of doing business. USDA's APHIS recently increased civil penalties for such violations from a maximum penalty of $1,000 to $50,000 per violation and $250,000 for a business.

Globalized Economy — International trade continues to expand in terms of both volume and markets, and technological advances in transportation help facilitate species introductions. Globalization of the economy has, to date, led to extensive spread of species worldwide.

Uncoordinated Detection Efforts — Currently, each state and federal agency individually determines which pests to survey, with only minimal input from other government agencies and stakeholders.

Task Force members also noted a need for more effective monitoring, a Rapid Response and Early Eradication Plan, and better decision-making processes.

5 State Jurisdictions

The following chapter, by attorney Stephanie Showalter and the staff of Mississippi-Alabama Sea Grant Legal Program, describes the myriad of state agency jurisdictions related to aquatic invasive species in Mississippi. (For federal laws, programs, and regulations, see Section 13.D.) Although some jurisdictions below may only be peripherally relevant to AIS, they were included for two reasons: (1) this Plan may eventually be expanded to encompass terrestrial as well as aquatic invasive species, and including terrestrial jurisdictional information may aid Mississippi in the expansion process; and (2) due to the unpredictability of bioinvasions, the jurisdiction information below may be relevant in a future rapid-response scenario. The MAIS Task Force chose to include jurisdictional information in this Plan that is both directly and indirectly relevant to invasive species. If terrestrial species are added to the Plan at some future time, it will be important to distinguish the terrestrial species from aquatic species. This will be necessary for the purpose of easily distinguishing between terrestrial and aquatic species sections of the Plan but also to assist in securing funds to implement the Plan. In all likelihood, any future funding for terrestrial species would be available from sources different from aquatic species.

5.A Mississippi Department of Wildlife, Fisheries, and Parks

5.A.1 General Authority

MDWFP has general control and management authority over aquatic species. Under Miss. Code Ann. §49-7-80, it is illegal to "place, release or cause to be released into any of the public waters of the state any aquatic species without first obtaining a permit from the Mississippi Department of Wildlife, Fisheries and Parks." Furthermore, "no person shall release or cause to be released within this state, any animal not indigenous to Mississippi without first obtaining a permit from the Mississippi Department of Wildlife, Fisheries and Parks." A violation of this provision is a misdemeanor and a Class I violation. The punishment for a Class I violation is stated in Section 49-7-141 of the Mississippi Code of 1972 as amended, as a fine not less than $2,000.00 and not more than $5,000.00; imprisonment in the county jail for 5 days; and forfeiture of all hunting, trapping, and fishing privileges for a period of not less than 12 consecutive months from the date of conviction. Before issuing or denying a permit, MDWFP must "complete a study of the species to determine any detrimental effect the species might have on the environment." MDWFP is also authorized to establish and maintain "a list of approved, restricted and prohibited species and establish rules governing importation, possession, sale and escape of those species."

In 1969, MDWFP made it unlawful for any person to transport into the state, offer for sale, or have in possession within the state live forms of fishes commonly called walking catfish and piranhas. Any person having either or both in their possession shall notify the local warden immediately of such possession. Conservation officers shall take possession and dispose of these fishes in such a way as to prevent their introduction into the waters of the state of Mississippi (Mississippi Game and Fish Commission. 1969. Public Notice #1405.).

The Commission on Wildlife, Fisheries, and Parks may also issue permits to kill any species of animals or native, non-migratory birds that may become injurious to agricultural or other interests in any particular community (Miss. Code Ann. §49-1-39).

5.A.2 Aquaculture

Miss. Code Ann. §79-22-15 states that the Commission on Wildlife, Fisheries and Parks may promulgate regulations that specify design criteria to protect the resources within its jurisdiction and to prevent the release of undesirable species from an aquaculture facility into the environment.

5.A.3 Private Shooting Preserves

Miss. Code Ann. §49-11-15(3) states that the Commission on Wildlife, Fisheries, and Parks is authorized to specify the species of nonnative wild game that may be released or hunted in commercial wildlife enclosures.

5.A.4 Nutria Control

"Any board of supervisors may, in its discretion, by appropriate resolution spread upon its minutes, offer a bounty not to exceed Five Dollars ($ 5.00) for each nutria, beaver or bobcat destroyed, where such board finds and determines that nutria, beaver or bobcats are in such quantities that the preservation of trees and other properties requires such bounties to be offered" (Miss. Code Ann. §19-5-51). MDWFP is responsible for redeeming receipts issued by the sheriffs upon the presentation of the complete tail of the animal.

5.A.5 Boating

The Mississippi Commission on Wildlife, Fisheries, and Parks has assumed and now exercises the duties and responsibilities of the Mississippi Boat and Water Safety Commission through MDWFP, except on marine waters under the jurisdiction of the Commission on Marine Resources (Miss. Code Ann. §59-21-111(1)). The Commission is authorized to promulgate regulations for the administration and enforcement of the Mississippi Boating Law of 1960 and to promote the fresh waterways of the state (Miss. Code Ann. §59-21-117).

Under Miss. Code Ann. §59-21-129(1), any state agency or political subdivision may apply to the Commission for the adoption of special rules or regulations relating to the operation, equipment, or safety of vessels on any waters within its territorial limits or jurisdiction. The Commission may adopt such special rules or regulations after public notice and a hearing.

5.B Mississippi Department of Marine Resources

5.B.1 General Authority

The Commission on Marine Resources has the authority "to exercise full jurisdiction and authority over all marine aquatic life and to regulate any matters pertaining to seafood, including cultivated seafood" and to adopt "rules and regulations necessary for the protection, conservation or propagation of all seafood in the waters under the territorial jurisdiction of the State of Mississippi" (Miss. Code Ann. §79-15-15). Section 49-15-11 vests MDMR with the authority "to manage, control, supervise, enforce and direct any matters pertaining to saltwater aquatic life and marine resources under the jurisdiction of the commission."

5.B.2 Coastal Wetland Protection Act

Section 49-27-3 states "it is declared to be the public policy of this state to favor the preservation of the natural state of the coastal wetlands and their ecosystems and to prevent the despoliation and destruction of them, except where a specific alteration of specific coastal wetlands would serve a higher public interest in compliance with the public purposes of the public trust in which coastal wetlands are held" (Miss. Code Ann. §49-27-9). No regulated activity, including the "Killing or materially damaging any flora or fauna on or in any coastal wetland" and "the erection of any structure or structures on suitable sites for water dependent industry," shall affect any coastal wetlands without a permit unless excluded in Section 49-27-7 (Miss. Code Ann. §49-27-7 and §49-27-9). In granting a permit under this chapter, the Commission on Marine Resources may impose conditions or limitations on the proposed activity designed to carry out the public policy set forth in this chapter" (Miss. Code Ann. §49-27-29). The Commission "may require a performance bond in an amount to be set by the commission with surety and satisfactory conditions securing to the state compliance with the conditions and limitations set forth in any permit" (Miss. Code Ann. §49-27-31).

5.B.3 Aquaculture

Under the Aquaculture Act, the "Commission on Marine Resources may promulgate regulations which specify design criteria to protect the resources within [its] jurisdiction and to prevent the release of undesirable species from an aquaculture facility into the environment" (Miss. Code

Ann. 79-22-15). Ordinance 13.001, An Ordinance to Regulate Aquaculture in the Marine Environment, contains MDMR's aquaculture regulations.

5.B.4 Boating

The Commission on Marine Resources has assumed and now exercises the duties and responsibilities of the Mississippi Boat and Water Safety Commission through MDMR on the marine waters of the state (Miss. Code Ann. §59-21-111(2)). The Commission is authorized to adopt rules and regulations necessary to carry out these duties (§59-21-117(2)).

Counties and municipalities bordering the Mississippi Sound and other coastal or tidal waters are authorized and empowered to adopt ordinances setting out special rules and regulations with reference to the operation, equipment, or safety of vessels or motorboats on waters within their territorial limits (Miss. Code Ann. §59-21-129(2)). The ordinances may not conflict with any provision of the Mississippi Boating Law or the regulations of any federal agency having jurisdiction over such waters. As a condition precedent to the adoption of the ordinance, the recommendation of the Commission of Marine Resources must be obtained following a public hearing.

5.C Mississippi Department of Agriculture and Commerce

5.C.1 Aquaculture

Effective July 1, 1993, the Mississippi Aquaculture Act of 1988 (Mississippi Code of 1972 as amended, Section 79-22-15) was revised to change the regulatory authority for aquaculture from MDWFP to MDAC. Under the Mississippi Aquaculture Act of 1988, an aquaculturist is required to obtain a cultivation and marketing permit from MDAC to produce products from "all nonnative aquatic plants and animals, including those that are well established in limited or extensive areas of natural lakes, rivers and streams in this state" (Miss. Code Ann. §79-22-9(1)(a)).

MDAC's Guidelines for Aquaculture Activities contain a listing of species of animals and plants that the Department has "determined to be detrimental to the State's native resources." The importation, sale, possession, transport, or release of the listed species or hybrids thereof is prohibited. The list includes piranhas, Nile perches, snakeheads, hydrilla, water hyacinth, and zebra mussels.

In the event of a release or escape of a nonnative species from a permitted facility, MDAC is required to notify MDWFP. MDWFP is authorized to conduct removal and eradication activities. MDWFP may also seek reimbursement for the cost associated with eradication efforts from the aquaculturist if the release was due to the aquaculturist's negligence or mismanagement.

5.C.2 Plant Pests

MDAC has regulatory authority over plant diseases and pests and noxious weeds. The Commissioner of Agriculture and Commerce may issue rules and regulations under which the Department's inspectors shall:

"(a) inspect places, plants and plant products, and things, and substances used or connected therewith;
(b) investigate, control, eradicate and prevent the dissemination of insect pests, diseases and noxious weeds; and
(c) supervise or cause the treatment, cutting and destruction of plants and plant products and other things infested or infected therewith" (Miss. Code Ann. §69-25-7).

The Commissioner of Agriculture and Commerce "shall list the insect pests, diseases and noxious weeds, of which he shall find that the introduction into, or the dissemination within, this state should be prevented in order to safeguard the environment, agricultural and horticultural

production and the plants and plant products of this state, together with the plants and plant products and other things likely to become infested or infected with such insect pests, diseases and noxious weeds" (Miss. Code Ann. §69-25-9). MDAC maintains lists of certain insects and diseases declared to be public nuisances (MDAC Plant Pest Programs Rule 1) and insects pests and diseases declared to be especially injurious (Rule 2). Any person having knowledge of the presence of a listed pest, disease, or noxious weed is required to report its presence to the Commission or an inspector. Any person engaging in the sale of plants and plant products infested, infected, or likely to become so, shall report the name and location of persons and localities where he purchased or obtained such plants and plant products.

In general, the owner or other person in possession or control of the place where a plant or plant product infested or infected with any insect, pest, disease, or noxious weed listed as a public nuisance is found is required to undertake control, eradication or other measures to prevent the dissemination of such pest, disease or weed. If an owner cannot be found or fails to take measures upon written notification by MDAC, required measures shall be carried out by MDAC (Miss. Code Ann. §69-25-15). The application or use of pesticides restricted by EPA or the Commissioner is prohibited unless the applicator is certified or licensed by MDAC (Miss. Code Ann. §69-23-111).

"It shall be unlawful for any person to sell, give away, carry, ship, or deliver for carriage or shipment within this state, any plants or plant products… unless such plant or plant products or other thing or substance have been officially inspected and a certificate issued by an inspector of the commissioner stating that the plants or plant products or other thing or substance have been inspected and found to be apparently free from insect pests, diseases and noxious weeds, and any other facts provided for in the rules and regulations made pursuant to this statute" (Miss. Code Ann. §69-25-19).

5.D Mississippi State Department of Health

The Mississippi State Department of Health (MSDH) has broad authority to protect the public from disease, including the authority to investigate potential health threats, inspect facilities, establish quarantine, and the power to take physical control of people and property at its discretion (Miss. Code Ann. §§41-3-15, 41-23-5). MSDH may declare a health threat to be a "nuisance" and take legal action to have it abated (Miss. Code Ann. §41-23-13). MSDH is authorized to inspect food service establishments (Miss. Code Ann. §41-3-15). MSDH inspects restaurant facilities to ensure that all shellfish come from National Shellfish Santination Program-listed sources, in accordance with the US Food and Drug Administration's Food Code (MSDH Reg. 10.3). MSDH has authority to shut down establishments that serve food when it determines that an imminent health hazard exists (MSDH Reg. 10.4). MSDH is authorized to regulate domestic and imported catfish (Miss. Code Ann. §41-3-15(4)(o); Miss. Code Ann. §§69-7-601 *et seq*. (Mississippi Catfish Marketing Law of 1975)).

5.E Mississippi Department of Transportation

The Mississippi Department of Transportation (MDOT) has broad authority relating to the maintenance of the state highway system. The Mississippi Transportation Commission is authorized "to expend funds in cooperation with the Bureau of Plant Industry, Mississippi Department of Agriculture and Commerce, the United States government or any department or agency thereof, or with any department or agency of this state, to control, suppress or eradicate serious insect pests, rodents, plant parasites and plant diseases on the state highway rights-of-way" (Miss. Code Ann. §65-1-8(s)). Recognizing that highways are a pathway for the spread of invasive species, the Mississippi Highway Department is prohibited from purchasing or planting seed in a right-of-way that contains more than the maximum allowance for noxious weed seed as prescribed by the Mississippi Pure Seed Law and regulations (Miss. Code Ann. §65-1-55). The

Department must also refrain from using sod that contains prohibited noxious weed plants or tubers (Miss. Code Ann. §65-1-55).

5.F Port Authorities and Commissions

Mississippi cities and counties with ports or harbor are authorized to establish port authorities and commissions. These commissions have jurisdiction over the port, terminals, harbors, and all vessels, common carriers, and public utilities therein (Miss. Code Ann. §59-1-1) and may promulgate rules and regulations to govern the harbor, docks, and passes within their jurisdictions (Miss. Code Ann. §59-1-9). The authority of the various port commissions is broad and can be used to address invasive species. The Mississippi State Port Authority at Gulfport, for instance, through its Operation and Procedures Manual, requires that all applications for Cargo Space Assignment are reviewed to determine if the cargo is of a type that could be subject to insect infestation (Code of MS Reg. 06-000-002, §430 (2005)). If it is, the assigned shed must be cleaned, washed, and inspected and treated, if necessary, by a pest control contractor.

6 Goal and Objectives

The MAIS Task Force decided upon the following goal and objectives to shape Mississippi's invasive species management responses:

6.A Goal

To minimize environmental and economic impacts to Mississippi from aquatic invasive species by preventing and controlling introductions of new nonindigenous species, by controlling the spread and impact of existing aquatic invasive species, and by eradication of locally established aquatic invasive species wherever possible.

6.B Objectives

6.B.1 Objective 1. Coordination of AIS Programs and Activities

Coordinate all AIS management activities or programs within Mississippi and collaborate with regional, national, and international AIS programs.[161]

6.B.2 Objective 2. Prevention and Control of AIS Through Education

Prevent and control the introduction/reintroduction of nonindigenous invasive species through education about species and pathways, targeting the general public (including schools), industries, user groups, government agencies, and nongovernmental organizations.

6.B.3 Objective 3. Monitoring, Early Detection and Early Eradication of AIS

Eliminate locally established invasive species through monitoring, early detection, rapid response, and early eradication.

6.B.4 Objective 4. Controlling the Spread of AIS

Control the spread of established invasive species through cooperative management activities designed to minimize impacts when eradication is impossible.

6.B.5 Objective 5. Prevention of AIS Through Legislation, Regulation and Enforcement

Prevent the introduction of nonnative species, or the spread of existing ones, through legislation, regulation, and enforcement.

7 Prioritization of Problems

Prioritizing invasive species problems and solutions presents a special challenge. The MAIS Task Force has conducted literature reviews and engaged in discussions and debate. It was decided that "exacerbating circumstances" would not be prioritized because all are equally important, and some are unresolvable. The Task Force has concluded that its collective intuition and professional judgment are the best guides to prioritize these aspects into "high," "medium," and "low" categories under four of the five objectives, rather than reliance on an overly complex and often misleading quantitative mechanism. Section 7.A lists the MAIS Task Force Prioritization of Pathways. Priorities were also based on the objectives of the Plan. It is important to note that ranking species by objective (Section 7.B) was conducted *relative to that species group*. For example, controlling the vermiculated sailfin catfish was ranked "high" as a priority among other finfish, but this does not necessarily imply it is as high a priority as controlling certain aquatic plants, such as hydrilla, that have proven far more problematic than the vermiculated sailfin catfish. (See Section 8, Management Actions, for more information on the goal and objectives of this Plan.)

7.A Prioritization of Pathways

PRIORITIZATION OF PATHWAYS BY OBJECTIVE	Approach			
	Objective: Prevent and Control through Education	**Objective:** Monitoring, Detection, Early Eradication	**Objective:** Control the Spread	**Objective:** Prevent Through Legislation, Regulation, & Enforcement
Pathways / Media				
Shipping	Medium	Low	Low	Medium
Boating	High	Medium	Low	Medium
Natural Disasters	Low	High	Low	Not Applicable
Transportation Corridors	High	High	Medium	Medium
Ballast Water	Medium	Low	Low	High
Hull Fouling	Medium	Low	Low	Low
Dunnage	Medium	Low	Low	Medium
Aquaculture	Medium	Low	Low	High[162]
Deliberate Stocking for Sportfishing	High	Medium	Low	High
Baitfish	High	Medium	Low	High
Horticulture	High	High	High	High
Agriculture	High	Low	Low	Low
Aquarium / Pet Industries	High	High	Low	High[163]
Fur Industry	Low	Low	Low	Low
Cultural Traditions	High	Low	Low	Low

7.B Prioritization of Species

PRIORITIZATION OF SPECIES BY OBJECTIVE	Approach			
	Objective: Prevent and Control through Education	**Objective:** Monitoring, Detection, Early Eradication	**Objective:** Control the Spread	**Objective:** Prevent through Legislation, Regulation, & Enforcement
Aquatic Plants				
Water hyacinth	High	Low	Medium	Low
Giant salvinia	High	High	High	Low
Common salvinia	High	Low	High	Low
Water lettuce	Medium	Low	Medium	Low
Eurasian watermilfoil	High	Medium	Medium	Low
Hydrilla	High	Low	High	Low
Purple loosestrife	High	Medium	Medium	Low
Torpedo grass	Medium	Medium	Low	Low
Wild taro	Medium	Medium	Low	Low
Peruvian watergrass	High	Medium	Medium	Low
Finfish				
Common carp	Low	Low	Low	Low
Grass carp	High	Low	Low	Medium
Silver carp	High	Low	Low	Low
Bighead carp	High	Low	Low	Medium
Tilapia	High	Medium	Medium	Medium
Black carp	High	Medium	High	High
Vermiculated sailfin catfish	High	High	High	High
Lionfish	High	High	High	High
Mollusks				
Zebra mussel	High	Medium	Low	Low
Green mussel	High	Medium	Low	Low
Island apple snail	High	High	High	High
Japanese mystery snail	High	High	High	High
Asian Tiger Shrimp	High	High	High	High
Mammals				
Nutria	Medium	Low	Medium	Low
Other				
Australian spotted jellyfish	Low	Low	Low	Low
Giant Malaysian prawn	High	Medium	Medium	Medium
Australian red claw crayfish	High	Medium	Medium	Medium
Microorganisms				
Viruses, bacteria, and other disease-causing microbes[164]	Not Applicable	Not Applicable	Not Applicable	Not Applicable

8 Management Actions

This chapter describes the various ongoing and proposed management actions identified by the MAIS Task Force, listed according to the objective they support. A table version of this list appears in Section 9, including relevant budget and full-time-employee information, where available.

Goal: Prevent and control the introduction of new nonindigenous species into Mississippi; control the spread and impact of existing aquatic invasive species; and eradicate locally established aquatic invasive species wherever possible.

8.A Objective 1: Coordinate all AIS management activities or programs within Mississippi and collaborate with regional, national, and international AIS programs.

ACTIONS
Actions are listed in alphabetical order, not in order of priority.

8.A.1 Establish Memorandum of Understanding to Address Overlapping Jurisdictions

One of the first actions taken by the MIAIS Council will be to establish one or several Memoranda of Understanding (MOU), to address overlapping or competing jurisdictions for invasive species. These issues should be resolved so that in the event of a Rapid Response action, no time is wasted determining which state agency is responsible for dealing with the issue. (See Section 8.C.1 for Rapid Response and Early Eradication Plan.)

8.A.2 Form Mississippi Interagency Aquatic Invasive Species Council

The MAIS Task Force recommends the formation of a permanent MIAIS Council, staffed by a full-time coordinator and chaired by a state agency with jurisdiction in AIS matters. Various subcommittees will be formed to address specific issues within the state, such as developing a Rapid Response Plan and educating the public about invasive species and pathways of concern. (See Section 10, Program Monitoring and Evaluation, for more details on the creation of an internal oversight board for evaluating the progress and implementation of this Plan.)

Mississippi joined the Gulf and South Atlantic Regional Panel on Aquatic Invasive Species in 2004 and has attended 12 of 16 panel meetings held from 2004 to 2011. Mississippi joined the Mississippi River Basin Regional Panel on Aquatic Nuisance Species in 2006 and has attended two panel meetings since 2004. Additionally, state agencies utilize and contribute to the USGS Nonindigenous Aquatic Species database and its alert system.

8.A.3 Hire a Statewide Mississippi Aquatic Invasive Species Coordinator

Task Force members agreed that a full-time coordinator will be essential for assisting the MIAIS Council in carrying out its duties. The coordinator should be housed within the lead agency, and could be a new employee hired specifically to serve as the statewide invasive species coordinator, or a person or group contracted by the lead agency to act as the coordinator.

Specific coordinator duties will be determined at a later date, but will include seeking funding from federal, state, and private sources to support the activities of the MIAIS Council, including supporting the coordinator. The coordinator will be also be charged with assisting the Council in developing a program to monitor the progress and implementation of this Plan and periodically updating the Plan as needed.

This action is the only one for which the MAIS Task Force is requesting federal funding to implement. Estimated annual costs for a coordinator's salary plus an operating budget (travel, supplies, printing costs, etc.) are $125,000.

8.B Objective 2: Prevent and control the introduction/reintroduction of nonindigenous invasive species through education about species and pathways, targeting the general public (including schools), industries, user groups, government agencies, and nongovernmental organizations.

ACTIONS
Actions are listed in alphabetical order, not in order of priority.

8.B.1 Aquatic Invasive Species Training for State Employees

This action proposes to train state agency field staff to identify aquatic invasive species they may encounter in the field during the course of their other duties. With proper field identification skills and documentation, the state may get a better picture of the occurrence and distribution of invasive species. If observed and documented properly, this training program may enable the state to better discover and eradicate new infestations, preventing the spread of invasive species.

8.B.2 Assessment of Invasive Species in Mississippi Waters

This action is designed as an educational project to promote public awareness of invasive species issues, train K-12 teachers, and develop teaching materials relative to invasive species in Mississippi. Funding is provided by MDEQ's CIAP.

8.B.3 Education of Boaters and Fishermen

Boat traffic is one of the primary pathways for aquatic plant dispersal. Public boat launches should receive signage, and private or non-state boat launches could be provided signs for posting at little-to-no cost to the boat ramp operators/owners. Aquatic plant information could be placed in boat license information, fishing regulations, and other sources of boating-related information. This activity could be done in conjunction with the "Stop Aquatic Hitchhikers" program run by USFWS. The Mobile District Corps of Engineers has posted "Stop Aquatic Hitchhiker" signs at all Corps boat ramps along the Tennessee-Tombigbee Waterway. MDMR has also posted similar signs at all coastal area boat ramps.

8.B.4 Education of Fish Stocking Entities

This action proposes to train and provide educational materials to employees of permitted fish stocking programs. Accidental introductions could occur through deliberate fish stocking; though the fish stocks themselves might not be invasive, the water used to transport them could be contaminated with invasive plants, invertebrates, or viruses. Fish stocks should be carefully inspected for such biological contaminants before relocation to a new waterbody. USFWS Southeast Region can provide Hazard Analysis and Critical Control Points (HACCP) materials and training to interested parties.[165] The MAIS Task Force will evaluate the HACCP program and will work with USFWS to obtain training for interested Mississippi agencies.

8.B.5 Fact Sheets on Invasive Aquatic Plants in Mississippi

The MSU Geosystems Research Institute (GRI; formerly known as the GeoResources Institute) is developing fact sheets with current information on control techniques for aquatic invasive plants in Mississippi. The information will be disseminated through printed and web-ready products. Approximately 15 species have been targeted thus far.[166] Funding is provided by USGS at $30,000 per year for 3 years.

8.B.6 Invasive Aquatic Animal Database of Mississippi

Similar to the Invasive Plant Atlas of the Midsouth (IPAMS, see Section 8.B.7), GRI has proposed to construct a similar database to that of the IPAMS to track invasive aquatic animals or organisms. Developing the database alone was estimated to cost $30,000, but funding has not been received.

8.B.7 Invasive Plant Atlas of the MidSouth

GRI has developed IPAMS, a web-based database of invasive plants (including aquatic and wetland plants) in the Midsouth region, including Mississippi, Arkansas, Tennessee, Louisiana, and Alabama. Goals of this activity include research, extension and outreach, training of volunteers, distribution of web-based information, and a web-based database to track specific locations of invasive plants. This is an ongoing activity that costs approximately $150,000 per year. Funding is secured through December 2011. IPAMS will likely continue past December 2011, though at a reduced level, from small funding and through the Mississippi CWMA.[167]

8.B.8 Invasive Species Education for Retail Pet Stores

The USGS species pathway data indicate that aquarium releases are responsible for about 9% of all nonnative aquatic species introductions. Potential future efforts by state agencies and the Mississippi Interagency Aquatic Invasive Species Council include the establishment of approved, restricted and prohibited species lists. These lists, in conjunction with responsible possession and ownership guidelines for preventing intentional release of pets, need to be disseminated to pet stores and pet owners. Pet store owners can be educated through the Pet Industry Joint Advisory Council and through onsite contacts at retail pet stores. Printed information concerning these topics should be developed for distribution by MDWFP Conservation Officers and MDAC personnel when they visit these locations. The Habitattitude campaign is a currently established social marketing campaign developed by USFWS. Habitattitude provides materials and resources to the pet industry to help educate the public on the dangers of aquarium releases. Habitattitude materials and resources will be used as guidance in the development of printed information.

8.B.9 Invasive Species Education for Wholesale and Retail Freshwater Bait Dealers

The USGS species pathway data indicate that bait bucket introductions are responsible for about 5% of all nonnative aquatic species introductions. Potential future efforts by state agencies and the MIAIS Council include the establishment of approved, restricted and prohibited species lists. MDWFP is considering the establishment of freshwater bait regulations and licensing requirements for live bait wholesale and retail dealers. The new regulations, in conjunction with guidelines on responsible culture, possession, transport and bait use, should be disseminated to bait dealers and anglers to prevent accidental and intentional introductions. Freshwater bait dealers can be educated through onsite contacts at their business locations. Printed information concerning these topics should be developed for distribution by MDWFP Conservation Officers when they visit these locations.

8.B.10 Invasive Species Education for Wholesale Plant Nurseries, Retail Garden Centers, and Landscape Architects

There are over 150 sod and ornamental plant producers in Mississippi. Each year, the Mississippi Nursery and Landscape Association hosts an educational meeting for these producers. The association also sponsors several plant shows around the state, many of which also have an educational component. Aquatic invasive species prevention, detection, monitoring, and control information should be presented to this trade group at their annual educational meetings and plant shows. Information concerning state and federal regulations, plant identification experts and responsible culture and ownership should be targeted toward aquatic plant producers and water gardeners. Since not all wholesale or retail plant sources are members of this organization, printed information concerning these topics should be developed for distribution by MDWFP Conservation Officers, Mississippi Cooperative Extension Service County Agents, and MDAC personnel.

8.B.11 Invasive Species Workshop for Public Officials

MDMR has tentative plans to co-host an invasive species workshop to educate public officials about this economic and environmental issue. Potential partners include the Natural Resources Conservation Service (NRCS) and USFWS. The workshop will target both aquatic and terrestrial invasive species.

8.B.12 Regional White Paper on Interactions of Aquaculture and Invasive Animal Species in the Southeastern United States

USDA SRAC will solicit authors to develop a comprehensive review of the interactions of aquaculture and nonindigenous animals in the southeastern United States. The review will focus on status, range, uses, risk assessments, regulations, and management of various nonindigenous fishes and invertebrates in the southeast. Total costs are estimated at $5,000. The USDA Cooperative State Research, Education, and Extension Service (CSREES) Regional Aquaculture Center will coordinate this activity and possibly partner with other Mississippi universities.

8.B.13 State Invasive Species Website

To facilitate information dissemination and educational efforts regarding aquatic invasive species in Mississippi, the proposed MIAIS Council and the statewide MAIS Coordinator (Sections 8.A.2 and 8.A.3) should work together to design and maintain an AIS website for Mississippi. This site would serve as a comprehensive source of information for citizens as well as local and state agency personnel regarding state AIS efforts, activities, and publications. The website should include a comprehensive list of points of contact on various issues and other relevant web links. The site should allow users to report AIS occurrences and access relevant state agency regulations, state laws and news releases concerning AIS. Finally, the website should be very user-friendly so that lay persons can easily become educated and report potential AIS sightings. It is estimated that this project would cost about $2,000 per year and would require 0.25 full-time equivalent (FTE).

8.C Objective 3: Eliminate locally established invasive species through monitoring, early detection, rapid response, and early eradication.

ACTIONS
With the exception of developing a Rapid Response and Early Eradication Plan, actions are listed in alphabetical order, not in order of priority. Developing the Rapid Response and Early Eradication Plan is the first priority of the proposed MIAIS Council.

8.C.1 Develop Rapid Response and Early Eradication Plan

The creation of a Rapid Response and Early Eradication Plan, toward the creation of a readily deployable crew to execute this Plan in the field, is a top priority. Among other elements, this Plan should include:

- Protocols for resolving potential jurisdictional conflicts;
- Contact information for experts who can confirm the identity and recommend actions;
- Establishment of reporting mechanisms (toll-free phone numbers, web pages, etc.); and
- Possible eradication options (herbicides, traps, manual extraction, etc.).

After establishing the MOUs in Section 8.A.1, developing a Rapid Response and Early Eradication Plan will be the most important goal of the MIAIS Council and will be fast-tracked by the members.

Mississippi representatives are already working with the Gulf and South Atlantic Regional Panel for Aquatic Invasive Species to develop guidelines for rapid response and early eradication. The Mississippi Rapid Response and Early Eradication Plan will be developed in accordance with the regional guidelines. Mississippi is also considering the use of the National Incident Command System or other similar structure for rapid response and early eradication. Mississippi anticipates providing the necessary details to adequately provide for coordination and communication to respond and eradicate appropriate AIS in its plan.

8.C.2 Aquatic Plant Surveys of Ross Barnett Reservoir

In 2006, GRI surveyed the extent of invasive aquatic plants in Ross Barnett Reservoir near Jackson, and evaluated the effectiveness of management techniques for long-term control of alligatorweed (*Alternanthera philoxeroides*), water hyacinth (*Eichhornia crassipes*), and hydrilla (*Hydrilla verticillata*) in the reservoir. This survey has been continued through summer 2011.

8.C.3 Coastal Preserve Hyperspectral Imagery Mapping Program

MDMR would like to conduct a large-scale aquatic vegetation mapping project using high-resolution hyperspectral imagery to identify aquatic invasive species populations in the Mississippi Coastal Preserve. This high-tech project is currently unfunded, but costs are estimated at approximately $425,000. Implementation of such a program would better enable early detection and rapid response scenarios, and could increase the likelihood of eradication if the infestation is caught in its early stages.

8.C.4 Monitor and Control Aquatic Invasive Species Degrading Marine Habitats

MDMR aims to develop a monitoring and control plan for invasive marine species. Funding is provided by NOAA, and administered through the Gulf States Marine Fisheries Commission. Aspects of the monitoring and control plan may include the following:

- Boat and airplane surveys of Mississippi's coastal and estuarine waters for aquatic invasive species infestations;
- Treatment of infestations using physical extraction techniques, biocontrol agents, herbicides, and other methods as appropriate. Existing publications will be searched to find the best management practices on a case-by-case basis with regard to the various species requiring treatment and the surrounding environmental conditions. Techniques will be selected based upon existing economic, environmental, and technical constraints; and
- Education and outreach activities to raise awareness about aquatic invasive species and how the public can minimize introductions and spread of future and existing invasives.

8.C.5 Monitoring of Aquaculture Facilities

The USGS species pathway data indicate that aquaculture practices are responsible for about 9% of all nonnative aquatic species introductions. Aquaculture facilities are periodically inspected by MDAC employees. Since monitoring is a critical tool for early detection and rapid response, coordination of monitoring activities is essential. Initial and renewal applications for aquaculture cultivation and marketing permits are also reviewed by several state and federal agencies. It is recommended that MDAC personnel inform these agencies of the aquaculture facility inspection schedule so they can accompany MDAC personnel on these inspections when possible.

8.C.6 Monitoring of Aquatic Wildlife in Biloxi Bay Estuary

The Gulf Coast Research Laboratory conducts monthly monitoring of early life history stages of fishes and invertebrates in the Biloxi Bay estuary. Exotic and invasive species captured in collections are identified and recorded, and sightings of invasive species, such as the Australian

spotted jellyfish (*Phyllorhiza punctata*), are noted by researchers. This is an ongoing project funded by NOAA.

8.C.7 Monitoring of Coastal Resources

The Gulf Coast Research Laboratory acquired funding for the 2006 calendar year to conduct broad-scale monthly monitoring of coastal resources. Sixteen-foot trawls allowed researchers to capture and identify aquatic species, including invasive aquatic species. Researchers also recorded sightings of invasive species, such as the Australian spotted jellyfish (*Phyllorhiza punctata*). Funds were provided by the Mississippi Tidelands Trust Funds. As a result of the Deepwater Horizon oil spill, extensive surveys were conducted in 2010 and 2011.

8.C.8 Monitoring of Plant Nursery Industry

The plant nursery industry is growing in Mississippi and has been identified as a potential pathway for introduction of aquatic plant pests. The funding and manpower available to many state agencies is insufficient to adequately protect the state from potential new invasive plants. However, closer monitoring by the state is necessary for effective early detection of species that may escape from plant nurseries, thereby making eradication a viable option. Monitoring the species of plants being sold may be necessary to prevent the escape and introduction of invasive weeds.

8.C.9 Rapid Assessment of Areas Impacted by Major Storms or Other Natural Disasters

The MAIS Task Force recommends that after any major storm or other natural disaster, such as Hurricane Katrina, a rapid assessment be conducted to determine what species are still alive in the affected areas, and to determine if any known invasive species appears to be expanding its range or may have entered public waters.

8.C.10 Risk Assessment Guidelines

A risk assessment should be conducted to determine the potential invasive characteristics of a new species that may be introduced for commercial reasons in Mississippi. For the species to be added to the Approved or Restricted List, a thorough scientific risk assessment should be conducted. (See Section 8.E.1 on Adoption of the Approved/Restricted/Prohibited Lists developed by the MAIS Task Force.) The MAIS Task Force plans to develop risk assessment guidelines in the future. The Task Force is aware of two risk assessment frameworks specifically for AIS management: a species and pathway risk analysis tool developed by ANSTF[168] and a pathways prioritization tool jointly developed by the National Invasive Species Council and ANSTF[169]. An action item for the MAIS Coordinator (see Section 8.A.3) will be to facilitate a review of the available plans by the MAIS Council, who will then select the most appropriate plan for Mississippi.

8.C.11 Screening Process for Risk Assessment

Because formalized “risk assessments” of nonnative species require in-depth analysis and can be very time-consuming, the Mississippi River Basin Panel on Aquatic Nuisance Species has developed a draft model state natural resources agency screening process.

This “screening process” is defined as an approach taken to quickly and efficiently evaluate a list of species and then decide which are:

- Species with assessed low risk of impact (i.e., no need for regulation at this time);
- Species with assessed high risk of impact (i.e., immediately regulate and manage if in public waters); and
- Species for which formalized risk assessment is recommended.

Formal “risk assessments” are more onerous, expensive, and require more in-depth analysis than screening species in this manner. Screening is recommended to minimize the number of risk assessments that an agency will conduct. It is recommended that the MIAIS Council and the MAIS Coordinator use this screening process to recommend to the relevant state agencies whether a formal risk assessment should be conducted for a particular aquatic species.

8.C.12 Second Rapid Assessment of Mississippi’s Coastal Areas

It is proposed to conduct a second rapid assessment of Mississippi’s coastal areas as a follow-up to the rapid assessment conducted in 2004. Comparisons of the data from the two events can be used to document population changes of both native and introduced species. The proposed rapid assessment sites include the Mississippi Sound, bays, bayous, and rivers. This initiative is currently unfunded, but costs are estimated at about $150,000. Potential funding sources include NOAA, National Marine Fisheries Service, and Alabama-Mississippi Sea Grant. Past and future partners include MDMR, the Gulf Coast Research Laboratory, the Gulf States Marine Fisheries Commission, and others.

8.C.13 Southeast Area Monitoring and Assessment Program

With funds provided by NOAA and project implementation by the Gulf Coast Research Laboratory, this ongoing project monitors offshore fishery resources. Annual project funding is $442,106.

8.C.14 Statewide Aquatic Plant Surveys of State Noxious Weeds

In 2005, with funding from MDAC, GRI surveyed selected waterbodies to locate new infestations of giant salvinia and hydrilla. Surveys for giant salvinia and hydrilla are funded for 2011 but have not been conducted as of August 2011. The survey is for the BPI division of MDAC and paid for by the Cooperative Agricultural Pest Survey (CAPS) program through BPI.

8.D Objective 4: Control the spread of established invasive species through cooperative management activities designed to minimize impacts when eradication is impossible.

ACTIONS
Actions are listed in alphabetical order, not in order of priority.

8.D.1 Development of a Comprehensive Management Plan to Reduce or Eliminate the Need for Black Carp for Trematode Management in Mississippi Aquaculture

Scientists at MSU (National Warmwater Aquaculture Center, Stoneville) and USDA-APHIS (National Wildlife Research Center, Starkville) plan to develop a comprehensive management plan to control *Bolbophorus* trematode infections of channel catfish (*Ictalurus punctatus*). The disease in channel catfish causes multimillion-dollar losses annually in the farm-raised catfish industry. The most effective control measure is eliminating the snail vector from ponds. Currently, biocontrol using black carp (*Mylopharyngdon piceus*) provides the most dependable long-term suppression of snail populations, but the black carp may escape from captivity, as has been documented in other states. Aspects of this proposed project include:

- Studies of the role of pelicans in the epidemiology of infections;
- Studies of pelican management and dispersal methods;
- Studies of the incidence and severity of trematode infections in catfish aquaculture populations; and
- Studies to identify alternatives to black carp for snail control.

This project has been ongoing annually since 2006. This work and additional work are being performed on a regular basis as part of a CIAP project.

8.D.2 Mapping and Controlling the Post-Hurricane Katrina Population of Giant Salvinia in the Lower Pascagoula River

MDMR and USGS are working jointly to control the giant salvinia (*Salvinia molesta*) population in the lower Pascagoula River. The project has two main objectives: (a) mapping the post-Katrina distribution of giant salvinia in the lower Pascagoula River system; and (b) controlling the giant salvinia population through the use of herbicides and/or biological controls. Funding was acquired from USGS in 2006, and mapping was completed in 2008. Results from the mapping project were published in 2010.[170] Control efforts as well as early detection of new invasions are still ongoing through a four-year CIAP project that began in July 2009 and runs through June 2013 (Tier 1 CIAP Project No. MS.R.718, "Aquatic Invasive Species Coordination, Assessment and Control Plan Implementation"). The total four-year budget for the project is $377,757.

8.E Objective 5: Prevent the introduction of nonnative species, or the spread of existing ones, through legislation, regulation, and enforcement.

ACTIONS
Actions are listed in alphabetical order, not in order of priority.

8.E.1 Adoption of the Approved/Restricted/Prohibited Species Lists

The MAIS Task Force recommends that MDWFP adopt the proposed Approved/Restricted/ Prohibited Species Lists (provided in its first iteration in Section 13.C) as the overall Approved/Restricted/Prohibited Species Lists for the entire state. MDWFP is mandated by law to create these lists, and after thorough consideration, the MAIS Task Force has made recommendations as to which species should be on each list. The lists are a living document, and may be updated regularly, as necessary.

8.E.2 Freshwater Fishing Bait Regulations

The USGS species pathway data indicate that bait bucket introductions are responsible for about 5% of all nonnative aquatic species introductions. Currently the only Mississippi freshwater fishing bait regulations that exist are those that require wholesale minnow dealers obtain a freshwater commercial fishing license to sell minnows within the state. There are no regulations to prevent anglers from using any desired freshwater fishing bait species. MDWFP has begun compiling a list of all freshwater fishing bait species and items currently being used. The goal is to prohibit the use of all nonnative species for freshwater bait sale, possession and use. To meet this goal, MDWFP may compose and adopt freshwater fishing bait regulations.

8.E.3 Permitting Australian Red Claw Crayfish in Aquaculture

MDAC is authorized to write permits for any farmer desiring to raise Australian red claw crayfish (*Cherax quadricarinatus)*. Farmers must install and maintain devices to prevent the escape of the crayfish from the aquaculture facilities. MDAC inspects crayfish-permitted facilities for regulation compliance.

8.E.4 Permitting Bighead Carp in Aquaculture

MDAC is authorized to write permits for any fish farmer desiring to raise bighead carp (*Hypophthalmichthys nobilis*) as a food fish. Usually the carp are transported out of state to Asian food markets, where they are a desirable food. Farmers must install and maintain screens and other devices to prevent the escape of the carp from the aquaculture ponds. MDAC inspects bighead carp-permitted facilities for regulation compliance. See Section 13.H.3 for additional information on this species.

8.E.5 Permitting Black Carp in Aquaculture

MDAC is authorized to write permits for any fish farmer desiring to stock black carp (*Mylopharyngdon piceus*) as a biocontrol fish for snails carrying parasites that may infect commercially valuable fish in aquaculture facilities. Farmers may only stock triploid (sterile) black carp, and they must install and maintain screens and other devices to prevent the escape of the carp from the aquaculture ponds. MDAC inspects black carp-permitted facilities for regulation compliance. See Section 13.H.5 for additional information on this species.

8.E.6 Permitting Freshwater Prawns in Aquaculture

MDAC is authorized to write permits for any farmer desiring to raise freshwater prawns. Farmers must install screens and other devices to prevent the escape of the prawns from the aquaculture facilities. MDAC inspects permitted facilities for regulation compliance.

8.E.7 Permitting Grass Carp in Aquaculture

MDAC is authorized to write permits for any fish farmer desiring to raise grass carp (*Ctenopharyngodon idella*). This is an economically valuable fish due to the substantial demand for use of this fish as a biocontrol for aquatic plants in lakes and ponds. Though it is recommended that farmers only stock triploid (sterile) grass carp, it is not a regulation. The farmers must install screens and other devices to prevent the escape of the carp from the aquaculture ponds. MDAC inspects grass carp-permitted facilities for regulation compliance.

8.E.8 Permitting Tilapia in Aquaculture

MDAC is authorized to write permits for any fish farmer desiring to raise tilapia (*Tilapia* spp., *Oreochromis* spp., and *Sarotherodon* spp.). Tilapia are a commercially valuable food fish. Farmers must install screens and other devices to prevent the escape of the fish from the aquaculture facilities. MDAC inspects tilapia-permitted facilities for regulation compliance.

8.E.9 Plant Assessments of Potentially Invasive Aquatic Plants

Using the USDA-APHIS procedure for evaluating plants, GRI has been developing plant assessments for potential invasive aquatic plants in the Midsouth. Assessments performed to date include beach vitex (*Vitex rotundifolia*) and roundleaf toothcup (*Rotala rotundifolia*). USGS provided funding for this activity, approximately $25,000 per year.

9 Implementation Table

This implementation table summarizes the management actions described in Section 8. Mississippi requests $125,000 in funding from USFWS. These funds will be used to implement the action described in Section 8.A.3, hiring a statewide Mississippi aquatic invasive species coordinator. The MAIS Task Force considers this action to be the most important and requires immediate funding in order to continue implementation of this Plan.

Goal: Prevent and control the introduction of new nonindigenous species into Mississippi; control the spread and impact of existing invasive species; and eradicate locally established invasive species wherever possible.

Objective 1. Coordinate all AIS management programs within Mississippi and collaborate with regional, national, and international AIS programs.
Objective 2. Prevent and control the introduction/reintroduction of nonindigenous invasive species through education about species and pathways, targeting the general public (including schools), industries, user groups, government agencies, and nongovernmental organizations.
Objective 3. Eliminate locally established invasive species through monitoring, early detection, rapid response, and early eradication.
Objective 4. Control the spread of established invasive species through cooperative management activities designed to minimize impacts when eradication is impossible.
Objective 5. Prevent the introduction of nonnative species, or the spread of existing ones, through legislation, regulation, and enforcement.

Tasks/Actions		Current Status*	Objective Addressed	Fund Source	Implementing Entity	Cooperating Organizations	Recent Efforts										Planned Efforts (FY12 – FY13)			
							FY07		FY08		FY09		FY10		FY11		DEDICATED		REQUESTED	
Number	Title/Summary						$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE
8.A.1	Establish Memorandum of Understanding to Address Overlapping Jurisdictions	Unfunded	1, 2, 3, 4, 5			MIAIS Council Members														
8.A.2	Form Mississippi Interagency Aquatic Invasive Species Council	Unfunded	1, 2, 3, 4, 5			MIAIS Council Members														
8.A.3	Hire Statewide Mississippi Aquatic Invasive Species Coordinator	Unfunded	1, 2, 3, 4, 5			MIAIS Council Members													125	1
8.B.1	Aquatic Invasive Species Training for State Employees	Unfunded	2		MDEQ	MDWFP, MDMR, MDAC														
8.B.2	Assessment of Invasive Species in Mississippi Waters	Funded	2	CIAP/MDEQ	GRCL	USM			91.99		0		0		0		0		0	
8.B.3	Education of Boaters and Fishermen	Unfunded	2			MDMR, MDWFP														
8.B.4	Education of Fish Stocking Entities	Unfunded	2		USFWS	MAIS Task Force														
8.B.5	Fact Sheets on Invasive Aquatic Plants in Mississippi	Funded	2	USGS	GRI	USGS, MSU ES, USACE ERDC	30	.5	30	.5	30	.5	30	.5	0	0	0	0	0	0
8.B.6	Invasive Aquatic Animal Database of Mississippi	Unfunded	2		GRI															
8.B.7	Invasive Plant Atlas of the Midsouth	Funded	2	USDA CSREES NRI	GRI	MDAC, USDA CSREES NRI, MSU ES, USGS, Univ. of Connecticut, NBII	150	1.0	150	1.0	150	1.0	150	1.0	0	0	0	0		
8.B.8	Invasive Species Education for Retail Pet Stores	Proposed	2	MDWFP	MDWFP	MDAC, PIJAC, MIAIS Council														
8.B.9	Invasive Species Education for Wholesale and Retail Freshwater Bait Dealers	Proposed	2	MDWFP	MDWFP															
8.B.10	Invasive Species Education for Wholesale Plant Nurseries, Retail Garden Centers, and Landscape Architects	Proposed	2	MDWFP	MDWFP	MDAC, MSU ES														
8.B.11	Invasive Species Workshop for Public Officials	Funded	2	MDMR	MDMR	NRCS, USFWS	0	0	1	1	0		0		0		0		0	
8.B.12	Regional White Paper on Interactions of Aquaculture and Invasive Animal Species in the Southeastern United States	Funded	2	SRAC	SRAC	MSU GRI	0	0	0	0	5		0		0		0		0	
8.B.13	State Invasive Species Website	Proposed	2		MIAIS Council															

Tasks/Actions		Current Status*	Objective Addressed	Fund Source	Implementing Entity	Cooperating Organizations	Recent Efforts										Planned Efforts (FY12 – FY13)			
							FY07		FY08		FY09		FY10		FY11		DEDICATED		REQUESTED	
Number	Title/Summary						$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE
8.C.1	Develop Rapid Response and Early Eradication Plan	Unfunded	3			MDEQ, MDMR, MDWFP, MDAC														
8.C.2	Aquatic Plant Surveys of Ross Barnett Reservoir	Funded	3	PRVWSD	GRI	MSU MWRRI, PRVWSD	30	.5	30	.5	30	.5	30	.5	40	.5	0	0	40	.5
8.C.3	Coastal Preserve Hyperspectral Imagery Mapping Program	Unfunded	3		MDMR															
8.C.4	Monitor and Control Aquatic Invasive Species Degrading Marine Habitats	Proposed	3	NOAA, GSMFC	MDMR	NOAA, GSMFC														
8.C.5	Monitoring of Aquaculture Facilities	Funded	3, 4	MDAC	MDAC	MDWFP, USFWS, MDMR		.1		.1		.1		.1		.1		.1		
8.C.6	Monitoring of Aquatic Wildlife in Biloxi Bay Estuary	Funded	3	NOAA, MDMR	GCRL	USM	0	0	35.4		0		0		0		0		0	
8.C.7	Monitoring of Coastal Resources	Funded	3	MTTF	GCRL	USM	43.7		43.7		0		0		0		0		0	
8.C.8	Monitoring of Plant Nursery Industry	Unfunded	3		MDAC	MDWFP, MDMR														
8.C.9	Rapid Assessment of Areas Impacted by Major Storms or Other Natural Disasters	Unfunded	3			MDMR, MDWFP, MDAC, MDEQ														
8.C.10	Risk Assessment Guidelines	Unfunded	3		MAIS Task Force															
8.C.11	Screening Process for Risk Assessment	Proposed	3		MIAIS Council	MDWFP, MDAC														
8.C.12	Second Rapid Assessment of Mississippi's Coastal Areas	Unfunded	3		GCRL, MDMR	MDWFP, AL-MS Sea Grant, GSMFC														
8.C.13	Southeast Area Monitoring and Assessment Program	Funded	3	NOAA	GCRL		118.4		0		0		442.1		442.1		0		0	
8.C.14	Statewide Aquatic Plant Surveys of State Noxious Weeds	Funded	3	MDAC	GRI	MDAC, USDA APHIS	5		5		5		5		0		0		5	
8.D.1	Development of a Comprehensive Management Plan to Reduce or Eliminate the Need for Black Carp for Trematode Management in Mississippi Aquaculture	Funded	4	USDA	MSU, USDA	MDAC			765		915		0		0		0		0	

Tasks/Actions		Current Status*	Objective Addressed	Fund Source	Implementing Entity	Cooperating Organizations	Recent Efforts										Planned Efforts (FY12 – FY13)			
							FY07		FY08		FY09		FY10		FY11		DEDICATED		REQUESTED	
Number	Title/Summary						$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE	$000	FTE
8.D.2	Mapping and Controlling the Post-Hurricane Katrina Population of Giant Salvinia in the Lower Pascagoula River	Funded	4	USGS	MDMR	USGS	0	0	0	0	40.3	1.5	114.0	1.5	111.1	1.5	112.3	1.75		
8.E.1	Adoption of the Approved / Restricted / Prohibited Species Lists	Unfunded	5		MDWFP	MAIS Task Force														
8.E.2	Freshwater Fishing Bait Regulations	Funded	5	MDWFP	MDWFP															
8.E.3	Permitting Australian Red Claw Crayfish in Aquaculture	Funded	5	MDAC	MDAC				2	0.2		.1		.1		.1		.1		
8.E.4	Permitting Bighead Carp in Aquaculture	Funded	5	MDAC	MDAC				2	0.2		.1		.1		.1		.1		
8.E.5	Permitting Black Carp in Aquaculture	Funded	5	MDAC	MDAC				10	0.2		.1		.1		.1		.1		
8.E.6	Permitting Freshwater Prawns in Aquaculture	Funded	5	MDAC	MDAC				1	0.2		.1		.1		.1		.1		
8.E.7	Permitting Grass Carp in Aquaculture	Funded	5	MDAC	MDAC				2	0.2		.1		.1		.1		.1		
8.E.8	Permitting Tilapia in Aquaculture	Funded	5	MDAC	MDAC				2	0.2		.1		.1		.1		.1		
8.E.9	Plant Assessments of Potentially Invasive Aquatic Plants	Funded	5	USGS	GRI	MSU, USGS	25		25		25		25		0		0		5	
	Approximate Total Funding and FTEs						**222.1**	**.6**	**1,196.1**	**4.3**	**1,200.3**	**4.2**	**796.1**	**4.2**	**593.2**	**2.7**	**112.3**	**2.45**	**175**	**1.5**

*Funding provided prior to 2007 has not been included in this table.

10 Program Monitoring and Evaluation

The MAIS Task Force developed this Plan to summarize the status of invasive aquatic species in the state, review the current information regarding management options, and present specific management actions to mitigate problems arising from invasive aquatic species in the state. The Task Force acknowledges that the Plan presents only an initial assessment of the status and management of the problem, and that the Plan must be flexible, adaptive, and continually updated to be effective in the long run. The Task Force also realizes that effective implementation of this and future versions of the Plan depends upon objective monitoring and evaluation of program progress. To that end, the Task Force has recommended the development of an MIAIS Council staffed by a full-time coordinator. Among other responsibilities, including seeking funding and developing MOUs for overlapping jurisdictions between state agencies, the MIAIS Council and MAIS Coordinator will be charged with developing a program to monitor the progress of this Plan in the prevention, limitation, and abatement of aquatic invasive species in the state. Monitoring and evaluation ensures effective implementation of management actions and provides a basis for periodically improving and updating the Plan.

Who should do the evaluation?
The Task Force suggests the creation of an internal oversight board or working group within the to-be-established MIAIS Council. The oversight board should consist of appropriate representatives of state natural resource management agencies, a representative from the governor's office, representatives from the MAIS Task Force, and at least one out-of-state, qualified professional to participate in the monitoring and evaluation. The oversight board will examine progress on management actions, evaluate the success of each action by examining the level of achievement of the tasks defined within each action, disseminating the results of their evaluation, and identifying amendments to enhance the effectiveness of this Plan.

How should the evaluation be done?
The five management objectives described in Section 8 provide the focal point for monitoring and evaluation. However, evaluation should also emphasize funding needs to successfully accomplish goals and associated tasks. Evaluation should also incorporate information from those groups affected by implementation of the Plan.

Specific methods for program monitoring and evaluation will be developed by the to-be-established Interagency Aquatic Invasive Species Council, but the following evaluative approaches should be considered:

Indicator actions—In this approach, evaluators select a representative group of actions as indicative of management plan progress. The degree to which those “indicator actions” acquire funding and are executed in their entirety is the degree to which success is declared. Advantages of this approach are that it is straightforward, inexpensive, and may be implemented in the early years of plan execution. The disadvantages are that it is based upon a small sample, does not address the larger issue of spreading of invasive species, and may not satisfy the public’s right to know overall program effectiveness: “Are we better off now than when this effort commenced?”

Quantitative biological measures—In this approach, field work is conducted to answer questions such as:

- Has the range of a particular species expanded?
- Have new invasive species arrived?
- Have ecological costs of the impact of certain species increased or spread?
- Biologically speaking, is this problem greater than it was 5 years ago?

Advantages of this approach include its scientific and quantitative nature, and it addresses fundamental questions rather than bureaucratic ones. Disadvantages include its costliness, its highly focused nature (one species may contract in range while another may expand), and the need to wait until the end of the 5-year cycle for actions to take potential effect. It may also be "setting the bar too high" to expect to control or eliminate certain species. Several monitoring programs are already in existence in Mississippi and may be considered by the internal oversight board as a method of gathering evaluation data (see Section 8, Management Actions).

Quantitative social measures—In this approach, surveys are conducted among stakeholders to answer such questions as:

- Can you define the term "invasive species?"
- Have you seen posted signs about invasive species at boat ramps and docks?
- Do you wipe off your outboard motor, trailer, and hull upon extracting it from the water?

When should the evaluation be done?
Initial evaluations should be submitted at the end of years 1 and 2, and will probably be limited to the "indicator actions" approach. Deeper assessments should occur in the latter 3 years of the Plan, when the biological and social quantitative methods should be employed, provided baseline data and funding are available. The Task Force may develop a "Performance Budget" funding request through the Mississippi Cooperative Extension Service or encourage universities in the state to develop research projects evaluating task force actions.

Details and the actual execution of program monitoring and evaluation will be left up to the internal oversight board, which will be responsible for a report to the Mississippi legislature every 2 years on progress, problems, and recommendations for plan improvement. The target audience of the report will include the general public; local, state, and federal resource managers; and legislative decision-makers.

11 Glossary of Terms

Acclimatization — the process by which an introduced species and resulting offspring adapt to a new environment.

Aquatic species — all organisms living at least partially in a water environment. Usage commonly refers to aquatic plants such as water hyacinth (*Eichhornia crassipes*) and giant salvinia (*Salvinia molesta*), fish, and invertebrates, but also includes mammals such as nutria (*Myocastor coypus*). For purposes of this Plan, selected species that impact aquatic ecosystems or arrived via aquatic pathways are also considered aquatic species.

Bait — any species (fish, insect, invertebrate) sold for use as bait for recreational fishing.

Ballast — water or other matter placed in specific areas of the hull of a vessel for navigation stability. Species are often inadvertently transported in ballast water when it is released in another water body. In earlier years, rocks and metal bars were used as ballast material. In all cases, species can be transported inadvertently or purposefully in or on ballast material.

Ballast tank sediment — particles suspended in water pumped into ships for ballast that have settled to the bottom of the ballast tank. This sediment can harbor bottom-dwelling species that might be accidentally carried in a ship's ballast water and subsequently released in a new environment.

Biocontrol — the use of living organisms to control other living organisms. It frequently involves the introduction of a nonnative predator, herbivore, pathogen or parasite that interacts with the invasive species in its natural geographic range. An element of risk is associated with biocontrol methods. All possible impacts should be tested before adding a biocontrol agent to an ecosystem because the agent can produce a new economic or ecological problem. For example, introduction of grass carp (*Ctenopharyngodon idella*) to control aquatic weeds was too successful and the carp ate the native vegetation as well.

Control methods — chemical, mechanical, or biological methods to reduce the impact of invasive species. These methods may also be used to contain a species to stop its further spread.

Cryptogenic species — a species of questionable origin; can be native or nonnative. Because humans have not kept a complete list of species by geographic location from the beginning of human life on the planet, there is no continuous, scientific record of all species and their original location(s) on earth. Those species for which the record of origin is questionable or unclear are labeled as cryptogenic.

Drainage basin — the catchment basin from which the waters of a stream, marsh, river, lake, or groundwater system are drawn. An example is the Yazoo River Basin, which comprises roughly 13,400 square miles in northwestern Mississippi.

Dunnage — any packing material used to protect cargo from movement, moisture, contamination, or other damage. Dunnage such as straw and wood has sometimes served as media for species introduction in shipping.

Early eradication — the complete elimination of an invasive species from a specific geographic area at the beginning of the species' colonization of that area. Early eradication is most likely to occur when the species is locally established and with a limited range or distribution.

Ecosystem — a community of organisms and their surrounding abiota functioning as one unit.

Escape — an unintentional introduction whereby an invasive species escapes into open water from captive conditions such as an aquaculture facility, research facility, zoological park, public or private aquaria or any source point. See "Source point."

Established species — a nonnative species with a permanent, reproducing population that is unlikely to be easily eliminated through human action or natural causes. Established species may or may not be invasive (environmentally or economically problematic).

Exotic species — a species that is not native to a designated ecosystem or geographic area. Synonyms include nonindigenous, nonnative, foreign, and alien species. Because some exotic species may be harmful or invasive while others are not, this term should be used with great care.

Freshwater species — aquatic species native to freshwater.

Habitat — area where a species has the necessary food, water, shelter, and space to live and reproduce.

Historic range — the area thought to have been occupied by an organism at the time of European colonization of North America

Indigenous species — organisms naturally occurring in a specific geographic area or ecosystem. Synonyms include native species.

Introduced species — an organism that is not native to a designated ecosystem or geographic area.

Invasive species — a species that is nonnative to the ecosystem under consideration and whose introduction causes or is likely to cause economic or environmental harm or harm to human health. To become invasive, the species must be introduced to an ecosystem in some manner, allowed to establish itself in the wild, achieve reproduction and increase in range and extent, and exert a negative impact or economic or ecological effect. For a nonnative organism to be considered an invasive species in the policy context, the negative effects that the organism causes or is likely to cause are deemed to outweigh any beneficial effects. For purposes of this Plan, the term nuisance species is almost always a synonym. In rare instances involving a native species functioning as a nuisance species, the words would not be synonymous.

Localized population — a reproducing population of introduced organisms that is confined to a particular area. Possibility for eradication is increased when the organism has a limited range or distribution.

Locally established species — a number of localized populations; that is, a nonnative organism with one or more reproducing populations within a limited range, with no geographic expansion yet. An example would be tilapia (*Tilapia* spp., *Oreochromis* spp., and *Sarotherodon* spp.). A small breeding population of tilapia are established in Robinson Bayou in the Pascagoula River drainage.

Marine species — aquatic species native to saline waters.

Media — natural and man-made materials infested or utilized by species as they are transported (accidentally or deliberately) to new locations. Media might include ballast water, shipping/packing materials, wholesale products, cargo, equipment, parts of railroads, airlines, ships, outboard motors, runoff and effluent.

Monitor — to watch, observe, or check for a special purpose. For purposes of the Plan, observing or checking activities based upon scientific method to accumulate data about aquatic invasive species and their environments.

Native species —all species known to occur naturally on the lands and in the freshwaters within the geographical boundary of the state of Mississippi and in the coastal waters of the state of Mississippi. Synonyms include indigenous species.

Naturalization — the creation or occupation of an ecological niche by an introduced species; occurs after acclimatization.

Nonindigenous species — a species that is nonnative (or alien) to the ecosystem under consideration.

Nonnative fish — all fish native to foreign countries and all fish native to the United States but not native to Mississippi.

Nonnative species — any species native to foreign countries and all species native to the United States but not native to the state of Mississippi.

Nuisance species — a plant or animal pest. For purposes of this Plan, these are nonnative species that threaten the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters. In rare instances, native species may function as nuisance species. A native animal example would be the Canada goose (*Branta canadensis*), and a native plant example would be Carolina fanwort (*Cabomba caroliniana*). The term invasive species is usually a synonym of nuisance species, but in the rare instances involving native species (functioning as nuisance species), the terms would not be synonymous.

Parasite — an organism living in or on another organism (the host), that is detrimental to the host.

Pathogen — a specific agent causing disease. May be a bacteria, virus, or fungus.

Pathway — geographical features or patterns by which species are physically transported to new areas. A pathway might be a shipping lane, highway, river, current, wind, trade route, or waterway. Pathway combined with media results in a vector.

Pioneer infestation — a small colony of an invasive species that has spread to a new geographic area from an established population.

Rapid response — all actions involving fast containment, control and eradication in response to the initial presence of an invasive species.

Regulation — a rule or order specifying actions or procedures and having the force of law.

Screening — process for examining imported cargo/products and deliberately transported species to prevent transport of invasive species.

Source point — any physical location on or in a pathway or in an industry where invasive species or media are located. Source points include, but are not limited to, wholesale and retail nurseries, garden centers, aquaculture facilities, research facilities, public and private aquaria, pet stores, bait shops, bait culture facilities, and botanical gardens.

Species — a fundamental category of taxonomy, ranking below genus and subgenus, consisting of related organisms capable of interbreeding and producing viable offspring that are reproductively isolated from other such groups.

Terrestrial species — organisms living primarily on land.

Vector — transportation of a species on or in a media through a pathway. Vector is a combination of the concepts of “media” and “pathway.”

Veliger — larval form of some mollusks, including zebra mussels (*Dreissena polymorpha*).

Watershed — according to USGS, “watershed” refers to the dividing ridges separating drainage basins, but recent usage has made it practically synonymous with drainage basin.

[1] USGS 1998.
[2] MDEQ 2007.
[3] Colautti and MacIsaac 2004.
[4] Invasive Species Advisory Council 2006.
[5] Mississippi Department of Transportation (undated).
[6] Office of Technology Assessment 1993, page 79.
[7] Mississippi State Port Authority 2011b.
[8] Office of Technology Assessment 1993, page 80.
[9] Mississippi State Port Authority 2011a.
[10] Riecke 2006.
[11] American Sportfishing Association 2008.
[12] Riecke 2006.
[13] Diaz 2005.
[14] Diaz 2006.
[15] Association of American Railroads (undated).
[16] Adams 2008.
[17] Meyers 2002.
[18] United States Coast Guard 2004.
[19] Meyers 2002; United States Coast Guard 2004.
[20] United States Coast Guard 2004.
[21] Carlton 2001, page 12.
[22] Gulf of Mexico Program 1998; United States Coast Guard 2004.
[23] Gulf of Mexico Program 1998, page 14.
[24] Carlton 2001, page 12; Godwin 2001.
[25] Transport Information Service 2000.
[26] Agricultural Research Service 2002; Johnson and Shilling 1998; Morisawa 2000.
[27] Office of Technology Assessment 1993, page 80.
[28] Phillips 2004.
[29] National Agricultural Statistics Service 2011.
[30] Hanson and Sites 2010.
[31] Phillips 2004.
[32] Nico and Cannister 2011.
[33] American Sportfishing Association 2008.
[34] Harper and Namminga 1986.
[35] Summerlin 2010.
[36] Riecke 2012.
[37] Riecke 2006.
[38] Mississippi Wildlife, Fisheries, and Parks 2006; Riecke 2011.
[39] Carlton 2001, page 13.
[40] Herod 2011.
[41] Holdsworth, Hale, and Frelich 2003.
[42] USGS 2011b.
[43] Maki and Galatowitsch 2003.
[44] Spurlock 2003.
[45] USDA Bureau of Entomology 1936.
[46] Capinera 2001; Capinera 1998.
[47] USGS 2011b.
[48] USGS 2011b.
[49] Hardy 2001.
[50] USGS 2011c.
[51] LiveAquaria.com 2011a.
[52] LiveAquaria.com 2011b.
[53] O'Connell 2003.
[54] Linscombe 2003.

[55] Linscombe 2003.
[56] Linscombe 2003.
[57] West 1997.
[58] Jacono, Richerson, and Howard 2011; USGS 2011f.
[59] Howard 2011.
[60] Howard 2011.
[61] Riecke 2007; Howard 2011.
[62] Clacote 2007.
[63] Diaz 2005.
[64] Diaz 2006.
[65] Morgan 2011b.
[66] Morgan 2011b.
[67] Tipping, Center, Hulslander, and Muth 2003.
[68] Ramey 2001.
[69] USGS 2011e.
[70] Colette, Jacono, and Richerson 2011; University of Florida Center for Aquatic and Invasive Plants 2010c.
[71] University of Florida Center for Aquatic and Invasive Plants 2010c; Colette, Jacono, and Richerson 2011.
[72] USGS 2011e.
[73] Riecke 2008.
[74] Jacono, Richerson, and Howard 2011.
[75] Riecke 2008.
[76] Jacono, Richerson, and Howard 2011; Lovell and Bahlinger 2002.
[77] Riecke 2007.
[78] Swearingen 1997; Thompson, Stuckey, and Thompson 1987; Washington State Department of Ecology (undated).
[79] Urbatsch and Skinner 2000.
[80] USGS 2005b.
[81] USDA Natural Resources Conservation Service 2005a.
[82] University of Florida Center for Aquatic and Invasive Plants 2010a.
[83] Langeland and Burks 1998, pages 42-43.
[84] US Army Corps of Engineers 2002.
[85] University of Florida Center for Aquatic and Invasive Plants 2010b.
[86] USGS 2010e.
[87] Burgess 2005.
[88] http://www.efloras.org/object_page.aspx?object_id=11083&flora_id=1
[89] Nico, Maynard, Schofield, and Cannister 2011.
[90] Aguirre and Poss 2000.
[91] Nico, Maynard, Schofield, and Cannister 2011.
[92] Nico, Fuller, and Schofield 2006; Poss and Aguirre 2000.
[93] Beiser and Folmar 2006.
[94] Nico, Fuller, and Schofield 2011.
[95] Nico, Fuller, and Schofield 2011; Poss and Aguirre 2000.
[96] Aguirre and Poss 2003a; Nico 2011a.
[97] Nico 2011a; Beiser and Folmar 2006.
[98] Aguirre and Poss 2003a.
[99] Nico and Fuller 2011.
[100] Riecke 2007.
[101] Aguirre and Poss 2003b; Nico and Fuller 2011.
[102] Suresh 2003.
[103] FAO 2006.
[104] USDA NASS 2006.
[105] McElroy 2003; Aguirre and Poss 1999a.
[106] Nico and Schofield 2011.

[107] Lutz 1998, page 1.
[108] US Fish and Wildlife Service 2002, pages 49281 – 49282.
[109] US Fish and Wildlife Service 2002, page 49281; Nico and Fuller 2011.
[110] Nico and Fuller 2011; US Fish and Wildlife Service 2002, page 49281.
[111] US Fish and Wildlife Service 2002, page 49282.
[112] Maher 2003.
[113] USGS 2004.
[114] US Fish and Wildlife Service 2007.
[115] Nico, Fuller, and Cannister 2011.
[116] Hard, Allen, and Poss 1999.
[117] USGS 2011d.
[118] Beiser and Folmar 2006.
[119] Saucier 2003; Carter 2003.
[120] Herod 2011.
[121] Dietz 1995.
[122] Benson, Marelli, Frischer, Danforth, and Williams 2002.
[123] Benson et al. 2002; Miller AW 2003; Benson 2011a.
[124] Power 2003; Benson 2011a.
[125] Florida Caribbean Science Center 2001; Crochet, Hicks, and Poss 1999.
[126] Zebra mussels had a similar effect on the Great Lakes. Water clarity improved, but some areas are experiencing overgrowths of submerged aquatic vegetation, and there is less phytoplankton for native species.
[127] Benson et al. 2002; Baker, Fajans, and Bergquist 2003.
[128] Benson 2011b.
[129] Riecke 2008.
[130] Mississippi Department of Agriculture and Commerce, Bureau of Plant Industry, Plant Pest Program 2001.
[131] Beiser 2009; Kipp and Benson 2011.
[132] LeBlanc 1994.
[133] Norris 2007.
[134] Smithsonian Marine Station 2001; Dauphin Island Sea Lab (undated); Higgins 2001.
[135] Raines 2000; Raines 2002.
[136] Raines 2000.
[137] Perry 2011.
[138] Anonymous 2001
[139] M. Graham, personal communication, 2006.
[140] Woodley et al. 2002.
[141] Avery 2007.
[142] Woodley et al. 2002.
[143] Woodley et al. 2002.
[144] Masser and Rouse 1997.
[145] Masser and Rouse 1997.
[146] Mississippi Aquatic Invasive Species Task Force 2006.
[147] Lipe 2007.
[148] Masser and Rouse 1997.
[149] Hanson 2007.
[150] Wolf 1988.
[151] Goodwin 2007.
[152] USDA APHIS 2003.
[153] Goodwin 2007.
[154] Hedrick et al. 2000.
[155] Hartman et al. 2004.
[156] Wolf 1988.
[157] USDA APHIS 2006.
[158] USDA APHIS 2007a.

[159] USDA APHIS 2007b.
[160] Goodwin 2007.
[161] The Mississippi Aquatic Invasive Species Task Force recognizes that there is no single "point person" or agency for the public to contact with questions about invasive species, and that those ongoing invasive species efforts may be disjointed and repetitive. Coordination of these efforts will be necessary to effectively combat invasive species in Mississippi.
[162] Though the Aquaculture pathway is ranked as a "High" priority, vis-à-vis the legislation, regulation, and enforcement objective, the Mississippi Aquatic Invasive Species Task Force does not necessarily mean to imply that more regulations are needed, but that it can be an effective tool.
[163] With regard to the Aquarium / Pet Industries pathway, the MAIS Task Force ranked the fourth objective (legislation, regulation, and enforcement) as a "High" priority because currently, there are very few regulations within the state of Mississippi.
[164] The Task Force decided not to prioritize microorganisms because the topic is very broad, and the "high," "medium," and "low" classifications for each objective may vary on a case-by-case basis. Also, there are other entities, both state and federal, better equipped to deal with issues surrounding microorganisms. Given the limited resources, the Task Force decided to prioritize other species. It should be noted, however, that VHSV—a fish virus that is described in Section 4.C.6 of this Plan—is a rapidly evolving issue and may need to be addressed in subsequent revisions of this Plan.
[165] Herod 2011.
[166] GRI 2011.
[167] Madsen 2011.
[168] http://www.anstaskforce.gov/Documents/ANSTF_Risk_Analysis.pdf
[169] http://www.anstaskforce.gov/Documents/Pathways_Training_and_Implementation_Guide_Jan_2007.pdf
[170] Fuller et al. 2010.
[171] Hoover 2012.
[172] Knott et al. 2012.
[173] Pursley 2012.
[174] Schofield et al. 2012.
[175] Albans and Hixon 2011

12 Literature Cited

Adams C. 2008. Personal communication on 14 February 2008 to Dennis Riecke. Mississippi Department of Transportation, Jackson, Mississippi.

Agricultural Research Service. 2002. Formosan Subterranean Termite Program: Background. Operation Fullstop, Southern Regional Research Center, Agricultural Research Service, United States Department of Agriculture, New Orleans, Louisiana. Retrieved 6 May 2003 from <www.ars.usda.gov/is/br/fullstop>

Aguirre W, and SG Poss. 1999a. Species Summary for *Oreochromis mossambicus*. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Retrieved 5 May 2003 from <www.gsmfc.org/nis/nis/Oreochromis mossambicus.html>

Aguirre W, and SG Poss. 1999b. Species Summary for *Pomacea canaliculata*. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Retrieved 20 February 2003 from <www.gsmfc.org/nis/nis/Pomacea canaliculata.html>

Aguirre W, and SG Poss. 2000. Species Summary for *Cyprinus carpio*. Gulf States Marine Fisheries Commission, Ocean Springs, MS. Retrieved 2 April 2003 from <www.gsmfc.org/nis/nis/Cyprinus carpio.html>

Aguirre W, and SG Poss. 2003a. Species Summary for *Hypophthalmichthys molitrix*. Gulf States Marine Fisheries Commission, Ocean Springs, MS. Retrieved 7 June 2006 from <http://nis.gsmfc.org/nis_factsheet.php?toc_id=189>

Aguirre W, and SG Poss. 2003b. Species Summary for *Hypophthalmichthys nobilis*. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Retrieved 7 June 2006 from <http://nis.gsmfc.org/nis_factsheet.php?toc_id=190>

Albins, M.A. and M.A. Hixon. 2011. Worst case scenario: potential long-term effects of invasive predatory lionfish *Pterois volitans* on Atlantic and Caribbean coral-reef communities. Environmental Biology of Fishes DOI 10.1007/s1064-011-9795-1.

American Sportfishing Association. 2002. Sportfishing in America: Values of Our Traditional Pastime. American Sportfishing Association, Alexandria, Virginia. Retrieved 17 May 2006 from <www.asafishing.org/asa/images/statistics/participation/sportfishing_america/fish_eco_impact.pdf>

American Sportfishing Association. 2008. Sportfishing in America. American Sportfishing Association, Alexandria, Virginia. Retrieved 24 January 2011 from <www.asafishing.org/images/statistics/resources/Sportfishing%20in%20America%20Rev.%207% 2008.pdf>

Association of American Railroads. Undated. State Railroad Rankings. Retrieved 14 February 2008 from <http://www.aar.org/PubCommon/Documents/AboutTheIndustry/RRState_Rankings.pdf>

Avery J. 2007. Personal communication on 10 December 2007. National Warmwater Aquaculture Center, Mississippi State University. Mississippi State, Mississippi.

Baker P, J Fajans, and D Bergquist. 2003. Invasive Green Mussels, *Perna viridis*, on Mangroves and Oyster Reefs in Florida. Presented at the Third International Conference on Marine Bioinvasions, March 16 – 19, 2003. La Jolla, California.

Beiser M. 2009. Personal communication on 24 March 2009. Mississippi Department of Environmental Quality. Jackson, Mississippi.

Beiser M, and H Folmar. 2006. Personal communication on 4 August 2006. Mississippi Department of Environmental Quality. Jackson, Mississippi.

Benson AJ. 2011a. Nonindigenous Aquatic Species Program Factsheet*: Perna viridis.* United States Geological Survey. Retrieved 26 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=110>

Benson AJ. 2011b. Nonindigenous Aquatic Species Program Factsheet: *Pomacea insularum*. United States Geological Survey. Retrieved 26 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=2599>

Benson AJ, DC Marelli, ME Frischer, JM Danforth, and JD Williams. 2002. Establishment of the green mussel, *Perna viridis* (Linnaeus 1758), (Mollusca: Mytilidae) on the west coast of Florida. Poster. Presented at the Eleventh International Conference on Aquatic Invasive Species, February 25 to March 1, 2002. Alexandria, Virginia. Retrieved 25 February 2003 from <www.fcsc.usgs.gov/posters/Nonindigenous/Green_Mussels/green_mussels.html>

Burgess R. 2005. Invasive Peruvian watergrass poised to wreak havoc in Vermilion Parish. The Lafayette Daily Advertiser, originally published on 23 February 2005. Retrieved 26 August 2005 from <www.acadiananow.com/apps/pbcs.dll/article?AID=20050223/NEWS01/502230310/1002>

Capinera JL. 1998. Featured Creatures: The Sweetpotato Weevil. University of Florida, Department of Entomology and Nematology, Gainesville, Florida. Retrieved 28 May 2003 from <http://creatures.ifas.ufl.edu/veg/potato/sweetpotato_weevil.htm>

Capinera JL. 2001. Featured Creatures: The Sugarcane Borer. University of Florida, Department of Entomology and Nematology, Gainesville, Florida. Retrieved 28 May 2003 from <http://creatures.ifas.ufl.edu/field/sugarcane_borer.htm>

Capo B. 2008. Snails Found in Gretna, Terrytown and Belle Chasse Worry Scientists. WWL-TV, Inc. Reported on 21 May 2008. Retrieved 26 May 2008 from <http://www.wwltv.com/local/stories/wwl052108mlcapo.179ce7c0.html>

Carlton JT. 2001. Introduced Species in US Coastal Waters: Environmental Impacts and Management Priorities. Pew Oceans Commission, Arlington, Virginia. Pages 12-13.

Carter P. 2003. Response to Louisiana Aquatic Invasive Species Task Force Homework Question 7: What ANS Control or Prevention Programs Does Your Organization Have Underway or Planned? United States Fish and Wildlife Service, Atlanta, Georgia. Submitted February 2003.

Clacote K. 2007. Bio-control suppresses Giant Salvinia. Plant Industry News 7(2):7. Mississippi Department of Agriculture and Commerce.

Colautti RI, and HJ MacIsaac. 2004. A neutral terminology to define 'invasive' species. Diversity and Distributions 10:135-141.

Colette J, CC Jacono, and MM Richerson. 2011. Nonindigenous Aquatic Species Program Factsheet: *Myriophyllum spicatum*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=237>

Crochet N, DW Hicks, and SG Poss. 1999. Species Summary for *Perna viridis*. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Retrieved 25 February 2003 from <www.gsmfc.org/nis/nis/Perna_viridis.html>

Dauphin Island Sea Lab. Undated. Dockwatch Program Factsheet: Have You Seen Me?: *Phyllorhiza punctata*. Dauphin Island Sea Lab, Dauphin Island, Alabama. Retrieved 7 March 2003 from <http://dockwatch.disl.org/haveyouseen.htm>

Dean S, T Hanson, and S Murray. 2003. Economic Impact of the Mississippi Farm-Raised Catfish Industry at the Year 2003. Mississippi State University Extension Service, Mississippi State University.

Dietz T. 1995. Environmental Tolerances of Zebra Mussels. In Summary of Proceedings of the Lower Mississippi Valley Zebra Mussel Information and Monitoring Workshop, 10-11 January 1995. Baton Rouge, Louisiana. Page 20.

Diaz D. 2005. Personal communications on 24 and 27 June 2005. Mississippi Department of Marine Resources. Biloxi, Mississippi.

Diaz D. 2006. Personal communication on 13 April 2006. Mississippi Department of Marine Resources. Biloxi, Mississippi.

FAO (Food and Agriculture Organization of the United Nations). 2006. Yearbook of Fishery Statistics, Commodities 2004. Rome: FAO Fisheries Department. 199 pp.

Fuller PL, MG Pursley, D Diaz, and W Devers. 2010. Effects of Hurricane Katrina on an incipient population of giant salvinia *Salvinia molesta* in the lower Pascagoula River, Mississippi. Gulf and Caribbean Research 22:63-65. March 2010. University of Southern Mississippi, Gulf Coast Research Laboratory.

Florida Caribbean Science Center. 2001. Nonindigenous Species Information Bulletin: Green mussel, *Perna viridis*. United States Geological Survey, Gainesville, Florida. Retrieved 25 February 2003 from <www.fcsc.usgs.gov/greenmussel4.pdf>

Godwin LS. 2001. Hull Fouling of Maritime Vessels as a Pathway for Marine Species Invasions to the Hawaiian Islands. Prepared for the Marine Facilities Panel 24th United States Japan Cooperative Program in Natural Resources, 4-21 November 2001, Honolulu, Hawaii. Retrieved 4 February 2003 from <www.dt.navy.mil/ip/mfp/24th_US_Papers/ESE_Godwin.pdf>

Goodwin A. 2007. Personal communication to Craig Tucker on 5 December 2007. University of Arkansas at Pine Bluff Fish Disease Laboratory. Pine Bluff, Arkansas.

Graham WM. Undated. A Timeline of the *Phyllorhiza punctata* occurrence in the northern Gulf of Mexico. Dauphin Island Sea Lab. Dauphin Island, Alabama. Retrieved 7 March 2003 from <http://www.disl.org/~mgraham/phyllorhiza.htm>

Graham, WM, DL Martin, DL Felder, VL Asper, and HM Perry. 2003. Ecological and economic implications of a tropical jellyfish invader in the Gulf of Mexico. Biological Invasions 5:53-69.

GRI (Geosystems Research Institute). 2011. Publications search (In-House, Keyword: Fact Sheet). Retrieved 19 September 2011 from <http://www.gri.msstate.edu/resources/pubs.php>

Gulf of Mexico Program. 1998. Ballast Water Profile by Battelle. Retrieved 28 January 2003 from <www.epa.gov/gmpo/species/ballast.html>

Hanson L. 2007. Personal communication to Craig Tucker on 6 December 2007. Mississippi State University College of Veterinary Medicine. Mississippi State, Mississippi.

Hanson T, and D Sites. 2010. 2009 US Catfish Database. Department of Agricultural Economics, Mississippi State University. Retrieved 16 August 2011 from

<http://www.aces.edu/dept/fisheries/aquaculture/catfish-database/catfish-2009.php>

Hard SD, YC Allen, and SG Poss. 1999. Species Summary for *Dreissena polymorpha*. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Retrieved 13 February 2003 from <www.gsmfc.org/nis/nis/Dreissena_polymorpha.html>

Hardy T. 2001. Memorandum to USDA-PPQ New Pest Advisory Group Officers Regarding *Pomacea canaliculata*, 1 January 2001. Louisiana Department of Agriculture and Forestry, Baton Rouge, Louisiana.

Harper JL, and HE Namminga. 1986. Fish Population Trends in Texoma Reservoir Following Establishment of Striped Bass. Pages 156-165 in Reservoir Fisheries Management: Strategies for the 80's. GE Hall and MJ Van Den Avyle, editors. Bethesda, Maryland.

Hartman KH, R Yanong, B Petty, R Francis-Floyd, and A Riggs. 2004. Koi Herpes Virus (KHV) Disease. IFAS (Institute of Food and Agricultural Sciences) Fact Sheet VM-149. University of Florida, Gainesville, Florida. Retrieved 10 December 2007 from <http://edis.ifas.ufl.edu/pdffiles/VM/VM11300

Hedrick RP, O Gilad, S Yun, JV Spangenberg, GD Marty, RW Nordhausen, MJ Kebus, H Bercovier, and A Eldar. 2000. A herpesvirus associated with mass mortality of juvenile and adult koi, a strain of common carp. Journal of Aquatic Animal Health 12:44-57.

Herod J. 2011. Personal communication via email August 2011. US Fish and Wildlife Service.

Higgins III J. 2001. Personal communications on 17 and 21 April 2001. Dauphin Island Sea Lab. Dauphin Island, Alabama.

Hill J. 2001. Native and Exotic Catfish in Florida, Part II. WaterWorks 5(2). University of Florida, Institute of Food and Agricultural Sciences, Department of Fisheries and Aquatic Sciences, Gainesville, Florida. Retrieved 7 June 2006 from <http://fishweb.ifas.ufl.edu/waterworks/WWV5N2.pdf>

Holdsworth A, C Hale, and L Frelich. 2003. Contain Those Crawlers: Invasive Earthworms in Our Forests. University of Minnesota Center for Hardwood Ecology and Minnesota Department of Natural Resources, St. Paul, Minnesota. Retrieved 15 October 2004 from www.dnr.state.mn.us/invasives/terrestrialanimals/earthworms/index.html

Hoover J. 2012. Personal communication via email. U.S. Army Corps of Engineers. Vicksburg, Mississippi.

Howard V. 2011a. Nonindigenous Aquatic Species Program Factsheet*: Pistia stratiotes.* United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1099>

Howard V. 2011b. Nonindigenous Aquatic Species Program Factsheet*: Salvinia molesta*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=298>

Howells RG. 2000. Applesnails (*Pomacea*) in U.S. Waters. Biostudies. Kerrville, Texas. Retrieved 10 August 2011 from <http://www.shellfish.uga.edu/AAW%202008/Volunteer%20Resources/AIS%20Manual/AQUATIC%20INVADERS/SUPPLEMENTAL%20MATERIALS/AI%20SPECIES/Related%20Species%20Handouts/Invertebrates/Channeled%20Applesnails/APPLES~1.PDF>

Invasive Species Advisory Council. 2006. Invasive species definition clarification and guidance white paper. The National Invasive Species Council, Washington, DC. Retrieved 10 August 2011 from

<http://www.invasivespecies.gov/global/ISAC/ISAC_documents/ISAC%20Definititions%20White%20Paper%20%20-%20FINAL%20VERSION.pdf >

Jacono CC, and MM Richerson. 2005. US Distribution Map of Giant Salvinia. US Geological Survey. Retrieved 13 July 2005 from <http://salvinia.er.usgs.gov/html/distribution_map.html>

Jacono CC, MM Richerson, and V Howard. 2011. Nonindigenous Aquatic Species Program Factsheet: *Eichhornia crassipes*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1130>

Jacono CC, MM Richerson, and VH Morgan. 2011. Nonindigenous Aquatic Species Program Factsheet: *Hydrilla verticillata*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?speciesID=6>

Kipp R, and A Benson. 2011. Nonindigenous Aquatic Species Program Factsheet*: Cipangopaludina japonica.* United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?speciesID=10466>

Knott, D.M., P.L. Fuller, A.J. Benson, and M.E. Neilson. 2012. *Penaeus monodon*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Retrieved 17 July 2012 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1209>

Langeland KA, and KC Burks, eds. 1998. Identification and Biology of Non-native Plants in Florida's Natural Areas. 165 pages. Retrieved 27 July 2005 from <http://www.fleppc.org/ID_book.htm>

LeBlanc DJ. 1994. Prevention and Control of Wildlife Damage — Nutria. United States Department of Agriculture's Animal and Plant Health Inspection Service, Port Allen, Louisiana. Retrieved 18 January 2011 from <http://wildlifedamage.unl.edu/handbook/handbook/rodents/ro_b71.pdf>

Linscombe G. 2003. Nutria History and Management in Louisiana. Presentation to the Louisiana Aquatic Invasive Species Task Force, 26 March 2003. Baton Rouge, Louisiana.

Lipe J. 2007. Personal communications on 3 and 6 December 2007. Mississippi Department of Agriculture and Commerce. Jackson, Mississippi.

LiveAquaria.com. 2011a. Anacharis Sales Page. Retrieved 18 January 2011 from <http://www.liveaquaria.com/product/aquarium-fish-supplies.cfm?c=767>

LiveAquaria.com. 2011b. Texas Cichlid Sales Page. Retrieved 18 January 2011 from <http://aquarium-fish.liveaquaria.com/search?w=Texas%20cichlid>

Lovell K, and K Bahlinger. 2002. Henderson Lake Weed Removal Project Works: News Release. Retrieved 18 January 2011 from <http://dnr.louisiana.gov/index.cfm?md=newsroom&tmp=detail&aid=774>

Lutz CG. 1998. Greenhouse Tilapia Production in Louisiana. Louisiana State University Agricultural Center, Louisiana State University, Baton Rouge, Louisiana, page 1.

Madsen J. 2006. Personal communication to MAIS Task Force on 22 September 2006. Mississippi State University GeoResources Institute, Mississippi State, Mississippi.

Madsen J. 2011. Personal communication to MAIS Task Force on 29 August 2011. Mississippi State University Geosystems Research Institute. Mississippi State, Mississippi.

Maher R. 2003. Personal communication on 10 April 2003. Illinois Department of Natural Resources, Commercial Fishing Program. Brighton, Illinois.

Maki K, and S Galatowitsch. 2003. Long-Range Movement of Invasive Aquatic Plants Through Water Garden Trade. Presented at the 12th International Conference Aquatic Invasive Species, 9–12 June 2003, Windsor, Ontario, Canada.

Masser MP, and DB Rouse. 1997. Australian Red Claw Crayfish. Southern Regional Aquaculture Center, Publication No. 244. Retrieved 18 January 2011 from <http://aquanic.org/publicat/usda_rac/efs/srac/244fs.pdf>
McElroy MG. 2003. Personal communication on 18 February 2003. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Meyers J. 2002. Current and Future Ballast Water Regulations. Presentation to the Louisiana Aquatic Invasive Species Task Force, 12 December 2002, Baton Rouge, Louisiana.

Miller AW. 2003. Personal communication on 18 March 2003. Smithsonian Environmental Research Center. Edgewater, Maryland.

Miller JH. 2003. Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control. USDA Forest Service, Southern Research Station, Auburn University, Alabama. 93 pp. Retrieved on 18 January 2011 from <http://www.srs.fs.usda.gov/pubs/gtr/gtr_srs062/>

Mississippi Aquatic Invasive Species Task Force. 2006. Discussion and personal communication on 15 February 2006. Mississippi Aquatic Invasive Species Task Force Meeting at the Mississippi Department of Marine Resources, Biloxi, Mississippi.

Mississippi Department of Agriculture and Commerce, Bureau of Plant Industry, Plant Pest Program. 2001. Emergency Regulation on Applesnails. Jackson, Mississippi. Retrieved 24 March 2009 from <http://www.mdac.state.ms.us/n_library/departments/bpi/bpi_plantpest_applesnail.html>

Mississippi Department of Environmental Quality. 2007. Mississippi's Basin Management Approach. With individual drainage basin descriptions and maps. Retrieved on 26 January 2011 from <http://www.deq.state.ms.us/mdeq.nsf/page/WMB_About_BMA?OpenDocument>

Mississippi Department of Transportation. 2011. Mississippi Ports Online. Mississippi Department of Transportation, Jackson, Mississippi. Retrieved 18 January 2011 from <http://www.gomdot.com/Divisions/IntermodalPlanning/resources/PortsOnline/Home.aspx>

Mississippi Department of Wildlife, Fisheries, and Parks. 2006. Mississippi Fish Stocking Data, 1963-2006. Excel Spreadsheet entitled 1FSTOCK.xls provided on 6 June 2006. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Mississippi State Port Authority. 2011a. About Us. Mississippi State Port Authority, Gulfport, Mississippi. Retrieved 18 January 2011 from <http://www.shipmspa.com/aboutus.htm>

Mississippi State Port Authority. 2011b. Comprehensive History of the Port of Gulfport. Mississippi State Port Authority, Gulfport, Mississippi. Retrieved 18 January 2011 from <http://www.shipmspa.com/facilities.htm>

Morgan VH. 2011a. Nonindigenous Aquatic Species Program Factsheet: *Egeria densa.* United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=1107>

Morgan VH. 2011b. Nonindigenous Aquatic Species Program Factsheet: *Salvinia minima*. United States Geological Survey. Retrieved 18 January 2011 from

<http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=297>

Morisawa T. 2000. Red Imported Fire Ant*: Solenopsis invicta* Buren. Wildland Invasive Species Team, The Nature Conservancy. Retrieved 18 January 2011 from <http://tncweeds.ucdavis.edu/moredocs/solinv01.html>

National Agricultural Statistics Service. 2011. Catfish Production. Agricultural Statistics Board, US Department of Agriculture. Washington, DC. 10 pp. Retrieved 11 August 2011 from <http://usda.mannlib.cornell.edu/usda/nass/CatfProd//2010s/2011/CatfProd-01-28-2011.pdf>

Nico LG. 2011a. Nonindigenous Aquatic Species Program Factsheet*: Hypophthalmichthys molitrix*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=549>

Nico LG. 2011b. Nonindigenous Aquatic Species Program Factsheet*: Mylopharyngodon piceus*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=573>

Nico LG, and M Cannister. 2011. Nonindigenous Aquatic Species Program Factsheet*: Pterygoplichthys multiradiatus*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=768>

Nico LG, and PJ Schofield. 2011. Nonindigenous Aquatic Species Program Factsheet*: Oreochromis niloticus*. United States Geological Survey. Retrieved 18 January 2011from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=468>

Nico LG, and PL Fuller. 2011. Nonindigenous Aquatic Species Program Factsheet*: Hypophthalmichthys nobilis*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=551>

Nico LG, E Maynard, PJ Schofield, and M Cannister. 2011. Nonindigenous Aquatic Species Program Factsheet*: Cyprinus carpio*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?speciesID=4>

Nico LG, PL Fuller, and M Cannister. 2011. Nonindigenous Aquatic Species Program Factsheet*: Pterygoplichthys disjunctivus*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/factsheet.aspx?SpeciesID=767>

Nico LG, PL Fuller, and PJ Schofield. 2011. Nonindigenous Aquatic Species Program Factsheet*: Ctenopharyngodon idella*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=514>

Norris S. 2007. Australian jellyfish invade U.S. waters. National Geographic News. Retrieved 19 September 2011 from <http://news.nationalgeographic.com/news/2007/08/070827-jellyfish-invasion.html>

O'Connell MT. 2003. O Cichlid, Where Art Thou? Presentation to the Aquatic Nuisance Species Task Force, 13 May 2003, New Orleans, Louisiana.

Office of Technology Assessment. 1993. Harmful Non-Indigenous Species in the United States, pages 79-80.

Perry H. 2011. Nonindigenous Aquatic Species Program Factsheet*: Phyllorhiza punctata*. United States Geological Survey. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/FactSheet.aspx?speciesID=1192>

Phillips G. 2004. Mississippi Aquaculture. Mississippi Farm Country. Mississippi Farm Bureau Federation, Jackson, Mississippi. Retrieved 5 June 2006 from
<www.msfb.com/news/Farmcountry/march04/Mississippi%20Aquaculture.html>

Poss SG, and W Aguirre. 2000. Species Summary for *Ctenopharyngodon idella*. Gulf States Marine Fisheries Commission, Ocean Springs, Mississippi. Retrieved 10 February 2003 from
<http://nis.gsmfc.org/nis_factsheet.php?toc_id=182>

Power AJ. 2003. Email communications to Aliens-L listserve on 7 and 23 October 2003. Marine Extension Service, University of Georgia, Athens, Georgia.
Raines B. 2000. New Jellyfish in the Northern Gulf of Mexico. Mobile Register, 3 September 2000. Retrieved 7 March 2003 from
<http://nas.er.usgs.gov/coelenterates/phyllorhiza.html>

Pursley, MG. 2012 Personal communication to H. Folmar and D. Riecke on 28 June, 2012. Mississippi Department of Marine Resources.

Raines B. 2002. Evidence suggests spotted jellies can thrive in Gulf waters: Reports of Australian spotted jellyfish massing off Louisiana coast portends invasion similar to 2000. Mobile Register, 28 June 2002. Retrieved 1 July 2002 from
<www.al.com>

Ramey V. 2001. Non-native Invasive Aquatic Plants in the United States: *Pistia stratiotes*. University of Florida Center for Aquatic and Invasive Plants, Gainesville, Florida. Retrieved 6 February 2003 from
<http://plants.ifas.ufl.edu/seagrant/pisstr2.html>

Riecke D. 2006. Personal communications on 12 and 17 May 2006 and 6 and 7 June 2006. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Riecke D. 2007. Personal communication on 14 December 2007. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Riecke D. 2008. Personal communication on 15 July 2008. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Riecke D. 2011. Personal communication on 24 January 2011. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Riecke D. 2012. Personal communication in June 2012. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Salyers B. 2008. Email communication to Dennis Riecke on 19 May 2008. Louisiana Department of Wildlife and Fisheries. Baton Rouge, Louisiana.

Saucier MH. 2003. Response to Louisiana Aquatic Invasive Species Task Force Homework Question 7: What ANS Control or Prevention Programs Does Your Organization Have Underway or Planned? United States Army Corps of Engineers, New Orleans, Louisiana. Submitted February 2003. 1 p.

Schofield, PJ, JA Morris, Jr, JN Langston, and PL Fuller. 2012. *Pterois volitans/miles*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. Retrieved 17 July 2012. <http://nas.er.usgs.gov/queries/factsheet.aspx?speciesid=963>

Smithsonian Marine Station. 2001. Indian River Lagoon News: *Phyllorhiza punctata*. Smithsonian Marine Station at Fort Pierce, Fort Pierce, Florida. Retrieved 7 March 2003 from
<www.sms.si.edu/IRLSpec/IRL_news.htm>

Spurlock SR. 2003. Economic Impacts from Agricultural Production in Mississippi. Department of Agricultural Economics, Mississippi State University, Mississippi. Retrieved 6 June 2006 from <www.agecon.msstate.edu/pubs/paper/AgricultureinMS.pdf>

St. Johns River Water Management District. 2001. Exotic invader found in lagoon waters. Indian River Lagoon Update, Fall 2001 Issue. St. Johns River Water Management District.

Summerlin C. 2010. Personal communication in December 2010. Mississippi Department of Wildlife, Fisheries, and Parks. Canton, Mississippi.

Suresh V. 2003. Tilapias. In Aquaculture: Farming Aquatic Animals and Plants. JS Lucas and PC Southgate, eds. Blackwell Publishing Ltd. Oxford, UK. Pp. 321-345.

Swearingen JM. 1997. Weeds Gone Wild — Alien Plant Invaders of Natural Areas Factsheet: Purple Loosestrife (*Lythrum salicaria*). Plant Conservation Alliance, Alien Plant Working Group, Washington, DC. Retrieved 18 January 2011 from
<http://www.nps.gov/plants/alien/fact/lysa1.htm>
Thompson DQ, RL Stuckey, and EB Thompson. 1987. Spread, Impact, and Control of Purple Loosestrife (*Lythrum salicaria*) in North American Wetlands. US Fish and Wildlife Service, Jamestown, ND. Retrieved 18 January 2011 from
<http://www.npwrc.usgs.gov/resource/plants/loosstrf/index.htm>

Tipping PW, TD Center, B Hulslander, and D Muth. 2003. Biological Control of Common Salvinia (*Salvinia minima*) in Louisiana: *S. minima* updates. United States Department of Agriculture, Agricultural Research Service, Invasive Plant Research Laboratory in Fort Lauderdale, Florida, and National Park Service, Jean Lafitte National Historical Park and Preserve in New Orleans, Louisiana. Retrieved 14 July 2003 from
<http://salvinia.er.usgs.gov/html/s_minima_updates.html>

Transport Information Service. 2000. Factsheet: Dunnage. Gesamtverband der Deutschen Versicherungswirtschaft, Berlin, Germany. Retrieved 19 June 2003 from
<www.tis-gdv.de/tis_e/misc/garnier.htm>

University of Florida Center for Aquatic and Invasive Plants. 2010a. Factsheet: Torpedo Grass (*Panicum repens*). Gainesville, Florida. Retrieved 18 January 2011 from
<http://plants.ifas.ufl.edu/node/308>

University of Florida Center for Aquatic and Invasive Plants. 2010b. Factsheet: Wild Taro (*Colocasia esculenta*). Gainesville, Florida. Retrieved 18 January 2011 from
<http://plants.ifas.ufl.edu/node/108>

University of Florida Center for Aquatic and Invasive Plants. 2010c. Factsheet: *Myriophyllum spicatum*. Gainesville, Florida. Retrieved 18 January 2011 from
<http://plants.ifas.ufl.edu/node/278>

Urbatsch L, and M Skinner. 2000. USDA Natural Resources Conservation Service's Plant Guide: Purple Loosestrife. Retrieved 18 January 2011 from
<http://plants.usda.gov/plantguide/pdf/pg_lysa2.pdf>

US Army Corps of Engineers. 2002. *Panicum repens* L. (Torpedo Grass). Retrieved 27 July 2005 from
<http://el.erdc.usace.army.mil/pmis/plants/html/panicum_.html>

US Coast Guard. Undated. *Ballast Water Brochure*. Originally retrieved 22 January 2003 but no longer available online. General information retrieved 18 January 2011 from
<http://www.uscg.mil/hq/cg5/cg522/cg5224/ans.asp>

US Coast Guard. 2004. Mandatory Ballast Water Management Program for US Waters. Final Rule by the Department of Homeland Security. 69 Federal Register 44952-44961.

US Coast Guard. 2011. Ballast Water Management for the Control of Aquatic Nuisance Species in the Waters of the United States. Retrieved 23 December 2007 from <http://www.uscg.mil/hq/cg5/cg522/cg5224/bwm.asp>

US Fish and Wildlife Service. 2002. Injurious Wildlife Species; Black Carp (*Mylopharyngodon piceus*): Proposed Rule by the Department of the Interior. 67 Federal Register 49280.

US Fish and Wildlife Service. 2007. Injurious Wildlife Species; Black Carp (*Mylopharyngodon piceus*): Final Rule by the Department of the Interior. 72 Federal Register 59019-59035.

US Rice Producers. 2002. Factsheet: A Little Snail with a Big Appetite May Threaten Texas Rice Industry. Retrieved 28 February 2003 from <www.usriceproducers.com/news/market_news/Snail%20White%20Paper.pdf>

USDA Agricultural Research Service. 2006. Southern Weed Science Research: News and Events. United States Department of Agriculture, Southern Weed Science Research Unit, Stoneville, Mississippi. Retrieved 13 September 2006 from <http://www.ars.usda.gov/News/News.htm?modecode=64-02-20-00>

USDA APHIS. 2003. Spring Viremia of Carp Tech Note. United States Department of Agriculture, Animal and Plant Health Inspection Service, Veterinary Services. Retrieved 18 January 2011 from <http://www.aphis.usda.gov/lpa/pubs/tn_ahspringcarp.pdf>

USDA APHIS. 2006. Viral Hemorrhagic Septicemia in the Great Lakes. July 2006 Emerging Disease Notice. United States Department of Agriculture, Animal and Plant Health Inspection Service, Centers for Epidemiology and Animal Health. Retrieved 18 January 2011 from <http://www.aphis.usda.gov/animal_health/emergingissues/downloads/vhsgreatlakes.pdf>

USDA APHIS. 2007a. Amended Federal Order, Viral Hemorrhagic Septicemia (VHS). United States Department of Agriculture, Animal and Plant Health Inspection Service, Centers for Epidemiology and Animal Health. Retrieved 10 December 2007 from <http://www.aphis.usda.gov/animal_health/animal_spec/aquaculture/downloads/vhs_fed_order_amended.pdf>

USDA APHIS. 2007b. Species affected by Viral Hemorrhagic Septicemia Federal Order. United States Department of Agriculture, Animal and Plant Health Inspection Service, Centers for Epidemiology and Animal Health. Retrieved 18 January 2011 from <http://dnr.wi.gov/fish/documents/vhs_fedorderModList.pdf>

USDA APHIS. 2008. Amended Federal Order, Viral Hemorrhagic Septicemia (VHS). 2 April 2008. United States Department of Agriculture, Animal and Plant Health Inspection Service, Centers for Epidemiology and Animal Health. Retrieved 18 January 2011 from <http://www.aphis.usda.gov/animal_health/animal_dis_spec/aquaculture/downloads/vhs_fed_order_amended.pdf>

USDA Bureau of Entomology. 1936. History of Tallulah Laboratory, United States Department of Agriculture, Bureau of Entomology. Written as a Work Project Administration Project by CS Lecky and MS Murphy, June 3, 1936. Retrieved 18 January 2011 from <http://www.rootsweb.ancestry.com/~lamadiso/articles/bughistory.htm>

USDA NASS. 2008. Census of Aquaculture (2005), Volume 3, Special Studies Part 2. Publication AC-02-SP-2. United States Department of Agriculture, National Agricultural Statistics Service, Washington, DC.

USDA NRCS. 2011. Plant Distribution – *Lythrum salicaria*, Purple Loosestrife. United States Department of Agriculture, Natural Resources Conservation Service. Retrieved 18 January 2011 from <http://plants.usda.gov/java/profile?symbol=LYTHR>

USGS. 1998. The rivers of Mississippi. Retrieved 26 January 2011 from <http://ms.water.usgs.gov/ms_proj/eric/>

USGS. 2003. Significant Nonindigenous Species Reports. Nonindigenous Aquatic Species, United States Geological Survey. Retrieved 15 April 2003 from <http://plants.usda.gov/java/profile?symbol=TRSE6>

USGS. 2004. Significant Nonindigenous Species Reports. Nonindigenous Aquatic Species, United States Geological Survey. Retrieved 17 May 2004 from <http://nas.er.usgs.gov/newreports.html>

USGS. 2011a. Query Results for Nonindigenous Fishes of Louisiana. United States Geological Survey, Nonindigenous Aquatic Species Program. Retrieved 18 January 2011 from <http://nas.er.usgs.gov>

USGS. 2011b. Problems with the Release of Exotic Fish. United States Geological Survey, Nonindigenous Aquatic Species Program. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/taxgroup/fish/docs/dont_rel.asp>

USGS. 2011c. Nonindigenous Aquatic Plant Records for *Egeria densa*. United States Geological Survey, Nonindigenous Aquatic Species Program. Retrieved 18 January 2011 from <http://nas.er.usgs.gov>

USGS. 2011d. *Dreissena polymorpha* Sightings. United States Geological Survey, Nonindigenous Aquatic Species Program, Gainesville, Florida. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/>

USGS. 2011e. Nonindigenous Aquatic Species Program's Search By Drainage: Hydrologic Units 31601 – Black Warrior-Tombigbee Drainage, 31602 – Mobile Bay-Tombigbee Drainage, 31700 – Pascagoula Drainage, 31800 – Pearl Drainage, 60300 – Middle Tennessee-Elks Drainage, 60400 – Lower Tennessee Drainage, 80102 – Hatchie-Obion Drainage, 80302 – Yazoo Drainage, 80601 – Lower Mississippi-Natchez Drainage, and 80602 – Big Black-Homochitto Drainage. United States Geological Survey, Nonindigenous Aquatic Species Program. Retrieved 18 January 2011 from <http://nas.er.usgs.gov/queries/plants/planthuc6se.asp>

Washington State Department of Ecology. Undated. Non-native Freshwater Plants Factsheet: Purple Loosestrife. Retrieved 7 February 2003 from <www.ecy.wa.gov/programs/wq/plants/weeds/aqua009.html>

West D. 1997. Good for Karma. Bad for Fish? Buddhists Release Animals, Dismaying Wildlife Experts. New York Times. 11 January 1997, page 27, Section 1. In Lexus-Nexus databases (Guided News Search, General News Category, Major Papers News Source, Buddhism and Species as Search Terms in the Headline and Lead Paragraphs, All Available Dates). Retrieved 23 May 2003 from <http://web.lexus-nexus.com/universe>

Wolf K. 1988. Fish Viruses and Fish Viral Diseases. Cornell University Press. Ithaca, New York. 476 pp.

Woodley CM, WT Slack, MS Peterson, and WV Vervaeke. 2000. Occurrence of the non-indigenous giant Malaysian prawn, *Macrobrachium rosenbergii* (De Man) in Simmons Bayou, Mississippi, USA. Crustaceana 75(8):1025-1031.

13 Appendices

13.A Appendix A. Members of the Mississippi Aquatic Invasive Species Task Force

Henry Folmar, Co-Chair
Mississippi Department of Environmental Quality
Office of Pollution Control
Chief, Field Services Division
P.O. Box 2261
Jackson, MS 39225
(601) 961-5529
(601) 961-6612 (fax)
henry_folmar@deq.state.ms.us

Mike Beiser, Co-Chair
Mississippi Department of Environmental Quality
Chief, Compliance and Enforcement Monitoring Section
1542 Old Whitfield Road
Pearl, MS 39208
(601) 961-5681
(601) 961-5704 (fax)
mike_beiser@deq.state.ms.us

Jimmy Avery
Mississippi State University
National Warmwater Aquaculture Center
P.O. Box 197
Stoneville, MS 38776
(662) 686-3273
(662) 686-3320 (fax)
javery@drec.msstate.edu

Brent Bailey
Mississippi Farm Bureau
P.O. Box 1972
Jackson, MS 39215
(601) 977-4248
(601) 977-4808 (fax)
bbailey@msfb.com

Phil Bass
US EPA Gulf of Mexico Program
Mail Code: EPA/GMPO
Building 1100, Room 232
Stennis Space Center, MS 39529-6000
(228) 688-2356
(228) 688-2709 (fax)
bass.phil@epa.gov

Mike Brainard
Mississippi Department of Marine Resources
1141 Bayview Avenue
Suite 101
Biloxi, MS 39530
(228) 374-5000
(228) 374-5220 (fax)
mike.brainard@dmr.ms.gov

Richard Campanella
Center for Bioenvironmental Research
102 Alcee Fortier Hall
Tulane University
New Orleans, LA 70118
(504) 862-8453
(504) 862-8455 (fax)
rcampane@tulane.edu

Josh Clemons
Mississippi-Alabama Sea Grant Legal Program
P.O. Box 1848
University, MS 38677
(662) 915-7775
(662) 915-5267
jeclemon@olemiss.edu

Danny Davis
Sea Grant Law Center
University of Mississippi, Kinard Hall
Wing E – Room 256
University, MS 38677
(662) 915-7775
dpdavis2@olemiss.edu

Dale Diaz
Mississippi Department of Marine Resources
1141 Bayview Avenue
Suite 101
Biloxi, MS 39530
(228) 374-5000
(228) 374-5220 (fax)
dale.diaz@dmr.state.ms.us

Eric Dibble
Mississippi State University
Department of Wildlife and Fisheries
Box 9690
Thompson Hall, Room 217
Mississippi State, MS 39762
(662) 325-7494
(662) 325-8726
edibble@cfr.msstate.edu

Ron Garavelli
Mississippi Department of Wildlife, Fisheries, and Parks
1505 Eastover Drive
Jackson, MS 39211-6374
(601) 432-2205
(601) 432-2203 (fax)
rong@mdwfp.state.ms.us

Vernon Hartley
Mississippi Farm Bureau
P.O. Box 1972
Jackson, MS 39215
(601) 977-4238
(601) 977-4808 (fax)
vhartley@msfb.com

Tom Herrington
US Food and Drug Administration/Gulf of Mexico Program
Stennis Space Center, MS 39529-6000
(228) 688-7941
(228) 688-2309 (fax)
tlh@cfsan.fda.gov
herrington.tom@epa.gov
thomas.herrington@fda.hhs.gov
herrington@bellsouth.net

Jim Lipe
Mississippi Department of Agriculture and Commerce
121 North Jefferson Street
Jackson, MS 39201
(601) 359-1135
(601) 354-6290 (fax)
jiml@mdac.state.ms.us

Alysia Kravitz Loshbaugh
941 Harmony Street
New Orleans, LA 70115
(504) 862-8209
aloshbaugh@gmail.com

Ron Lukens
Gulf States Marine Fisheries Commission
PO Box 726
Ocean Springs, MS 39566-0726
(228) 875-5912
(228) 875-6604 (fax)
rlukens@gsmfc.org

John Madsen
Mississippi State University
GeoResources Institute
Box 9652
Mississippi State, MS 39762-9652
(662) 325-2428
(662) 325-7692 (fax)
jmadsen@gri.msstate.edu

David Mauldin
Chief Warrant Officer 2nd Class
Eighth Coast Guard District
500 Poydras Street
New Orleans, LA 70130
(504) 271-2153
David.L.Mauldin@uscg.mil

Shelley Meaux
Center for Bioenvironmental Research
102 Alcee Fortier Hall
Tulane University
New Orleans, LA 70118
(504) 862-8441
(504) 862-8455
smeaux@tulane.edu

Douglas Meffert
Center for Bioenvironmental Research
Tulane University
1430 Tulane Avenue, SL-3
New Orleans, LA 70112
(504) 988-4678
(504) 988-6428 (fax)
dmeffert@tulane.edu

Marilyn O'Leary
Southeast Aquatic Resources Partnership
2420 Shadowbrook Drive
Baton Rouge, LA 70816
(225) 892-7470
moleary@mbolcomm.com

Harriet Perry
Gulf Coast Research Laboratory
University of Southern Mississippi
P.O. Box 7000
Ocean Springs, MS 39564
(228) 872-4218
(228) 872-4204 (fax)
harriet.perry@usm.edu

Dennis Riecke
Mississippi Department of Wildlife, Fisheries, and Parks
1505 Eastover Drive
Jackson, MS 39211-6374
(601) 432-2207
(601) 432-2203 (fax)
dennisr@mdwfp.state.ms.us

Gene Robertson
Mississippi Department of Agriculture and Commerce
121 North Jefferson Street
Jackson, MS 39201
(601) 359-1102
(601) 359-1175 (fax)
gene@mdac.state.ms.us

Stephanie Showalter
Sea Grant Law Center
University of Mississippi, Kinard Hall
Wing E – Room 256
University, MS 38655
(662) 915-7775
(662) 915-5267 (fax)
sshowalt@olemiss.edu

Dave Thompson
Mississippi Department of Transportation
Maintenance Division 75-01
401 N. West Street
Jackson, MS 39201
(601) 359-7111
dgthompson@mdot.state.ms.us

Craig Tucker
Mississippi State University
National Warmwater Aquaculture Center
P.O. Box 197
Stoneville, MS 38776
(662) 686-3286
(662) 686-3320 (fax)
ctucker@drec.msstate.edu

Robbie Wilbur
Mississippi Department of Environmental Quality
P.O. Box 2261
Jackson, MS 39225
(601) 961-5277
(601) 961-5715 (fax)
robbie_wilbur@deq.state.ms.us

13.B Appendix B. Aquatic Invasive Species in Mississippi

Aquatic Invasive Species Reported, Introduced, and/or Established in Mississippi[1]

Group*	Scientific Name	Common Name
Amphibians	*Eleutherodactylus planirostris*	greenhouse frog
Annelids	*Boccardiella ligerica*	a spinoid worm
Coelenterates	*Craspedacusta sowerbyi*	freshwater jellyfish
Coelenterates	*Drymonema larsoni*	pink meanie
Coelenterates	*Phyllorhiza punctata*	Australian spotted jellyfish
Crustaceans	*Callinectes bocourti*	Bocourt swimming crab, red blue crab
Crustaceans	*Daphnia lumholtzi*	water flea
Crustaceans	*Eurytemora affinis*	a calanoid copepod
Crustaceans	*Macrobrachium rosenbergii*	giant Malaysian prawn
Crustaceans	*Mesocyclops pehpeiensis*	no common name
Crustaceans	*Orconectes virilis*	virile crayfish
Crustaceans	*Penaeus monodon*	Asian tiger shrimp
Fishes	*Alosa sapidissima*	American shad
Fishes	*Astronotus ocellatus*	oscar
Fishes	*Carassius auratus*	goldfish
Fishes	*Ctenopharyngodon idella*	grass carp
Fishes	*Cyprinus carpio*	common carp
Fishes	*Enneacanthus gloriosus*	bluespotted sunfish
Fishes	*Fundulus catenatus*	northern studfish
Fishes	*Gambusia affinis*	western mosquitofish
Fishes	*Hypophthalmichthys molitrix*	silver carp
Fishes	*Hypophthalmichthys nobilis*	bighead carp
Fishes	*Micropterus dolomieu*	smallmouth bass
Fishes	*Morone chrysops*	white bass
Fishes	*Morone chrysops x M. saxatilis*	wiper
Fishes	*Morone saxatilis*	striped bass
Fishes	*Oncorhynchus mykiss*	rainbow trout
Fishes	*Oreochromis niloticus*	Nile tilapia
Fishes	*Oreochromis* spp., *Sarotherodon* spp., *Tilapia* spp.	tilapia
Fishes	*Perca flavescens*	yellow perch
Fishes	*Piaractus brachypomus*	pirapatinga, red-bellied pacu
Fishes	*Pimephales promelas*	fathead minnow
Fishes	*Pterygoplichthys disjunctivus*	vermiculated sailfin catfish
Fishes	*Salmo salar sebago*	landlocked Atlantic salmon
Fishes	*Sander canadensis*	sauger
Fishes	*Sander vitreus*	walleye
Fishes	*Tinca tinca*	tench
Mammals	*Myocastor coypus*	nutria
Mollusks	*Corbicula fluminea*	Asian clam
Mollusks	*Cipangopaludina japonica*	Japanese mysterysnail
Mollusks	*Dreissena polymorpha*	zebra mussel

[1]This table is a compilation of species reported for Mississippi by USGS (http://nas.er.usgs.gov), as accessed online on August 12, 2011.

Group*	Scientific Name	Common Name
Mollusks	*Pomacea insularum*	island applesnail
Plants	*Alternanthera philoxeroides*	alligatorweed
Plants	*Alopecurus geniculatus*	water foxtail, marsh meadow-foxtail
Plants	*Agrostis gigantea*	redtop, black bent, water bentgrass
Plants	*Cabomba caroliniana*	Carolina fanwort
Plants	*Colocasia esculenta*	wild taro
Plants	*Echinochloa crusgalli Var. hispishum, L.*	barnyard grass
Plants	*Egeria densa*	Brazilian waterweed
Plants	*Eichhornia crassipes*	water-hyacinth
Plants	*Hydrilla verticillata*	hydrilla
Plants	*Iris pseudacorus*	yellow iris
Plants	*Landoltia (Spirodela) punctata*	dotted duckweed
Plants	*Ludwigia grandiflora*	Uruguay waterprimrose, water primrose
Plants	*Ludwigia peploides*	creeping waterprimrose, floating primrose
Plants	*Lycopus europaeus*	European water horehound
Plants	*Lysimachia nummularia*	moneywort
Plants	*Lythrum salicaria*	purple loosestrife
Plants	*Mentha spicata*	spearmint
Plants	*Murdannia keisak*	marsh dewflower, aneilima, Asian spiderwort
Plants	*Myosotis scorpioides*	true forget-me-not
Plants	*Myriophyllum aquaticum*	parrot-feather, Brazilian watermilfoil
Plants	*Myriophyllum spicatum*	Eurasian water-milfoil
Plants	*Najas minor*	brittle naiad
Plants	*Nasturtium officinale*	water-cress
Plants	*Nelumbo nucifera*	sacred lotus
Plants	*Nymphoides peltata*	yellow floating-heart
Plants	*Oxycaryum cubense*	Cuban bulrush
Plants	*Panicum repens*	torpedo grass
Plants	*Pistia stratiotes*	water-lettuce
Plants	*Pluchea odorata odorata*	marsh fleabane, sweet scent
Plants	*Polygonum caespitosum longisetum*	oriental lady's thumb, bristly lady's thumb
Plants	*Polygonum persicaria*	lady's thumb, smartweed, spotted knotweed
Plants	*Potamogeton crispus*	curly pondweed
Plants	*Rorippa sylvestris*	creeping yellow cress
Plants	*Rumex obtusifolius*	bitter dock
Plants	*Sagittaria montevidensis*	giant arrowhead
Plants	*Salvinia minima*	water spangles
Plants	*Salvinia molesta*	giant salvinia
Plants	*Solidago sempervirens*	seaside goldenrod
Plants	*Sonchus arvensis*	field sow thistle
Reptiles	*Crocodylus niloticus*	Nile crocodile
Reptiles	*Graptemys pseudogeographica kohnii*	Mississippi map turtle

Potential Aquatic Invasive Species Threats to Mississippi

Group*	Scientific Name	Common Name
Crustaceans	*Cherax quadricarinatus*	Australian red claw crayfish
Fishes	*Mylopharyngodon piceus*	black carp
Mollusks	*Perna viridis*	green mussel
Plants	*Azolla pinnata*	feathered mosquito fern
Plants	*Eichhornia azurea*	rooted water hyacinth
Plants	*Lagarosiphon major*	oxygen weed
Plants	*Luziola peruviana*	Peruvian watergrass

*Excludes insects.

The USGS Nonindigenous Aquatic Species Database makes no determination as to whether native or exotic species are nuisance (invasive) species for a report location. The following status terms are used in discussion of database entries:

Collected – species was collected or observed from the site; reproduction is not known. This is the default status; many of these are actually established populations.
Established – population is reproducing and overwintering.
Eradicated – population was eliminated by human activity, i.e., Rotenone.
Extirpated – population died out on its own, without human interference, i.e., cold winter.
Failed – population was stocked but died out; failed to reproduce.
Stocked – species was introduced, as opposed to being caught.
Unknown – used when all other categories do not fit.

13.C Appendix C. Proposed Mississippi Approved, Restricted, and Prohibited Species Lists

Mississippi statute §49-7-80 requires MDWFP to "establish and maintain a list of approved, restricted and prohibited species and establish rules governing importation, possession, sale and escape of those species." In addition to developing a statewide aquatic invasive species management plan, Governor Haley Barbour charged the MAIS Task Force to work with MDWFP to develop these approved, restricted, and prohibited species lists for the state of Mississippi. However, the MAIS Task Force is not a regulatory agency and submits these lists merely as recommendations to MDWFP.

After much discussion and consideration, the MAIS Task Force defined the Approved, Restricted, and Prohibited lists in the following manner:

Approved Species List: no restrictions or permits required for the possession, use, culture, sale, import, export or transport within the state of Mississippi, unless otherwise required by state or federal laws or regulations.

1. All native species.
2. The following nonnative species:
   (a) Water-cress (*Nasturtium officinale*);
   (b) Rice (*Oryza sativa*);
   (c) Common carp (*Cyprinus carpio*);
   (d) Gold fish (*Carassius auratus*); and
   (e) Triploid grass carp (*Ctenopharyngodon idella*).

Restricted Species List: permits are required for the possession, use, culture, sale, import, export, or transport within the state of Mississippi:

1. The following nonnative aquatic species:
   (a) Diploid grass carp (*Ctenopharyngodon idella*);
   (b) Bighead carp (*Hypophthalmichtys nobilis*);
   (c) Silver carp (*Hypophthalmichtys molitrix*);[1]
   (d) Black carp (*Mylopharyngodon piceus*);[2]
   (e) Tilapia species (all species in the genera *Tilapia*, *Oreochromis*, and *Sarotherodon*);
   (f) Australian red claw crayfish (*Cherax quadricarinatus*); and
   (g) Giant Malaysian prawn (*Macrobranchium rosenbergii*).
2. Other nonnative aquatic species that meet all of the following criteria:
   (a) A scientific risk assessment has been conducted (at the expense of the person or entity wishing to import the species to the state) for the species using an approved methodology;
   (b) The results of the approved scientific risk assessment have been submitted to the Mississippi Interagency Aquatic Invasive Species Council for evaluation;

[1] Silver carp (*Hypophthalmichtys molitrix*) was permitted in Mississippi prior to being placed on the list of species banned under the Lacey Act.
[2] Black carp (*Mylopharyngodon piceus*) was permitted in Mississippi prior to being placed on the list of species banned under the Lacey Act.

(c) The MIAIS Council has determined that the nonnative species is unlikely to be an invasive species (i.e., a species whose introduction does not cause or is unlikely to cause economic or environmental harm or harm to human health); and

(d) The MIAIS Council recommends that the nonnative species be added by MDWFP to the Restricted Species List.

Prohibited Species List: It is illegal to possess, use, culture, sell, offer for sale, import, or export, or transport within the State of Mississippi live individuals or specimens of the following species (except as otherwise allowed by federal and state laws and regulations):

1. All nonnative aquatic species not listed on the Approved Species List or the Restricted Species List;
2. All nonnative aquatic species listed as Injurious Wildlife Species in the Federal Lacey Act [USC §42(a)(1)]. See Section 13.I for the species listed under this act as of May 2009;
3. All nonnative aquatic species listed on the Federal Noxious Weed List at 7 CFR §360.200. See Section 13.J for the species listed from this act as of May 2009; and
4. All nonnative aquatic species listed on the Mississippi Noxious Weed List Rule 41: Regulation of Noxious Weed Under Sections 69-25-1 through 69-25-47, Chapter 380, Laws of Mississippi 1974. See Section 13.K for the species listed under this Rule.

The aquatic species placed on the lists below should in no way be interpreted as a comprehensive list of all species in the state of Mississippi. There are numerous terrestrial nonindigenous species in the state of Mississippi that are either benign or beneficial, such as cattle and corn. Conversely there are also numerous terrestrial nonindigenous species in the state of Mississippi that are detrimental (i.e., kudzu). These species are not on the approved list because they are not aquatic and are therefore outside the scope of this Plan.

The MAIS Task Force recognizes the possibility that new species may arrive in the state on a regular basis and may not be on the approved, restricted, or prohibited lists. Given this possibility, the MAIS Task Force recommends all nonnative species not already on the approved or restricted lists should be placed on the prohibited list.

The species below are listed by the USGS Nonindigenous Aquatic Species database as present in Mississippi, its neighboring states (Alabama, Arkansas, Louisiana, and Tennessee), and/or Florida.

13.C.1 Prohibited Species List

13.C.1.a Prohibited Plant Species

Scientific Name	Common Name
Alternanthera philoxeroides	alligatorweed
Bacopa egensis	Brazilian water-hyssop
Blyxa aubertii	blyxa
Brachiaria mutica	para grass
Callitriche stagnalis	pond water-starwort
Ceratopteris thalictroides	water sprite
Colocasia esculenta	wild taro
Cryptocoryne beckettii	water-trumpet
Cryptocoryne undulata	no common name
Cryptocoryne wendtii	water-trumpet
Cyperus alopecuroides	foxtail flatsedge
Cyperus prolifer	dwarf papyrus
Dopatrium junceum	dopatrium

Scientific Name	Common Name
Egeria densa	Brazilian waterweed
Eichhornia crassipes	water-hyacinth
Hydrilla verticillata	hydrilla
Hydrocleys nymphoides	water-poppy
Hygrophila polysperma	Indian hygrophila
Hymenachne amplexicaulus	West Indian marsh grass
Ipomoea aquatica	water-spinach
Iris pseudacorus	yellow iris
Landoltia (Spirodela) punctata	dotted duckweed
Limnophila indica	Indian marshweed
Limnophila sessiliflora	Asian marshweed
Limnophila X ludoviciana	marshweed
Ludwigia hexapetala	Uruguay seedbox
Luziola peruviana	Peruvian watergrass
Lythrum salicaria	purple loosestrife
Marsilea hirsuta	bristly water-clover
Marsilea macropoda	big-foot water-clover
Marsilea minuta	small water-clover
Marsilea mutica	nardoo
Marsilea vestita	hairy water-clover
Murdannia keisak	marsh dewflower
Myriophyllum aquaticum	parrot-feather
Myriophyllum spicatum	Eurasian water-milfoil
Najas minor	brittle naiad
Nelumbo nucifera	sacred lotus
Nymphaea ampla	dot-leaf water-lily
Nymphaea capensis	Cape Blue water-lily
Nymphaea capensis zanzibariensis	Cape Blue water-lily
Nymphaea lotus	white Egyptian lotus
Nymphaea X daubeniana	no common name
Nymphoides cristata	crested floating-heart
Nymphoides indica	water snowflake
Nymphoides peltata	yellow floating-heart
Ottelia alismoides	duck-lettuce
Panicum repens	torpedo grass
Pistia stratiotes	water-lettuce
Potamogeton crispus	curly pondweed
Rotala indica	Indian toothcup
Rotala rotundifolia	roundleaf toothcup
Sagittaria guyanensis guyanensis	Guyana arrow-head
Sagittaria montevidensis	long-lobed arrow-head
Sagittaria montevidensis montevidensis	long-lobed arrow-head
Salvinia minima	water spangles
Salvinia molesta	giant salvinia
Scirpus cubensis	cuban bulrush
Solanum tampicense	wetland nightshade

13.C.1.b Prohibited Animal Species

Group	Family	Scientific Name	Common Name
Amphibians-Frogs	Leptodactylidae	*Eleutherodactylus planirostris*	greenhouse frog
Annelids-Polychaetes	Spionidae	*Boccardiella ligerica*	a spionid worm
Coelenterates-Hydrozoans	Clavidae	*Cordylophora caspia*	freshwater hydroid
Coelenterates-Hydrozoans	Olindiidae	*Craspedacusta sowerbyii*	freshwater jellyfish
Coelenterates-Scyphozoan	Mastigiidae	*Phyllorhiza punctata*	Australian spotted jellyfish (North America)
Crustaceans-Barnacles	Balanidae	*Balanus amphitrite*	striped barnacle, purple acorn barnacle
Crustaceans-Barnacles	Balanidae	*Balanus reticulatus*	barnacle
Crustaceans-Barnacles	Balanidae	*Balanus trigonus*	a barnacle
Crustaceans-Cladocerans	Daphnidae	*Daphnia lumholtzi*	water flea
Crustaceans-Copepods	Argulidae	*Argulus japonicus*	parasitic copepod
Crustaceans-Crabs	Grapsidae	*Eriocheir sinensis*	Chinese mitten crab
Crustaceans-Crabs	Grapsidae	*Platychirograpsus spectabilis*	saber crab
Crustaceans-Crabs	Portunidae	*Callinectes bocourti*	red blue crab
Crustaceans-Crabs	Portunidae	*Charybdis hellerii*	an Indo-Pacific crab
Crustaceans-Isopods	Ligiidae	*Ligia exotica*	wharf roach
Crustaceans-Isopods	Sphaeromatidae	*Sphaeroma terebrans*	an isopod
Crustaceans-Isopods	Sphaeromatidae	*Sphaeroma walkeri*	an isopod
Crustaceans-Shrimp	Nannosquillidae	*Pullosquilla litoralis*	mantis shrimp
Crustaceans-Shrimp	Palaemonidae	*Palaemon africanus*	African prawn
Crustaceans-Shrimp	Penaeidae	*Penaeus monodon*	Asian tiger shrimp
Ectoprocts	Victorellidae	*Victorella pavida*	a bryozoan
Fishes	Channidae	*Channa argus*	northern snakehead
Fishes	Channidae	*Channa marulius*	bullseye snakehead
Fishes	Characidae	*Astyanax mexicanus*	Mexican tetra
Fishes	Cichlidae	*Cichlasoma cyanoguttatum*	Rio Grande cichlid
Fishes	Cichlidae	*Cichlasoma nigrofasciatum*	convict cichlid
Fishes	Clariidae	*Clarias batrachus*	walking catfish
Fishes	Cobitidae	*Misgurnus anguillicaudatus*	Oriental weatherfish
Fishes	Cyprinidae	*Hypophthalmichthys molitrix*	silver carp
Fishes	Cyprinidae	*Hypophthalmichthys molitrix X nobilis*	hybrid silver/bighead carp
Fishes	Cyprinidae	*Leuciscus idus*	ide
Fishes	Cyprinidae	*Scardinius erythrophthalmus*	rudd
Fishes	Scatophagidae	*Scatophagus argus*	scat
Fishes	Scorpaenidae	*Pterois volitans*	lionfish
Fishes	Synbranchidae	*Monopterus albus*	Asian swamp eel
Mammals	Capromyidae	*Myocastor coypus*	nutria
Mollusks-Bivalves	Corbiculidae	*Corbicula fluminea*	Asian clam
Mollusks-Bivalves	Dreissenidae	*Dreissena polymorpha*	zebra mussel
Mollusks-Bivalves	Mytilidae	*Mytella charruana*	Charru mussel
Mollusks-Bivalves	Mytilidae	*Perna viridis*	green mussel

Group	Family	Scientific Name	Common Name
Mollusks-Gastopods	Ampullariidae	*Pomacea canaliculata*	channeled applesnail
Mollusks-Gastropods	Ampullariidae	*Marisa cornuarietis*	giant rams-horn snail
Mollusks-Gastropods	Ampullariidae	*Pomacea bridgesii*	spiketop applesnail
Mollusks-Gastropods	Ampullariidae	*Pomacea paludosa*	Florida applesnail
Mollusks-Gastropods	Planorbidae	*Biomphalaria glabrata*	bloodfluke planorb
Mollusks-Gastropods	Thiaridae	*Melanoides tuberculatus*	red-rim melania
Mollusks-Gastropods	Thiaridae	*Melanoides turriculus*	fawn melania
Mollusks-Gastropods	Thiaridae	*Tarebia granifera*	quilted melania
Mollusks-Gastropods	Truncatellidae	*Truncatella subcylindrica*	snail
Mollusks-Gastropods	Viviparidae	*Cipangopaludina chinensis malleata*	Chinese mysterysnail
Mollusks-Gastropods	Viviparidae	*Cipangopaludina japonica*	Japanese mysterysnail
Reptiles-Crocodilians	Alligatoridae	*Caiman crocodilus*	common caiman
Reptiles-Crocodilians	Crocodylidae	*Crocodylus niloticus*	Nile crocodile
Reptiles-Snakes	Pythonidae	*Python molurus bivittatus*	Burmese python
Tanaids	Tanaidae	*Zeuxo maledivensis*	a tanaid
Tunicates	Styelidae	*Botryllus schlosseri*	tunicate
Tunicates	Styelidae	*Styela plicata*	tunicate

13.D Appendix D. Summary of Federal Laws, Programs, and Regulations Relevant to Aquatic Invasive Species

13.D.1 Federal Laws

13.D.1.a Clean Water Act, 33 USC §1251 *et seq.*

The Clean Water Act (CWA) protects the nation's waters, including lakes, rivers, aquifers, and coastal areas.[1] The CWA includes a framework of standards and requires the development of technology and financial assistance to address the causes of pollution and poor water quality.[2] The CWA provides for a permitting process to protect wetlands and other aquatic habitats in order to ensure environmentally sound development.[3] EPA, DOD, and USCG share authority to manage incidental liquid discharges, including clean ballast water, from Armed Forces vessels through the Uniform National Discharge Standards.[4]

The CWA's permitting process may provide EPA with some authority to control and manage invasive species. EPA currently is reviewing its authority under the CWA with regard to invasive species.[5]

13.D.1.b Coastal Zone Management Act, 16 USC §1451 *et seq.*

The Coastal Zone Management Act (CZMA) is another avenue by which invasive species can be controlled and managed. Under the CZMA, the federal and state governments work together "to preserve, protect, develop, and where possible, to restore or enhance, the resources of the Nation's coastal zone for this and succeeding generations."[6] Specifically, the federal government is to encourage and assist the states to achieve "wise use" of land and water resources in the coastal zone.[7] Issues surrounding invasive species could be incorporated into states' Coastal Zone Management Plans through modification or amendment, subject to the approval by the Department of Commerce (DOC).[8] Section 306A(b) of the CZMA [16 USC §1455a(b)] allows DOC to make grants to eligible coastal states to assist them in preserving or restoring specific areas, redevelopment of deteriorating and underutilized urban waterfronts and ports, access to public beaches, or development of a permit process to regulate aquaculture facilities in the coastal zone. DOC also shall assist states in identifying and obtaining technical assistance and other financial assistance so they may carry out the objectives of the CZMA.[9]

The CZMA calls for coordination and cooperation between DOC and other interested federal agencies to the maximum extent practicable.[10] The agency also shall not approve any coastal zone management program submitted by any state pursuant to Section 306 (16 USC §1455) unless the views of federal agencies "principally affected" by such program have been considered.[11]

Section 315 of the CZMA (16 USC §1461) establishes the National Estuarine Research Reserve System. Research in designated national estuarine reserves is to help identify and establish priorities of coastal management issues.[12] This program could sponsor monitoring and other research of invasive species.

---

[1] *See* 33 USC § 1251(a).
[2] See id.
[3] *See id.* § 1342.
[4] *See id.* USC § 1322.
[5] *See* National Agricultural Library for the National Invasive Species Council, National Management Plan: Appendix 3 - Legal Authorities Related to Invasive Species. Retrieved 25 July 2003 from www.invasivespecies.gov/council/appendix3.shtml.
[6] *See* 16 USC § 1452(1).
[7] *See id.* § 1454(2).
[8] *See id.* §1455(e).
[9] *See id.* § 1455a(f).
[10] *See id.* § 1456(a).
[11] *See id.* § 1456(b).
[12] *See id.* § 1461(c).

13.D.1.c Cooperative Forestry Assistance, 41 USC §2104

Under the Cooperative Forestry Assistance (CFA), USDA is responsible for protecting the health of the national forests and other lands in the United States. Protection of forests from invasive species is included in the CFA. USDA may conduct surveys to "detect and appraise insect infestations and disease conditions ... and establish a monitoring system ... to determine detrimental changes or improvements that occur over time ...."[13] USDA may also implement the biological, chemical, and mechanical measures necessary "to prevent, retard, control, or suppress incipient, potential, threatening, or emergency insect infestations and disease conditions affecting trees."[14] Furthermore, USDA is required to provide technical information, advice, and related assistance on available techniques to maintain healthy forests.[15]

Included is USDA's authority to appropriate funds to implement this policy to other federal agencies to prevent, retard, control, or suppress insect infestations and diseases affecting trees on said lands.[16] Moreover, USDA may contract or enter into a cooperative agreement to provide financial assistance to state forestry officials or the equivalent thereof and private forestry and other organizations to monitor forest health and to protect forest lands. Such state officials or private or other organizations shall make contributions in the amount and manner deemed appropriate by USDA.[17]

However, the CFA only applies to insect infestations and disease conditions affecting trees. There is no authority in the CFA for invasive plant species.

13.D.1.d Endangered Species Act, 16 USC §1531 *et seq.*

The US Department of the Interior (DOI) is in charge of implementing the Endangered Species Act of 1973 (ESA). The ESA relates to invasive species that pose a threat to local endangered species.[18] If invasive species threaten local endangered species, then the ESA could be used as a basis for control and eradication. However, the ESA does not contain specific language that directly relates to invasive species or language that mentions how DOI could regulate particular pathways by which invasive species may become a threat to endangered species.

13.D.1.e Federal Insecticide, Fungicide, and Rodenticide Act, 7 USC §136 *et seq.*

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) focuses on federal control of pesticide distribution, sale, and use. EPA studies the effects of pesticide use and requires users to register when purchasing certain pesticides. All pesticides used in the United States must be registered with EPA.[19] Registration ensures that pesticides are properly labeled and that if pesticides are used in accordance with specifications, they will not cause unreasonable adverse effects on the environment.[20]

If pesticides are used to control or reduce the impacts of invasive species, then FIFRA will apply. FIFRA also gives EPA review authority for biological control agents when they are used to control invasive pests.[21]

13.D.1.f Federal Noxious Weed Act, 7 USC §2801 *et seq.*

The Federal Noxious Weed Act (FNWA) has been replaced by the Plant Protection Act, 7 USC §7701 *et seq.,* except for Section 2814.

---

[13] 16 USC § 2104(b)(1).
[14] *Id.* § 2104(b)(2), (3).
[15] *See id.* § 2104 (b)(4).
[16] *See id.* § 2104(e).
[17] *See id.* § 2104(g).
[18] *See* 16 USC § 1533.
[19] *See* 7 USC § 136a for registration requirements and procedure and classification of pesticides.
[20] See id.
[21] See id.

Section 2814 of the FNWA requires each federal agency to manage "undesirable plants"[22] on federal lands. They are to develop and coordinate a management program to control such plants on said land and to enter into cooperative agreements with state agencies to implement their management plans. However, a federal agency is not required to carry out a management plan on federal lands unless similar programs are being implemented on state or private lands in the same area.

13.D.1.g Federal Seed Act, 7 USC §1551 *et seq.*

The Federal Seed Act (FSA) regulates interstate and foreign commerce in seeds, requires labeling to prevent misrepresentation of seeds in interstate commerce, and requires certain standards with respect to certain imported seeds. The FSA may offer protection against invasive species entering the states because it requires labeling of seeds entering interstate commerce and requires standards for certain imported seeds.

It unlawful for a person to transport or deliver for transportation in interstate commerce any agricultural seeds or mixture thereof unless each container bears a label that includes information in accordance with regulations and prescribed by law under Section 402 of the FSA.[23] One piece of required information on a label is the origin of each agricultural seed, which has been designated by USDA as one on which knowledge of the origin is important from the standpoint of crop production.[24] This section specifically includes noxious weed seeds in its labeling requirement.

The FSA requires that all persons transporting or delivering for transportation, in interstate commerce, agricultural seeds shall keep for 3 years a complete record of origin, treatment, germination, and purity of each lot of such agricultural seeds. This requirement also applies to all persons transporting or delivering for transportation, in interstate commerce, vegetable seeds.[25]

The FSA lists exemptions to the labeling and recording requirements. The provisions of Sections 201 and 202 do not apply to any carrier in respect to any seed transported or delivered for transportation in the ordinary course of its business as a carrier, provided that such carrier is not engaged in processing or merchandising seed subject to the provisions of this Act.[26] Such provisions also do not apply to seeds produced by any farmer on his own premises and sold by him directly to the consumer, provided that such farmer is not engaged in the business of selling seeds not produced by him.[27] However, such seeds produced or sold when transported or offered for transportation to any state, territory, or district, shall not be exempted from Sections 201 and 202 unless the seeds are in compliance with the operation and effect of the laws of such state, territory, or district, which are enacted in the exercise of its police power.[28]

The FSA prohibits the dissemination of any false advertisement concerning seed, by the United States Postal Service or in interstate and foreign commerce, in any manner or by any means, including radio broadcasts.[29]

Finally, the FSA prohibits the importation into the United States of any agricultural or vegetable seeds if any such seeds contain noxious weed seeds or the labeling of which is false or misleading in any respect.[30]

---

[22] "Undesirable plant species" means "plant species that are classified as undesirable, noxious, harmful, exotic, injurious, or poisonous, pursuant to State or Federal law." 7 USC § 2814(e)(7).
[23] *See* 7 USC § 201.
[24] See id.
[25] *See id*. § 202.
[26] *See id*. § 203.
[27] See id.
[28] See id.
[29] *See id*. § 205.
[30] *See id*. § 301.

13.D.1.h Fish and Wildlife Coordination Act, 16 USC §661 *et seq.*

One of the purposes of the Fish and Wildlife Coordination Act (FWCA) is to give wildlife conservation equal consideration and coordination with other features of water resource development programs "through the effectual and harmonious planning, development, maintenance, and coordination of wildlife conservation and rehabilitation ..."[31] The FWCA requires DOI to provide assistance to, and cooperate with, federal, state, and public or private agencies and organizations to control, manage, and protect wildlife resources.[32]

The FWCA encourages consultation between agencies. If an impoundment, diversion, or deeper channeling of the waters of any stream or other waterbody is necessary by any department or agency of the United States, or by any public or private agency under federal permit or license, then that department or agency first shall consult with USFWS, DOI, and the head of the agency exercising administration over the wildlife resources that may be affected by the action.[33] Furthermore, DOI shall make reports and recommendations on the wildlife aspects of such projects.[34] Such goals and cooperation between departments and agencies could encompass control and management of invasive species through research and recommendations.

Projects to control and manage invasive species also may be funded through grants and cooperative agreements.[35]

13.D.1.i Hawaii Tropical Forest Recovery Act, 16 USC §4502a *et seq.*

The Hawaii Tropical Forest Recovery Act (HTFRA), enacted in 1992, largely amended the International Forestry Cooperation Act (see Section 13.D.1.j). The HTFRA authorizes USDA's Forest Service to protect indigenous plants and animals from invasions; establish biological control agents for invasive species that threaten natural ecosystems; establish monitoring systems to identify baseline conditions and determine detrimental changes or improvements over time; and provide assistance to states with tropical forests.[36]

13.D.1.j International Forestry Cooperation Act, 16 USC §4501 *et seq.*

The main focus of the International Forestry Cooperation Act (IFCA) is to promote sustainable development and global environmental stability for the world's forests by providing assistance to foreign countries that need it.[37] The IFCA concentrates on key nations that "could have a substantial impact on emissions of greenhouse gases related to global warming."[38] Under the IFCA, the USDA Secretary provides assistance in the form of grants, contracts, or cooperative agreements to prevent and control invasions from nonindigenous animals, plants, and pathogens in tropical forests.[39]

Under the authority of the IFCA, the USDA Forest Service, as part of its Forest Research and Development Program, conducts research and development for management and protection of vegetation, fish, and wildlife and delivers research and development products in water and air sciences, resource valuation and use, and inventory and monitoring.[40] This program addresses all aspects of USDA's invasive species activities, including prevention, control, rapid response, management, and restoration of areas affected by invasive species.[41]

---

[31] 16 USC § 661.
[32] *See id*. § 661(1).
[33] *See id*. § 662(a).
[34] *See id*. § 662(b).
[35] *See id*. § 663. *See also* §§ 661 and 662.
[36] *See* 16 USC § 4501(a).
[37] *See* 16 USC § 4501(b).
[38] *Id*. § 4501(a).
[39] *See id*. § 4502a(b).
[40] USDA Forest Service, Research and Development. Retrieved 26 February 2003 from http://www.fs.fed.us/research.
[41] See id.

13.D.1.k National Forest Management Act, 16 USC §1604

Congress has required that USDA develop and maintain forest plans for each administrative unit of the National Forest System.[42] However, site-specific management decisions must be consistent with the relevant forest plan for that site, or the plan itself must be amended to permit the activity.[43] Moreover, each plan must be consistent with the National Environmental Policy Act, the Multiple-Use and Sustained-Yield Act, and other federal environmental laws.[44] Since forest management is specific to each area, management may relate to invasive species as it becomes an issue in particular forest areas.

13.D.1.l Lacey Act, 18 USC §42; 16 USC §3371-3378.

There are two separate parts of the Lacey Act. Title 18 (18 USC §42 *et seq.*) is a law administered by USFWS that prohibits the importation of certain categories of animal species into the United States or any of its territories. Title 16 (16 USC §3371 *et seq.*) is a separate provision administered by DOI, DOC, and USDA. Title 16 generally makes it unlawful to import, export, sell, receive, acquire, purchase (or attempt to commit any such act) certain animals and plants in violation of federal, state, tribal, or foreign law. Each has common purposes and restrictions, as well as limitations on how they may be utilized to control and manage invasive species.

Title 18 of the Lacey Act prohibits importation of animal species that the Secretary of the Interior has prescribed by regulation as "injurious to human beings, to the interests of agriculture, horticulture, forestry, or to wildlife or the wildlife resources of the United States." However, the Secretary may allow the importation for zoological, educational, medical, and scientific purposes, where such importation would otherwise be prohibited by this Act.[45] Also, the Act does not restrict importation by federal agencies for their own use.[46]

It is important to note that Section 42 of Title 18 contains restrictions that limit DOI's ability to fully address the control and management of invasive species. First, Section 42 is limited to specific animals. It applies only to those animal species specified in the Act plus mammals, fish, birds, reptiles, amphibians, mollusks, and crustaceans. In addition, the Lacey Act seems to exclude domesticated birds and mammals because only "wild"[47] birds and mammals are specified in the Act. Finally, the Act excludes from regulation under the Lacey Act species already regulated under the Plant Pest Act. The Act specifically states that Section 42 does not authorize "any action with respect to the importation of any plant pest as defined by the FPPA, insofar as such importation is subject to regulation under that Act."[48]

Title 16 [16 USC §3372(a)(1)] prohibits the import, export, sale, receipt, acquirement, or purchase of any wildlife, fish, or plant "taken, possessed, transported, or sold in violation of any law, treaty, or regulation of the United States or in violation of any Indian tribal law." This section also prohibits the import, export, or transport in interstate commerce any container or package containing any fish or wildlife unless it has been previously marked, labeled, or tagged in accordance with regulations issued pursuant to the Act.

[42] *See* 16 USC § 1604(f).
[43] *See id.* § 1604(i).
[44] *See id.* § 1604(e), (g)(1).
[45] *See id.* § 42(3).
[46] See id.
[47] According to 16 USC § 42(a)(1), "wild" refers to "any creatures that, whether or not raised in captivity, normally are found in a wild state."
[48] *See id.* § 42(a)(1).

Sale or purchase of fish or wildlife for the illegal taking, acquiring, receiving, transport, or possession of fish or wildlife is prohibited by the Lacey Act.[49] It is also unlawful for a person to make or submit a false record, account, label for, or any false identification of any fish, wildlife, or plant which has been, or is intended to be, imported, exported, sold, purchased, or received from any foreign country; or transported in interstate or foreign commerce.[50]

All fish, wildlife, or plants imported, exported, transported, sold, received, acquired, or purchased in violation of the Lacey Act or any regulation thereto shall be subject to forfeiture to the United States as well as any civil or criminal penalties that may be assessed.[51] In addition, all vessels, vehicles, aircraft, or other equipment used to aid in the violation shall be subject to forfeiture to the United States if the facts meet certain criteria. If the owner at the time of the alleged violation was a consenting party or privy thereto or in the exercise of due care should have known his property would be used in a criminal violation of the OLA, and the violation involved the sale or purchase of or the offer or intent to sell or purchase fish, wildlife, or plants, then his property shall be subject to forfeiture.[52]

Title 16 has restrictions similar to those in 18 USC §42. The definition of "fish or wildlife" is also limited to wild animals, though it is broader than the one in Section 42.[53] What Title 16 includes that Section 42 does not include is plant species. However, the definition of "plant" is limited to "any wild member of the plant kingdom, including roots, seeds, and other parts thereof (but excluding common food crops and cultivars), which is indigenous to any state and which is either listed on an appendix to the Convention on International Trade in Endangered Species of Wild Flora and Fauna or listed pursuant to any state law that provides for the conservation of species threatened with extinction."[54] This means that any plant that falls outside of this definition is not covered, and some plant species that are not covered may be invasive plant species in Mississippi that need to be controlled and managed.

There are exceptions to prohibitions under the Title 16 of the Lacey Act. For instance, the prohibitions do not apply to activities regulated by plan under the Magnuson-Stevens Fishery Conservation and Management Act. Second, the provisions of paragraph 1 of subsection 3(a) of do not apply to any activity regulated by a fishery management plan in effect under the Magnuson-Stevens Fishery Conservation and Management Act. Also, the OLA does not prevent the states or Indian tribes from making or enforcing laws or regulations as long as they are consistent with the Title 16 of the Lacey Act.[55]

13.D.1.m Magnuson-Stevens Fishery Conservation and Management Act, 16 USC §1801 *et seq.*

The Magnuson-Stevens Fishery Conservation and Management Act (Magnuson Act) may apply to invasive species and their pathways through Section 1855(b). The Essential Fish Habitat (EFH) provisions allow for review of Federal and/or other actions that could affect EFH with authority to make recommendations for conservation of EFH.

Specifically, the DOC, in consultation with participants in the fishery, shall provide each Fishery Management Council with recommendations and information regarding each fishery under that council's authority.[56] The purpose is to assist the councils in identification of essential fish habitat,

[49] "Sale" of fish or wildlife in violation of this Act means a person for money or other consideration who offers or provides guiding, outfitting, or other services or a hunting or fishing license or permit. 16 USC § 3372(c)(1)(A)-(B). "Purchase" of fish or wildlife in violation of this Act means a person who obtains for money or other consideration guiding, outfitting, or other services or a hunting or fishing license or permit. 16 USC § 3372(c)(2)(A)-(B).
[50] 16 USC § 3372(d)(1)-(2).
[51] *See* 16 USC § 3374(1).
[52] 16 USC § 3374(a)(2)
[53] The definition of "fish and wildlife" in 16 USC § 3371(a) includes "any wild animal, whether alive or dead, including without limitation any wild mammal, bird, reptile, amphibian, fish, mollusk other invertebrate."
[54] 16 USC § 3371(f).
[55] 16 USC § 3378(a)
[56] *See* 16 USC § 1855(b)(1)(B).

the adverse impacts on that habitat, and the actions that should be considered to ensure the conservation and enhancement of that habitat.[57] Also, the DOC shall review programs it administers and ensure that any relevant programs further the conservation and enhancement of essential fish habitat.[58] Finally, the DOC shall coordinate with and provide information to other federal agencies to further the conservation and enhancement of essential fish habitat.[59]

In a similar regard, each federal agency shall consult with the DOC with respect to any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by such agency that may adversely affect any EFH identified under this Act.[60]

Each council may comment on and make recommendations to the DOC and any federal or state agency concerning any activity authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, by any federal or state agency that may affect habitat, including EFH, of a fishery resource under its authority.[61] The council shall comment on and make recommendations to the DOC and any other federal or state agency concerning activity that, in the view of the council, is likely to substantially affect the habitat, including EFH, of an anadromous fishery resource under its authority.[62]

13.D.1.n Multiple-Use Sustained-Yield Act, 16 USC §528 *et seq*.

The policy behind the Multiple-Use Sustained-Yield Act (MUSY) is that the "national forests are established and shall be administered for outdoor recreation, range, timber, watershed, and wildlife and fish purposes."[63] The MUSY authorizes the USDA to develop and administer renewable surface resources of the national forests and to cooperate with interested State and local government agencies and others in the development and management of national forests.[64]

Therefore, the MUSY may be a possible source of authority if invasive species threaten the vitality of national forests and their ability to produce a sustained yield of products and services under the principles of multiple use.[65]

13.D.1.o National Environmental Policy Act, 42 USC §4321 *et seq*.

The National Environmental Policy Act (NEPA) applies to all departments and agencies. The purposes of NEPA that are relevant here are: to declare a national policy that will encourage productive and enjoyable harmony between man and his environment; to promote efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the nation.[66] The NEPA calls for cooperation between agencies to share information and coordinate efforts in order to administer NEPA to the fullest extent possible.[67] If invasive species pose a threat to the environment through intentional introductions related to major Federal actions, then NEPA requires the Federal government agencies to consider the effects of their actions by preparing Environmental Impact Statements (EIS).[68] That is, the effects of

[57] See id.
[58] *See* 16 USC § 1855(b)(1)(C).
[59] *See* 16 USC § 1855(b)(1)(D).
[60] *See* 16 USC § 1855(b)(2).
[61] 16 USC § 1855(b)(3)(A).
[62] *See* 16 USC § 1855(b)(3)(B).
[63] 16 USC § 528.
[64] *See id.* § 529.
[65] *Id*. "Multiple use" means the management of all the various renewable surface resources of the national forests so that they are used in the combination that best meets the needs of the American people. *See id.* § 531(a). "Sustained yield" means the achievement and maintenance "in perpetuity" (i.e., forever) of a high level annual or regular periodic output of resources without impairment of the productivity of the lands of the national forests. *See id.* § 531(b).
[66] 42 US.C. § 4321
[67] 42 USC § 4332
[68] An EIS is a document that describes the effects on the environment as a result of a proposed Federal action. *See* 40 CFR § 1508.11. It also describes impacts of alternatives as well as plans to mitigate impacts. "Environment" means "the natural and physical environment, and the relationship of people with that environment." 40 CFR § 1508.14. The

invasive species, if they would be harmful to the environment, must be included in the EIS. However, the Animal and Plant Heath Inspection Service (APHIS) may approve and issue permits for importing invasive species after the preparation of an Environmental Assessment (EA).[69] Permits for importing invasive species into containment facilities or interstate movement between containment facilities are excluded from NEPA regulations.

13.D.1.p National Invasive Species Act, 16 USC §4701 *et seq.*

The National Invasive Species Act (NISA) reauthorized and amended the Nonindigenous Aquatic Nuisance Prevention and Control Act (NANPCA). While not the only issue addressed, a major focus of NISA was to prevent the spread of nuisance species through ballast water releases. NISA created the National Aquatic Nuisance Species Task Force (ANSTF) co-chaired by the Director of USFWS and the Undersecretary of Commerce for Oceans and Atmosphere.[70] One task the ANSTF was charged with was developing and implementing a program to prevent the unintentional introduction and dispersal of aquatic nuisance species[71] through the implementation of ballast water management.[72]

The NISA requires the development of voluntary national guidelines to prevent the introduction and spread of nonindigenous species into US waters via ballast water of commercial vessels.[73] The guidelines apply to vessels equipped with ballast water tanks and directs vessels that enter US waters after operating beyond the EEZ to undertake ballast exchange in the seas.[74] The Secretary[75] is also required to establish record keeping and reporting procedures and sampling techniques, based on the best available science, to monitor compliance.[76] However, a vessel is not required to conduct ballast water exchange if the exchange would threaten the safety or stability of the vessel, its crew, or its passengers.[77]

Furthermore, the Secretary and the ANSTF are required to conduct ecological and ballast discharge studies and surveys in waters highly susceptible to invasion or requiring further study.[78] The purpose of conducting these surveys is to examine invasions and the effectiveness of ballast management and its guidelines.[79]

States, through their respective governors, may submit their own comprehensive management plans to the ANSTF for approval.[80] These management plans identify areas or activities within each State or the surrounding region, except for those related to public facilities, for technical,

---

"environment" considered in an EIS includes land, water, air, structures, living organisms, environmental values at the site, and the social, cultural, and economic aspects. *See id*. "Effect" means a change in consequence that results from an activity. 40 CFR § 1508.8. Impacts can be positive, negative, or both. *See id.* An EIS describes impacts, as well as ways to mitigate impacts. "Mitigate" means "to lessen or remove negative impacts." 40 CFR § 1508.20.

[69] An EA is a concise public document, for which a Federal agency is responsible, that briefly provides sufficient evidence and analysis for determining whether there is a need to prepare an EIS or a Finding of No Significant Impact. It also aids in an agency's compliance with the Act when no EIS is necessary and facilitates preparation of a statement when one is necessary. An EA shall include brief discussions of the need for the proposal, of alternatives as required by 42 USC § 4332 (2)(E), of the environmental impacts of the proposed action and alternatives, and a listing of agencies and persons consulted. *See* 40 CFR § 1508.9.

[70] *See* 16 USC § 4721(a).

[71] Under NISA, "aquatic nuisance species" means "a nonindigenous species that threatens the diversity or abundance of native species or the ecological stability of infested waters, or commercial, agricultural, aquacultural, or recreational activities dependent on such waters." *Id*. § 4702(1). "Nonindigenous species" means "any species or other viable biological material that enters an ecosystem beyond its historic range, including any such organism transferred from one country to another." *Id.* § 4702(11).

[72] *See id*. § 4722(a).

[73] *See id*. § 4711.

[74] See id.

[75] Under the NISA, "Secretary" means the Secretary of the Department in which the US Coast Guard is operating. *See* 16 USC § 4702(12).

[76] 16 USC § 4711(2)(F)(i), (G), and (I).

[77] *See id*. § 4711(c)(2).

[78] 16 USC § 4712(a).

[79] See id.

[80] *See id*. § 4724.

enforcement, or financial assistance (or any combination thereof) to reduce or eliminate the risks associated with aquatic nuisance species.[81]

The NISA promotes research on species that fall under the definition "aquatic nuisance species" through competitive research grants, educational programs, and technical assistance to State and local governments and individuals.[82] Such research may include the environmental and economic risks associated with the introduction of such species, the pathways by which such species are introduced and dispersed, possible methods for prevention, monitoring, and control, and assessment of the effectiveness of such methods.[83]

13.D.1.q National Marine Sanctuary Act, 16 USC §1431 *et seq.*

The National Marine Sanctuary Act (NMSA) established the National Marine Sanctuary System, the purpose of which is to "improve the conservation, understanding, management, and wise and sustainable use of marine resources; enhance public awareness, understanding, and appreciation of the marine environment; and maintain for future generations the habitat and ecological services of the natural assemblage of living resources that inhabit these areas."[84]

Some of the major goals of the NMSA include research, monitoring, and education.[85] The DOC is to coordinate and promote the use of sanctuaries for such purposes. In addition, the DOC may issue special use permits for specific activities, if necessary, to "establish conditions of access and use of any sanctuary resources or to promote public use and understanding of a sanctuary resource."[86] The DOC may enter into cooperative agreements, contracts, or other agreements with states, local governments, regional agencies, interstate agencies, or other persons in order to carry out the purposes and policies of the NMSA.[87]

Grant and contract funds are available for research, monitoring, and education for conservation and management purposes.[88] Such purposes could include control and management of any invasive species that is or may be in the future in a particular sanctuary.

Under the NMSA, it is unlawful for any person to "destroy, cause the loss, or injure any sanctuary resource managed under law or regulations for the sanctuary."[89] Therefore, regulations for particular sanctuaries could prohibit the introduction of invasive species into the sanctuaries. For example, the Florida Keys National Marine Sanctuary's management plan explicitly prohibits the introduction of invasive species into the sanctuary.[90]

13.D.1.r Plant Protection Act, 7 USC §7701 *et seq.*

The underlying policy of the Plant Protection Act (PPA) is to prevent the introduction or dissemination of plant pests[91] into the United States.[92] With certain exceptions, no person is authorized to import, enter, export, or move in interstate commerce any plant pest, unless such importation, entry, exportation, or movement is authorized under a general or specific permit and is in accordance with USDA regulations.[93]

---

[81] See id.
[82] *See id*. § 4722(f).
[83] See id.
[84] 16 USC § 1431(a)(4).
[85] *See id*. § 1440.
[86] *See id.* § 1441(a).
[87] *See id*. § 1442(a).
[88] *See id*. § 1440(b)(1).
[89] *Id*. § 1436(1).
[90] *See* National Agricultural Library for the National Invasive Species Council, National Management Plan: Appendix 3 - Legal Authorities Related to Invasive Species. Retrieved 25 July 2003 from http://www.invasivespecies.gov/council/appendix3.shtml.
[91] *See* 7 USC § 403(14) for a definition of "plant pest."
[92] *See id*. § 411(a).
[93] See id.

As previously noted, there are exceptions to the rule. USDA may allow the importation, entry, exportation, or movement in interstate commerce of specified plant pests without further restriction if USDA finds that a permit is not necessary.[94] Any person may petition USDA to add or remove a plant pest from the regulations.[95]

PPA prohibits unauthorized mailing of plant pests.[96] "Any letter, parcel, box, or other package containing any plant pest, whether sealed as letter-rate postal matter or not, is not mailable and shall not be knowingly conveyed in the mail or delivered from any post office or by any mail carrier unless it is mailed in compliance with regulations to prevent the dissemination of plant pests into the United States or interstate."[97] Moreover, no person is authorized to open any mailed letter or other mailed sealed matter except in accordance with the postal laws and regulations.[98]

The movement of plants, plant products, biological control organisms, noxious weeds, articles, and means of conveyance are also regulated.[99] USDA may prohibit or restrict the importation, entry, exportation, or movement of the aforementioned in interstate commerce if it determines that prohibition or restriction is necessary to prevent the introduction into the United States or the dissemination of a plant pest or noxious weed within the United States.[100] USDA may publish, by regulation, a list of noxious weeds that are prohibited or restricted in interstate commerce.[101] Likewise, USDA may publish, by regulation, a list of organisms that are not prohibited or restricted in interstate commerce.[102] However, lists may take into account distinctions between organisms such as "indigenous," "invasive," "newly introduced," or "commercially raised."[103]

PPA includes notification and holding requirements upon arrival. The Department of the Treasury (the Treasury) is required to promptly notify USDA of the arrival of any plant, plant product, biological control organism, plant pest, or noxious weed at a port of entry.[104] Then the Treasury is required to hold the plant, plant product, biological control organism, plant pest, or noxious weed until it has been inspected and authorized for entry into or transit movement through the United States or is otherwise released by USDA.[105] However, these requirements do not apply to any plant, plant product, biological control organism, plant pest, or noxious weed that is imported from a country or region of a country designated as exempt by USDA.[106]

Parties who are responsible for any such plants, biological organisms or means of conveyance have certain duties under PPA. Parties are required to have a permit under Sections 411 or 412 and shall notify USDA "as soon as possible" after the arrival of the plant, biological organism, or the means of conveyance at the port of entry and before it is moved from the port of entry.[107] No person is to move from a port of entry or interstate any plant, biological organism, or means of conveyance unless it is inspected and authorized for entry into or transit movement through the United States or otherwise released by USDA.[108]

PPA authorizes USDA to hold, treat, or destroy items if necessary to prevent dissemination of a plant pest or noxious weed that is "new or not known to be widely prevalent or distributed within

[94] *See id.* § 411(c).
[95] See id.
[96] *See id.* § 411(d).
[97] *Id*.
[98] See id.
[99] *See id.* § 412.
[100] See id.
[101] *See id.* §12(f)(1).
[102] See id.
[103] *See id.* § 412(g).
[104] *See id.* § 413.
[105] See id.
[106] See id.
[107] *See id.* § 413(b).
[108] See id.

and throughout the United States."[109] Likewise, USDA may order the owner of any plant, biological organism, or means of conveyance subject to action under Section 414(a), or the owner's agent, to treat, apply other remedial measures to, destroy, or otherwise dispose of it without cost to the federal government.[110]

PPA encourages cooperation between USDA and other federal agencies or entities, states or political subdivisions of states, national governments, local governments of other nations, domestic or international organizations, domestic or international associations, and other persons to carry out this law.[111]

13.D.1.s Virus-Serum-Toxin Act, 21 USC §151 *et seq.*

Persons, firms, and corporations are not authorized to deal in any worthless, contaminated, dangerous, or harmful biological product[112] for use in the treatment of domestic animals unless prepared under and in compliance with regulations prescribed by USDA at an establishment licensed by USDA.[113] Also, USDA regulates the importation and exportation of any biological product for use in the treatment of domestic animals without a permit from USDA or, in the case of an article originating from Canada, a permit or certification by Canada.[114]

13.D.2 Federal Programs

13.D.2.a Conservation Technical Assistance

The USDA Natural Resources Conservation Service (NRCS) administers Conservation Technical Assistance (CTA). The CTA is a voluntary program for landowners, communities, state and local governments, and other federal agencies for assistance in "planning and implementing natural resource solutions to reduce soil erosion, improve soil and water quantity and quality, improve and conserve wetlands, enhance fish and wildlife habitat ... and improve woodlands."[115] The CTA program also provides assistance for implementation of programs authorized by the 1996 Farm Bill, such as highly erodible land and wetlands conservation provisions.[116] The CTA program can be utilized for management of invasive species. NRCS can provide technical assistance in preventing invasions and controlling, managing, and eradication of invasive species. (For more information on this program, visit http://www.nrcs.usda.gov/programs/cta/index.html.)

13.D.2.b Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP), administered by NRCS, was reauthorized in the Farm Security and Rural Investment Act of 2002 (Farm Bill 2002). Both governmental organizations and private landowners that engage in agricultural and livestock production to control and manage invasive species can utilize the EQIP.[117] Participation in EQIP is voluntary.[118] EQIP activities are implemented according the operation plans developed by both the government and producer.[119] The program provides financial assistance, through incentive payments and cost-shares, to protect against threats to soil, water, and other natural resources.[120] Specifically, EQIP can provide technical assistance for preventing invasions and the

---

[109] *Id*. § 414(a).
[110] See id.
[111] *See id.* § 431.
[112] The term "biological product" includes, but is not limited to, "vaccines, bacterins, allergens, antibodies, antitoxins, toxoids, immunostimulants, certain cytokines, antigenic or immunizing components of live organisms, and diagnostic components, that are of natural or synthetic origin or that are derived from synthesizing or altering various substances or components of substances ..." CFR § 101.2.
[113] *See* 21 USC §151.
[114] *See id.* §152.
[115] *See* 7 CFR §601.1(f)(1)(i).
[116] See id.
[117] *See* 7 CFR §1466.4(d).
[118] *See id.* §1466.4(a).
[119] *See id. See also* 7 CFR §1466.6(a).
[120] See id.

use of cropping systems that discourage the introduction and spread of invasive species.[121] The program also can provide technical, educational, and financial assistance to eradicate/control invasive species and to manage lands to prevent future invasions. Finally, NRCS also can provide assistance for planning and installation measures, such as structural and land management practices, to protect land from future invasions after eradication.[122] (For more information on this program, visit http://www.nrcs.usda.gov/programs/eqip/.)

13.D.2.c Plant Materials Program

The Plant Materials Program, administered by NRCS, provides plant recommendations and technology for the Farm Bill 2002 programs, such as EQIP, Wetlands Reserve Program, and the Wildlife Habitat Incentives Program. Plant Materials Centers assemble, test, and release plant species for commercial production and use of plant materials for natural resource conservation and development, including but not limited to soil erosion on all lands, protection of upstream watersheds, and improvement of wildlife food and cover.[123] Plant Materials Centers work in cooperation with other USDA agencies and with other federal and state research agencies to achieve these goals.[124] Plant materials are produced in the quantity required to do a specific conservation job that will serve the public and only if the plant materials are not commercially available.[125] Currently, there are 23 Plant Materials Centers in the United States, not including the National Plant Materials Center in Beltsville, Maryland.[126] (For more information on this program, visit http://plant-materials.nrcs.usda.gov/.)

13.D.2.d Wetlands Reserve Program

Farm Bill 2002 reauthorized the Wetlands Reserve Program (WRP), which is a voluntary program administered by NRCS. There is a Wetland Reserve location in Coffeeville, Mississippi, the Whitten Plant Materials Center. The purpose of WRP is to "offer landowners the opportunity to protect, restore, and enhance wetlands on their property" in the long term.[127] WRP provides financial, technical, and educational assistance to landowners through a Wetlands Reserve Plan of Operations in order to maintain healthy wetlands and to manage the hydrological conditions of the soil, native vegetation, and natural topography of eligible lands.[128] USDA may provide cost-share assistance to landowners, as well as assistance with planning and installing features to restore wetland habitat, which could include wetlands altered by invasive species.[129] (For more information on this program, visit http://www.nrcs.usda.gov/programs/wrp/.)

13.D.2.e Wildlife Habitat Incentives Program

Farm Bill 2002 reauthorized the Wildlife Habitat Incentives Program (WHIP), a voluntary program administered by NRCS. The purpose of WHIP is to "help participants develop habitat for upland wildlife, wetland wildlife, threatened and endangered species, fish, and other types of wildlife."[130] Protection of wildlife would include protections against the threats to wildlife posed by invasive species, as well as the lands that they inhabit. WHIP provides financial and technical assistance to landowners who develop wildlife habitat through a Wildlife Habitat Development Plan (WHDP).[131] Financial assistance is through cost-share payments and agreements.[132] Technical assistance includes application, assessment, monitoring, enforcement, and other actions

[121] *See id.* § 1466.8(a).
[122] See *id.* § 1466.1.
[123] *See* 7 CFR §§ 613.1, 613.2.
[124] *See id.* § 613.2.
[125] *See id.* § 613.4.
[126] *See id.* § 613.5.
[127] *See* NRCS Wetlands Reserve Program. Retrieved 28 February 2003 from www.nrcs.usda.gov/programs/wrp/.
[128] *See* 7 CFR § 1467.4(a).
[129] See id.
[130] 7 CFR § 636.1(a).
[131] *See id.* § 636.7
[132] *See id.* §§ 636.8, 636.10.

necessary to fulfill the goals of WHIP and WHDP.[133] (For more information on this program, visit http://www.nrcs.usda.gov/programs/whip/.)

[133] *See id.* §636.4.

13.D.3 Citations to the Code of Federal Regulations

Clean Water Act
- 7 CFR §601
- 9 CFR §590
- 40 CFR §6, 25, 35, 122, 123, 130, 401

Coastal Zone Management Act
- 49 CFR §1105

Cooperative Forestry Assistance Act
- 36 CFR §200, 230

Endangered Species Act
- 7 CFR §319, 355, 356, 371, 650
- 15 CFR §904, 922
- 19 CFR §12, 10
- 21 CFR §25
- 30 CFR §773
- 32 CFR §190
- 36 CFR §2, 13
- 43 CFR §414, 8340
- 49 CFR §1105
- 50 CFR §10, 14, 17, 23, 81, 222, 402, 424, 453

Federal Agricultural Improvement and Reform Act
- 7 CFR §12, 1794

Federal Insecticide, Fungicide, and Rodenticide Act
- 7 CFR §110, 301, 319, 760
- 9 CFR §71, 85, 121
- 14 CFR §137
- 19 CFR §12
- 21 CFR §211
- 40 CFR §2, 17, 22, 23, 35, 40, 129, 152, 154, 158, 159, 160, 163, 164, 166, 167, 170-173

Federal Noxious Weed Act
- 7 CFR §340, 371
- 50 CFR §24

Federal Plant Pest Act
- 7 CFR §351
- 50 CFR §24

Federal Seed Act
- 7 CFR §97, 201, 371

Fish and Wildlife Coordination Act
- 30 CFR §773, 736
- 40 CFR §122
- 43 CFR §8, 24
- 50 CFR §10005

Food Security Act
- 7 CFR §400, 614, 1940
- 9 CFR §205
- 46 CFR §381
- 9 CFR §205
- 46 CFR §381

The Lacey Act
- 50 CFR §10, 11, 12, 13, 14, 16

The Lacey Act Amendments of 1981
- 7 CFR §356, 371
- 15 CFR §904
- 50 CFR §10, 11, 12, 14, 300

Magnuson-Stevens Fishery Management and Conservation Act
- 15 CFR §904, 905
- 50 CFR §229, 300, 600, 622, 640, 648

Multiple-Use Sustained-Yield Act
- 36 CFR §200, 219

National Environmental Policy Act
- 7 CFR §372, 520, 622, 624, 632, 650, 799, 1710, 1780, 1794, 3407
- 10 CFR §51, 1021
- 12 CFR §408, 1815
- 14 CFR §1216
- 16 CFR §1, 1021
- 18 CFR §2, 380, 707, 725
- 21 CFR §25
- 22 CFR §161
- 23 CFR §751, 771
- 24 CFR §50
- 28 CFR §61
- 29 CFR §11
- 32 CFR §775
- 33 CFR §230
- 36 CFR §805, 907, 1010
- 38 CFR §26
- 39 CFR §775
- 40 CFR §6, 1500, 1501- 1508, 1515
- 43 CFR §1601, 1610, 3160, 3400, 3430
- 44 CFR §9, 10
- 46 CFR §504
- 49 CFR §80, 260, 520, 622, 1105
- 50 CFR §402, 530

National Forest Management Act
- 36 CFR §200, 215, 219

National Invasive Species Act
- 33 CFR §151

National Marine Sanctuary Act
- 15 CFR §904, 922

Plant Protection Act
- 7 CFR §301, 318, 319, 330, 340, 351, 352, 355, 360, 371

Soil Conservation and Domestic Allotment Act
- 7 CFR §7, 601, 701

Virus-Serum-Toxin Act
- 9 CFR §101, 102, 105, 114, 115, 116, 121, 123
- 32 CFR §627

13.E Appendix E. Section 1204 of the National Invasive Species Act of 1996

SECTION 1204. STATE AQUATIC NUISANCE SPECIES MANAGEMENT PLANS

(a) STATE OR INTERSTATE INVASIVE SPECIES MANAGEMENT PLANS —

(1) IN GENERAL – After providing notice and opportunity for public comment, the governor of each State may prepare and submit, or the Governors of the States and the governments of Indian Tribes involved in an interstate organization, may jointly prepare and submit —

(A) a comprehensive management plan to the Task Force for approval which identifies those areas or activities within the State or within the interstate region involved, other than those related to public facilities, for which technical, enforcement, or financial assistance (or any combination thereof) is needed to eliminate or reduce the environmental, public health, and safety risk associated with aquatic nuisance species, particularly the zebra mussel; and

(B) a public facility management plan to the Assistant Secretary for approval which is limited solely to identifying those public facilities within the State or within the interstate region involved for which technical and financial assistance is needed to reduce infestations of zebra mussels.

(2) CONTENT – Each plan shall, to the extent possible, identify the management practices and measures that will be undertaken to reduce infestations of aquatic nuisance species. Each plan shall —

(A) identify and describe State and local programs for environmentally sound prevention and control of the target aquatic nuisance species;

(B) identify Federal activities that may be needed for environmentally sound prevention and control of aquatic nuisance species and a description of the manner in which those activities should be coordinated with State and local government activities;

(C) identify any authority that the State (or any State or Indian Tribe involved in the interstate organization) does not have at the time of the development of the plan that may be necessary for the State (or any State or Indian Tribe involved in the interstate organization) to protect public health, property, and the environment from harm by aquatic nuisance species; and

(D) a schedule of implementing the plan, including a schedule of annual objectives and enabling legislation.

(3) CONSULTATION —

(A) In developing and implementing a management plan, the State or interstate organization should, to the maximum extent practicable, involve local governments and regional entities, Indian Tribes, and public and private organizations that have expertise in the control of aquatic nuisance species.

(B) Upon the request of a State or the appropriate official of an interstate organization, the Task Force or the Assistant Secretary, as appropriate under paragraph (1), may provide technical assistance in developing and implementing a management plan.

(4) PLAN APPROVAL — Within 90 days after the submission of a management plan, the Task Force or the Assistant Secretary in consultation with the Task Force, as appropriate under paragraph (1), shall review the proposed plan and approve it if it meets the requirements of this subsection or return the plan to the Governor or the interstate organization with recommended modifications.

(b) GRANT PROGRAM —

(1) STATE GRANTS — The Director may, at the recommendation of the Task Force, make grants to States with management plans approved under subsection (a) for the implementation of those plans.

(2) APPLICATION — An application for a grant under this subsection shall include an identification and description of the best management practices and measures which the State proposes to utilize in implementing an approved management plan with any Federal assistance to be provided under the grant.

(3) FEDERAL SHARE —

(A) The Federal share of the cost of each comprehensive management plan implemented with Federal assistance under this section in any fiscal year shall not exceed 75 percent of the cost incurred by the State in implementing such management program and the non-Federal share of such costs shall be provided from non-Federal sources.

(B) The Federal share of the cost of each public facility management plan implemented with Federal assistance under this section in any fiscal year shall not exceed 50 percent of the cost incurred by the State in implementing such management programs and the non-Federal share of such costs shall be provided from non-Federal sources.

(4) ADMINISTRATIVE COSTS — For the purposes of this section, administrative costs for activities and programs carried out with a grant in any fiscal year shall not exceed 5 percent of the amount of the grant in that year.

(5) IN-KIND CONTRIBUTIONS — In addition to cash outlays and payments, in-kind contributions of property or personnel services by non-Federal interests for activities under this section may be used for the non-Federal share of the cost of those activities.

(c) ENFORCEMENT ASSISTANCE — Upon request of a State or Indian Tribe, the Director or Under Secretary, to the extent allowable by law and in a manner consistent with section 141 of title 14, United States Code, may provide assistance to a State or Indian Tribe in enforcing an approved State or interstate invasive species management plan.

13.F Appendix F. Executive Order 13112 of February 3, 1999

By the authority vested in me as President by the Constitution and the laws of the United States of America, including the National Environmental Policy Act of 1969, as amended (42 USC 4321 *et seq*.), Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990, as amended (16 USC 4701 *et seq*.), Lacey Act, as amended (18 USC 42), Federal Plant Pest Act (7 USC 150aa *et seq*.), Federal Noxious Weed Act of 1974, as amended (7 USC 2801 *et seq*.), Endangered Species Act of 1973, as amended (16 USC 1531 *et seq*.), and other pertinent statutes, to prevent the introduction of invasive species and provide for their control and to minimize the economic, ecological, and human health impacts that invasive species cause, it is ordered as follows:

Section 1. Definitions.

(a) ''Alien species'' means, with respect to a particular ecosystem, any species, including its seeds, eggs, spores, or other biological material capable of propagating that species, that is not native to that ecosystem.

(b) ''Control'' means, as appropriate, eradicating, suppressing, reducing, or managing invasive species populations, preventing spread of invasive species from areas where they are present, and taking steps such as restoration of native species and habitats to reduce the effects of invasive species and to prevent further invasions.

(c) ''Ecosystem'' means the complex of a community of organisms and its environment.

(d) ''Federal agency'' means an executive department or agency, but does not include independent establishments as defined by 5 USC 104.

(e) ''Introduction'' means the intentional or unintentional escape, release, dissemination, or placement of a species into an ecosystem as a result of human activity.

(f) ''Invasive species'' means an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health.

(g) ''Native species'' means, with respect to a particular ecosystem, a species that, other than as a result of an introduction, historically occurred or currently occurs in that ecosystem.

(h) ''Species'' means a group of organisms all of which have a high degree of physical and genetic similarity, generally interbreed only among themselves, and show persistent differences from members of allied groups of organisms.

(i) ''Stakeholders'' means, but is not limited to, State, tribal, and local government agencies, academic institutions, the scientific community, nongovernmental entities including environmental, agricultural, and conservation organizations, trade groups, commercial interests, and private landowners.

(j) ''United States'' means the 50 States, the District of Columbia, Puerto Rico, Guam, and all possessions, territories, and the territorial sea of the United States.

Section 2. Federal Agency Duties.

(a) Each Federal agency whose actions may affect the status of invasive species shall, to the extent practicable and permitted by law;

(1) identify such actions;

(2) subject to the availability of appropriations, and within Administration budgetary limits, use relevant programs and authorities to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost-effective and

environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them; and

(3) not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species in the United States or elsewhere unless, pursuant to guidelines that it has prescribed, the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species; and that all feasible and prudent measures to minimize risk of harm will be taken in conjunction with the actions.

(b) Federal agencies shall pursue the duties set forth in this section in consultation with the Invasive Species Council, consistent with the Invasive Species Management Plan and in cooperation with stakeholders, as appropriate, and, as approved by the Department of State, when Federal agencies are working with international organizations and foreign nations.

Section 3. Invasive Species Council.

(a) An Invasive Species Council (Council) is hereby established whose members shall include the Secretary of State, the Secretary of the Treasury, the Secretary of Defense, the Secretary of the Interior, the Secretary of Agriculture, the Secretary of Commerce, the Secretary of Transportation, and the Administrator of the Environmental Protection Agency. The Council shall be co-chaired by the Secretary of the Interior, the Secretary of Agriculture, and the Secretary of Commerce. The Council may invite additional Federal agency representatives to be members, including representatives from subcabinet bureaus or offices with significant responsibilities concerning invasive species, and may prescribe special procedures for their participation. The Secretary of the Interior shall, with concurrence of the Co-Chairs, appoint an Executive Director of the Council and shall provide the staff and administrative support for the Council.

(b) The Secretary of the Interior shall establish an advisory committee under the Federal Advisory Committee Act, 5 USC App., to provide information and advice for consideration by the Council, and shall, after consultation with other members of the Council, appoint members of the advisory committee representing stakeholders. Among other things, the advisory committee shall recommend plans and actions at local, tribal, State, regional, and ecosystem-based levels to achieve the goals and objectives of the Management Plan in section 5 of this order. The advisory committee shall act in cooperation with stakeholders and existing organizations addressing invasive species. The Department of the Interior shall provide the administrative and financial support for the advisory committee.

Section 4. Duties of the Invasive Species Council.

The Invasive Species Council shall provide national leadership regarding invasive species, and shall:

(a) oversee the implementation of this order and see that the Federal agency activities concerning invasive species are coordinated, complementary, cost-efficient, and effective, relying to the extent feasible and appropriate on existing organizations addressing invasive species, such as the Aquatic Nuisance Species Task Force, the Federal Interagency Committee for the Management of Noxious and Exotic Weeds, and the Committee on Environment and Natural Resources;

(b) encourage planning and action at local, tribal, State, regional, and ecosystem-based levels to achieve the goals and objectives of the Management Plan in section 5 of this order, in cooperation with stakeholders and existing organizations addressing invasive species;

(c) develop recommendations for international cooperation in addressing invasive species;

(d) develop, in consultation with the Council on Environmental Quality, guidance to Federal agencies pursuant to the National Environmental Policy Act on prevention and control of invasive species, including the procurement, use, and maintenance of native species as they affect invasive species;

(e) facilitate development of a coordinated network among Federal agencies to document, evaluate, and monitor impacts from invasive species on the economy, the environment, and human health;

(f) facilitate establishment of a coordinated, up-to-date information-sharing system that utilizes, to the greatest extent practicable, the Internet; this system shall facilitate access to and exchange of information concerning invasive species, including, but not limited to, information on distribution and abundance of invasive species; life histories of such species and invasive characteristics; economic, environmental, and human health impacts; management techniques, and laws and programs for management, research, and public education; and

(g) prepare and issue a national Invasive Species Management Plan as set forth in section 5 of this order.

Section. 5. Invasive Species Management Plan.

(a) Within 18 months after issuance of this order, the Council shall prepare and issue the first edition of a National Invasive Species Management Plan (Management Plan), which shall detail and recommend performance-oriented goals and objectives and specific measures of success for Federal agency efforts concerning invasive species. The Management Plan shall recommend specific objectives and measures for carrying out each of the Federal agency duties established in section 2(a) of this order and shall set forth steps to be taken by the Council to carry out the duties assigned to it under section 4 of this order. The Management Plan shall be developed through a public process and in consultation with Federal agencies and stakeholders.

(b) The first edition of the Management Plan shall include a review of existing and prospective approaches and authorities for preventing the introduction and spread of invasive species, including those for identifying pathways by which invasive species are introduced and for minimizing the risk of introductions via those pathways, and shall identify research needs and recommend measures to minimize the risk that introductions will occur. Such recommended measures shall provide for a science-based process to evaluate risks associated with introduction and spread of invasive species and a coordinated and systematic risk-based process to identify, monitor, and interdict pathways that may be involved in the introduction of invasive species. If recommended measures are not authorized by current law, the Council shall develop and recommend to the President through its Co-Chairs legislative proposals for necessary changes in authority.

(c) The Council shall update the Management Plan biennially and shall concurrently evaluate and report on success in achieving the goals and objectives set forth in the Management Plan. The Management Plan shall identify the personnel, other resources, and additional levels of coordination needed to achieve the Management Plan's identified goals and objectives, and the Council shall provide each edition of the Management Plan and each report on it to the Office of Management and Budget. Within 18 months after measures have been recommended by the Council in any edition of the Management Plan, each Federal agency whose action is required to implement such measures shall either take the action recommended or shall provide the Council with an explanation of why the action is not feasible. The Council shall assess the effectiveness of this order no less than once each 5 years after the order is issued and shall report to the Office of Management and Budget on whether the order should be revised.

Section. 6. Judicial Review and Administration.

(a) This order is intended only to improve the internal management of the executive branch and is not intended to create any right, benefit, or trust responsibility, substantive or procedural, enforceable at law or equity by a party against the United States, its agencies, its officers, or any other person.

(b) Executive Order 11987 of May 24, 1977, is hereby revoked.

(c) The requirements of this order do not affect the obligations of Federal agencies under 16 USC 4713 with respect to ballast water programs.

(d) The requirements of section 2(a)(3) of this order shall not apply to any action of the Department of State or Department of Defense if the Secretary of State or the Secretary of Defense finds that exemption from such requirements is necessary for foreign policy or national security reasons.

WILLIAM J. CLINTON
THE WHITE HOUSE
February 3, 1999

13.G Appendix G. Summary of International Laws and Treaties Relevant to Aquatic Invasive Species

13.G.1 International Laws

13.G.1.a Codex Alimentarius Commission

The United Nations' Food and Agricultural Organization (FAO) and the World Health Organization (WHO) created the Codex Alimentarius Commission (Codex) in 1962.[1] The purpose of the Codex is to encourage fair international trade in food while promoting the health and economic interests of consumers.[2] In the United States, Codex activities are coordinated by USDA, EPA, and Food and Drug Administration.[3]

Volume 1A of the Codex empowers the Commission to create specialized committees. One such committee that relates to invasive species is the Committee on Import/Export Inspection and Certification Systems.[4] To fulfill its goal of protecting consumer health in the area of food safety, the Codex has formulated standards for specific food commodities, pesticide and drug residues, food contaminants and additives, labeling, and food safety.[5] Invasive species are relevant to the Codex if they threaten food safety or the international food trade.

13.G.1.b Convention on Biological Diversity

The Convention on Biological Diversity (CBD) recognizes the importance of "ecological, genetic, social, economic, scientific, educational, cultural, recreational, and aesthetic" values of biological diversity throughout the world.[6] Countries have rights over their own biological resources, but also have the responsibility of conserving them and using them in a sustainable manner.[7] A fundamental requirement for the conservation of biological diversity is *in situ* conservation.[8] CBD recognizes the need to "prevent the introduction of and control or eradicate those alien species which threaten ecosystems, habitats, or species."[9] CDB has a program to target introduction of invasive species.[10] The Global Invasive Species Programme works with CBD to provide expertise through the CBD's Subsidiary Body on Science, Technology, and Technical Assistance.[11] The United States has not ratified the agreement.

13.G.1.c Convention on International Trade in Endangered Species of Wild Flora and Fauna

The purpose of The Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES) is to foster international cooperation in order to protect certain species of flora and fauna from over-exploitation through international trade.[12] CITES divides species of wild flora and fauna into three appendices. Trade of any species in Appendices I, II, or III is prohibited, except in

---

[1] *See* Food Safety and Inspection Service US Codex Office, Codex Alimentarius Commission. Retrieved 17 February 2003 from www.fsis.usda.gov/OA/codex/.
[2] See id.
[3] See id.
[4] *See* FAO/WHO Food Standards, Codex Alimentarius. Retrieved 17 February 2003 from www.codexalimentarius.net/.
[5] See id.
[6] Convention on Biological Diversity, June 5, 1002, Preamble.
[7] See id.
[8] i*n-situ* conservation means "the conservation of ecosystems and natural habitats and the maintenance and recovery of viable populations of species in their natural surroundings and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties." *Id*. Article 2.
[9] *Id*. Article 2(h).
[10] *See* Convention on Biological Diversity, Alien Species Introduction. Retrieved 17 February 2003 from www.biodiv.org/programmes/cross-cutting/alien/.
[11] *See* Convention on Biological Diversity, Alien Species Introduction. Retrieved 17 February 2003 from www.biodiv.org/programmes/cross-cutting/alien/gisp.asp.
[12] *See* Convention on International Trade of Endangered Species of Wild Flora and Fauna, March 3, 1973, Preamble.

accordance with provisions set forth in CITES.[13] Trade of species included in Appendices I, II, and III are regulated through a system of import, export, and re-export permits.[14]

Appendix I includes species threatened with extinction that are or may be affected by trade. Trading members of these species are the most strictly regulated in order not to further endanger their survival.[15] For these species, trade is authorized in only "exceptional" circumstances.[16]

Appendix II includes species that currently are not threatened with extinction, but would become so threatened without strict regulation.[17] Appendix II also recognizes that trade in other species also must be regulated in order to effectively protect species included in Appendix II.[18]

Appendix III includes all species that any party to CITES declares to be subject to regulation within its jurisdiction to prevent or restrict exploitation, and "as needing cooperation of other parties in the control of trade."[19]

13.G.1.d Office of International Epizootics

The Office of International Epizootics (OIE) is an international organization created by agreement in 1924. Its purposes are to guarantee the transparency of animal diseases worldwide; to collect, analyze, and disseminate veterinary scientific information; to provide expertise and promote international solidarity for the control of animal diseases; and to guarantee the sanitary safety of world trade by developing sanitary rules for international trade in animals and animal products.[20]

OIE collects and disseminates information through cooperation between member countries. Each member reports to OIE animal diseases that it identifies within its territory.[21] OIE thereby disseminates this information to other members so that each may act upon this information accordingly.[22] OIE provides technical support to member countries that request assistance in controlling and eradicating animal diseases.[23] OIE also creates "normative documents relating to rules that member countries can use to protect themselves from diseases without setting unjustified sanitary barriers."[24] Such normative documents include the International Animal Health Code[25] and Manual Standards for Diagnostic Tests and Vaccines.[26] While OIE generally focuses on issues such as livestock diseases and developing standards for diagnostic tests and vaccines, it recently has started to focus on diseases affecting wildlife, including aquatic species, by publishing its International Aquatic Animal Health Code.[27]

13.G.1.e International Plant Protection Convention

The purpose of the International Plant Protection Convention (IPPC) is to prevent the introduction and spread of pests of plants and plant products and to promote appropriate control measures.[28] IPPC was adopted in 1951 and was revised in November 1997. However, the 1997 revision,

---

[13] *See id*. Article II.4.
[14] *See id*. Article III.2, III.3, and III.4. See also Article IV.2, IV.3, IV.4, and IV.5 and Article V.2, V.3, and V.4.
[15] *See id*. Article II.1.
[16] *Id*.
[17] *See id*. Article II.2(a).
[18] *See id*. Article II.2(b).
[19] *See id*. Article II.3.
[20] *See* Office of International Epizootics, What is the OIE?. Retrieved 17 February 2003 from www.oie.int/eng/OIE/en_oie.htm.
[21] See id.
[22] See id.
[23] See id.
[24] See id.
[25] *See* Office of International Epizootics, Terrestrial Animal Health Code 2003. Retrieved 25 July 2003 from www.oie.int/eng/normes/mcode/A_summry.htm.
[26] *See* Office of International Epizootics, Manual Standards for Diagnostic Tests and Vaccines 2000. Retrieved 28 February 2003 from www.oie.int/eng/normes/mmanual/A_summry.htm.
[27] *See* Office of International Epizootics, International Aquatic Animal Health Code 2002. Retrieved 28 February 2003 from www.oie.int/eng/normes/fcode/A_summry.htm.
[28] *See* International Plant Protection Convention, December 6, 1951, current text adopted in 1979, Article I.1.

while adopted, is not yet in force.[29] Under IPPC, each contracting party agrees to cooperate with each other to prevent the introduction of plant pests and diseases and prevent their spread across national boundaries.[30] The Food and Agriculture Organization of the United Nations disseminates information on import restrictions, requirements, prohibitions, and regulations to all contracting parties and regional plant protection organizations.[31]

Each contracting party is responsible for creating a national plant organization to carry out the provisions of IPPC, such as inspection of consignments of plants and plant products moving in international traffic that may carry pests and diseases and protecting endangered areas.[32] If necessary for phytosanitary conditions, contracting parties may regulate the entry of plants into their territories by setting requirements of importation; prohibiting importation of specific plants; inspecting and detaining specific plants; and treating, destroying, or refusing entry to specific plants.[33] However, contracting parties shall not take measures more stringent than necessary to accomplish the goals of IPPC in order to minimize interference with international trade.[34]

13.G.1.f North American Free Trade Agreement

The main objectives of the North American Free Trade Agreement (NAFTA) are to eliminate trade barriers and to promote fair competition between the Parties to the Agreement.[35] NAFTA requires that each party to the greatest extent practicable, participate in international and North American standardizing organizations, such as the Codex, OIE, IPPC, and North American Plant Protection Organization, to promote the "development and periodic review of international standards, guidelines and recommendations."[36]

Chapter 7 relates to invasive species. It allows each party to adopt sanitary or phytosanitary measures necessary for the protection of human, animal, or plant life or health in its territory.[37] Such measures may be more stringent than international standards, guidelines, or recommendations.[38] Such measures should be based on research and risk assessment.[39] However, measures should not arbitrarily or unjustifiably discriminate against another party's goods.[40] Furthermore, in conducting risk assessments in order to determine appropriate measures of protection, one of the factors that the parties must take into account is "the prevalence of relevant diseases or pests, including the existence of pest-free or disease-free areas or areas of low pest or disease prevalence."[41]

13.G.1.g World Trade Organization Agreement on the Application of Sanitary and Phytosanitary Measures

The Sanitary and Phytosanitary Measures Agreement (SPS Agreement) is a supplement to the World Trade Organization Agreement. It encourages members to adopt measures necessary to protect human, animal or plant life or health.[42] However, such measures should not arbitrarily or unjustifiably discriminate against members that experience the same conditions in their territories or be disguised as a restriction on international trade.[43] The SPS Agreement also encourages

[29] *See* International Phytosanitary Portal, Documents and Publications. Retrieved 3 March 2003 from www.ippc.int/cds_ippc_prod/IPP/En/publications.htm.
[30] *See* International Plant Protection Convention, December 5, 1951, current text adopted in 1979, Preamble.
[31] *See id*. Article VI.4.
[32] *See id*. Article IV.1(a)(i), (ii).
[33] *See id*. Article VI.1.
[34] *See id*. Article VI.2.
[35] *See* North American Free Trade Agreement, 17 December 1992, Article 102.
[36] *Id*. Chapter 7, § B, Art. 713(5).
[37] *See id*. Chapter 7, § B, Art. 712(1).
[38] See id.
[39] *See id*. Chapter 7, § B, Art. 715(1).
[40] *See id*. Chapter 7, § B, Art. 712(4))
[41] *Id*. Chapter 7, § B, Art.715(1)(e).
[42] *See* Agreement on Sanitary and Phytosanitary Measures, 15 April 1994, Preamble.
[43] *See id*. Article 5.5.

members to use other international guidelines, such as the Codex, OIE, and IPPC[44] to promote within these organizations the development and periodic review of standards, guidelines, and recommendations with respect to all aspects of sanitary and phytosanitary measures.[45] The SPS Agreement members should conduct scientific research and collect evidence in order to set appropriate levels of sanitary and phytosanitary protection with the least impact on international trade.[46] Such evidence includes the prevalence of specific diseases or pests, existence of pest-free or disease-free areas, relevant ecological and environmental conditions, and quarantine or other treatment.[47]

[44] *See id*. Preamble. *See also* Article 3.4.
[45] *See id*. Article 3.4.
[46] *See id*. Article 5.4.
[47] *See id*. Article 5.2.

13.H Appendix H. Addendum to Section 4.C.2 of Plan Text

13.H.1 Section 4.C.2.a.ii. Grass Carp (*Ctenopharyngodon idella*)

USFWS organized an Asian Carp Working Group (Working Group) to develop a comprehensive management and control plan for Asian carp in the United States (USFWS 2006). This group was charged with:

1) Developing a plan that protects our nation's natural resources;

2) Developing a plan that provides solutions for a viable aquaculture industry when implemented; and

3) Developing a plan that provides a framework for the responsible use of domestic stocks of Asian carp.

The working group agreed that the desired endpoint of the plan is the extirpation of all Asian carps (grass carp, silver carp, bighead carp and black carp) in the wild, except for non-reproducing grass carp within planned locations where nuisance aquatic vegetation can be controlled using planned introductions of sterile (triploid) fish contained within a designated area (USFWS 2006).

Strategies and recommendations were developed to address the seven goals to protect the nation's natural resources. The working group reached consensus on 48 strategies and 131 recommendations to manage and control Asian carp (Conover et al. 2007). In 2006, the notice of the draft plan and request for comments was published (USFWS 2006). The final plan was approved by ANSTF in November 2007 (Conover et al. 2007) and is available at: http://www.anstaskforce.gov/Documents/Carps_Management_Plan.pdf

There were three unresolved issues in the plan. One of these is the use of grass carp on aquaculture facilities and in farm ponds in watersheds with self-sustaining populations of grass carp. The plan encourages states to allow only the use of triploid grass carp (Conover et al. 2007).

In the United States, bighead carp are polycultured with channel catfish when stocked at recommended rates. Bighead carp do not significantly affect catfish production or food conversion ratios. Bighead carp are an important source of additional income that, at times of low catfish prices, helps farmers cover production costs.

Citations:

Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force. Washington, DC. 223 pp.

Engle, C. undated. Annual cost and returns of raising bighead carp in commercial catfish ponds. University of Arkansas-Pine Bluff. Accessed 27 January 2010 at <http://aquanic.org/species/catfish/documents/fsa9078.pdf>

Stone, N., C. Engle, D. Heikes and D. Freeman. 2000. Bighead carp. Southern Regional Aquaculture Center, SRAC Publications No. 438. Accessed 27 January 2010 at <http://aquanic.org/publicat/usda_rac/efs/srac/438fs.pdf>

USFWS. 2006. Draft Management and Control Plan for Asian Carps in the United States. Notice of document availability and request for comments. 71 Federal Register 62292-62293.

13.H.2 Section 4.C.2.a.iii. Silver Carp (*Hypophthalmichthys molitrix*)

In October 2002, USFWS received a petition signed by 25 members of Congress representing the Great Lakes region to add black, bighead and silver carp to the list of injurious wildlife under the Lacey Act (USFWS 2007). In July 2003, USFWS published a notice of inquiry on silver carp in the Federal Register and solicited comments. In September 2005 a proposed rule was published concerning the listing of silver carp and comments were solicited. USFWS received and considered 116 letters during the public comment periods and in July 2007 decided to add all live forms of silver carp (*Hypophthalmicthys molitrix*), gametes, viable eggs, and hybrids and all live forms of largescale silver carp (*Hypophthalmicthys harmandi*) to the list of injurious species of wildlife under the Lacey Act effective August 6, 2007 (USFWS 2007). Live silver carp, gametes, viable eggs, and hybrids can be imported only by permit for scientific, medical, educational, or zoological purposes, or without a permit by federal agencies solely for their own use. Permits are required for the interstate transportation of live silver and largescale silver carp, gametes, viable eggs, or hybrids currently within the United States.

A biological synopsis and environmental risk assessment for silver carp was recently published by Kolar et al. (2007). Since the property of establishment rated high and the consequence of establishment rated medium to high, the overall organism risk potential rated high (Kolar et al. 2007).

Citations:

Kolar, C.S., D.C. Chapman, W.R. Courtenay, Jr., C.M. Housel, J.D. Williams, and D.P. Jennings. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment. American Fisheries Society, Special Publication 33, Bethesda Maryland.

USFWS. 2007. Injurious Wildlife Species; Silver Carp (*Hypophthalmicthys molitrix*), and Largescale Silver Carp (*Hypophthalmicthys harmandi*), Final rule. US Department of the Interior. 72 Federal Register 37459-37469.

13.H.3 Section 4.C.2.a.iv. Bighead Carp (*Hypophthalmichthys nobilis*)

USFWS proposed to list bighead carp as injurious wildlife under the Lacey Act in 1977 (USFWS 1977). This proposal was not adopted due to opposing viewpoints. In September 2003, a notice of inquiry concerning listing bighead carp to the injurious species of wildlife under the Lacey Act was published in response to a petition from 25 members of Congress representing the Great Lakes region (USFWS 2003). To date, no decision on this listing for bighead carp has been released (Kolar et al. 2007). One of the unresolved issues in the *Management and Control Plan for Bighead, Black, Grass, and Silver Carps in the United States* was the commercial domestic transport of live farm-raised bighead carp (Conover et al. 2007). A biological synopsis and environmental risk assessment for bighead carp was recently published (Conover et al. 2007). Since the probability of establishment rated high and the consequence of establishment rated medium to high, the overall organism risk potential rated high (Kolar et al. 2007).

On December 14, 2010, President Obama signed into law the Asian Carp Prevention and Control Act, S.1421, which added the bighead carp species of Asian carp to the list of injurious species that are prohibited from being imported or shipped in the United States under the Lacey Act. Listing bighead carp under the Lacey Act prevents the intentional introduction of the species by prohibiting the interstate transportation or importation of live Asian carp without a permit. Permits are only issued for the interstate transport of live bighead carp that are used for educational, medical, or research purposes.

At the time, at least three Mississippi fish farmers (Quiver River Aquaculture, Inc., Trans Fisheries, Inc., and Nobile Fish Farms) were raising bighead carp. Their markets were for live fish sold as food. Since the law became effective immediately, these farms were prohibited from

shipping live bighead carp out of the state of Mississippi. Subsequent communications with knowledgeable aquaculture personnel revealed that these farms were culturing at least 75,000 pounds of bighead carp (Riecke 2011).

Citations:

Conover, G., R. Simmonds, and M. Whalen, editors. 2007. Management and control plan for bighead, black, grass and silver carps in the United States. Asian Carp Working Group, Aquatic Nuisance Species Task Force. Washington, DC. 223 pp.

Kolar, C.S., D.C. Chapman, W.R. Courtenay, Jr., C.M. Housel, J.D. Williams, and D.P. Jennings. 2007. Bigheaded carps: a biological synopsis and environmental risk assessment. American Fisheries Society, Special Publication 33, Bethesda Maryland.

Riecke, D. 2011. Email communication to Henry Folmar on 19 April 2011. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

US Fish and Wildlife Service. 1977. Injurious wildlife. Proposed importation and shipment requirements. Federal Register 42(44):12972-12978.

US Fish and Wildlife Service. 2003. Review of information concerning bighead carp (*Hypophthalmichthys nobilis*). Federal Register 68(180):54409.

13.H.4 Section 4.C.2.a.v. Tilapia (*Tilapia* spp., *Oreochromis* spp., and *Sarotherodon* spp.)

Studies of the food habits, habitat use and reproductive strategies of the Nile tilapia (*Oreochromis niloticus*) population reveal that the species has successfully colonized the freshwater and low-salinity regions of this area (Peterson et al. 2004, 2005, 2006; McDonald 2006). In October 2006, personnel from USGS, MDWFP, MMNS, GCRL, and MDMR applied rotenone to ponds at the Custom Pack aquaculture facility site near Davis Bayou (Jackson County), which had been destroyed by Hurricane Katrina and abandoned. The facility had cultured tilapia and Malaysian prawns. Schofield et al. (2007) reported that 9,173 Nile tilapia were killed in ponds ranging in salinity from 4.1 to 16.7 ppt. Nile tilapia were also found in Robinson Bayou near the abandoned Sea Chick aquaculture facility and were reproducing in the Black Creek cooling pond owned by Mississippi Power Company (Schofield et al. 2007).

In December 2007, MDWFP learned that tilapia were present in an abandoned aquaculture facility near Picayune, Mississippi (Riecke 2008).

Citations:

McDonald, J.L. 2006. Habitat characteristics and reproductive behavior of introduced Nile tilapia (*Oreochromis niloticus* (Linnaeus)) in coastal Mississippi: interactions with native centrarchid species: *Tilapia nilotica.* Unpublished MS thesis. University of Southern Mississippi, Hattiesburg, MS.

Peterson, M.S., W.T. Slack, and C.M. Woodley. 2005. The occurrence of nonindigenous Nile tilapia, *Oreochromis niloticus* (Linnaeus) in coastal Mississippi, USA: ties to aquaculture and thermal effluent. Wetlands 25:112-121.

Peterson, M.S., W.T. Slack, G.L. Waggy, J. Finley, C.M. Woodley, and M.L. Partyka. 2006. Foraging in nonnative environments: comparison of Nile tilapia and three co-occurring native centrarchids in invaded coastal Mississippi watersheds. Environmental Biology of Fishes 76:283-301.

Peterson, M.S., W.T. Slack, N.J. Brown-Peterson, and J.L. McDonald. 2004. Reproduction in nonnative environments: establishment of Nile tilapia, *Oreochromis niloticus,* in coastal Mississippi watersheds. Copeia 2004:842-849.

Riecke, D. 2008. Personal communication on 1 February 2008. Mississippi Department of Wildlife, Fisheries and Parks. Jackson, Mississippi.

Schofield, P.J., W.T. Slack, M.S. Peterson, and D.R. Gregoire. 2007. Assessment and control of an invasive aquaculture species: an update on Nile tilapia (*Oreochromis niloticus*) in coastal Mississippi after Hurricane Katrina. Southeastern Fishes Council Proceedings 49:9-15.

13.H.5 Section 4.C.2.b.i. Black Carp (*Mylopharyngodon piceus*)

According to an Arkansas fish farmer, at least two farms in Mississippi had black carp in 1995. One, a hybrid striped bass operation, had less than 2,000 black carp, all triploids. The other had an unknown number of diploids. When the Guidelines for Aquaculture Activities in Mississippi were revised in May 1997, black carp use by aquaculturists was not prohibited, since some farmers already possessed black carp. From 1993 to 1997, USFWS reported that 9,655 black carp had been certified as triploid by black carp producers in Arkansas for shipment to Mississippi fish farmers (Nico et al. 2005).

In late 1999, MDWFP and MDAC personnel held two meetings concerning the use of black carp in Mississippi. The meetings were triggered by the fear of an imminent threat of a serious disease outbreak in the commercial catfish industry caused by a digenic trematode, *Bolbophorus damnificus* (Overstreet et al. 2002). Severe outbreaks of *B. damnificus* have caused high mortality rates and decreased production in channel catfish, and can make fish unsuitable for processing. Ram's horn snails are the first intermediate hosts and fish are the second intermediate hosts to *B. damnificus*. Catfish farmers were advocating the use of black carp to consume ram's horn snails in their ponds to eliminate the first intermediate host for the parasite.

In November 1999, MDAC issued requirements for the sale of black carp to Mississippi fish farmers and their stocking of black carp in aquaculture ponds (Riecke 2000). These requirements state that Mississippi fish farmers wishing to stock black carp must:

- Apply for an aquaculture permit from MDAC;
- Install a dual filter system on pond pipes;
- Have the filter system inspected by MDAC prior to stocking black carp;
- Try to obtain triploid black carp that have gone through the triploid process but have not been certified or sorted; and
- Discontinue stocking diploid black carp until December 31, 2000, if triploid or triploid processed fish cannot be found.

Black carp producers were required to obtain a copy of the MDAC aquaculture cultivation and marketing permits from all Mississippi fish farmers desiring to purchase black carp and to notify MDAC of all sales of black carp to Mississippi fish farmers (Riecke 2000). Since 1999, approximately 30 fish farms in Mississippi have received permits to stock black carp. Between 2000 and 2007, 174,227 black carp were shipped to Mississippi from Arkansas fish farmers. Of these, 9,630 to 42,763 fish were diploid and 132,598 to 164,566 fish were triploid. Ranges of diploid and triploid fish are given as the producers estimated the percentages (Riecke 2011). The number of black carp spawned and sold in Mississippi by Mississippi fish farmers between 2000 and 2007 is unknown.

Concerns over black carp's potential effect on threatened or endangered mussel populations led the American Fisheries Society to adopt a resolution in 1994—similar to the one passed by the North Central Division of the Society the previous year—which urged all state, provincial and federal governmental natural resource agencies to take immediate steps to eliminate all existing populations of black carp in North America and prohibit any additional importation of these fish (Nico et al. 2005).

These potential impacts led the Aquatic Nuisance Species Task Force to develop a risk assessment for this species (Nico et al. 2005). A draft risk assessment was published in 1996 (Nico and Williams 1996). After updating, a final risk assessment was published in 2001 (Nico et al. 2001), and revised in 2005 in consideration of new information that became available (Nico et al. 2005). The last risk assessment rated the Organism Risk Potential (ORP) as high because both the probability of establishment and the consequence of establishment were assessed as high (Nico et al. 2005). The Mississippi River and several of its major tributaries are especially susceptible to invasion by black carp because most of the fish farms stocked with black carp are located in the floodplain of the lower Mississippi River (Nico et al. 2005).

In February 2000, USFWS received a petition from the Mississippi Interstate Cooperative Resource Association (MICRA) to list black carp as an injurious species of wildlife under the Lacey Act (18 USC 42) (USFWS 2007). In October 2002, USFWS received a petition signed by 25 members of Congress representing the Great Lakes region to add black, bighead, and silver carp to the list of injurious wildlife under the Lacey Act. Beginning in June 2000, USFWS solicited comments on the proposed rulemaking action, and published additional notices in the Federal Register in July 2002, August 2005, and October 2005. During these four public comment periods, USFWS received 315 comments (USFWS 2007).

One comment associated with the October 2005 Federal Register notice listing black carp (USFWS 2007) as an injurious species under the Lacey Act stated that, "only triploid black carp are currently used for snail control in the United States and that these sterile fish are only allowed in Arkansas, Mississippi and Missouri; about 30-50,000 are utilized in any given year." In November 2007, a black carp producer notified USFWS that he had shipped 117 triploid and 3,614 diploid black carp to Mississippi. He commented that these were the first black carp that he had sold for broodstock and represented his last shipment of black carp to Mississippi (Riecke 2008).

In 2003, fish farms in the Mississippi counties of Coahoma, Humphreys, Leflore, Sunflower, Tunica and Washington were utilizing black carp for snail control (Nico et al. 2005). From 2003 to 2004, 35 sites along 128 kilometers of the Big Sunflower, Bogue Phalia, and Yazoo rivers were sampled with electrofishing to determine the presence of black carp in natural waters adjacent to aquaculture facilities permitted to have black carp. Black carp were not collected in any river segments sampled in Mississippi, Louisiana, or Arkansas (Schramm and Basler 2005).

Citations:

Nico, L.G., and J.D. Williams. 1996. Risk assessment on black carp (Pisces: Cyprinidae). Final report submitted to the Risk Assessment and Management Committee of the Aquatic Nuisance Species Task Force. US Geological Survey, Gainesville, Florida.

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.

Overstreet, R.M., S.S. Curran, L.M. Pote, D.T. King, C.K. Blend, and W.D. Grater. 2002. Bolbophorus damnificus n. sp. (Digenea: Bolbophoridae) from the channel catfish *Ictalurus punctatus* and American white pelican *Pelecanus crythrorhynchos* in the USA based on life-cycle and molecular data. Systematic Parasitology 52:81-96.

Riecke, D. 2000. Black carp in Mississsippi. In: Proceedings: Asian Carp Management and Control Workshop. US Fish and Wildlife Service, Columbia, Missouri.

Riecke, D. 2008. Personal communication from Greg Conover, USFWS.

Riecke, D. 2011. Email communication to Henry Folmar on 27 April 2011. Mississippi Department of Wildlife, Fisheries, and Parks. Jackson, Mississippi.

Schramm, H.L., and M.C. Balser. 2005. Evaluation of capture methods and distribution of black carp in Arkansas, Louisiana, and Mississippi. Final Report 1 June 2004 – 31 May 2005. Submitted to US Fish and Wildlife Service, Region 4, Fisheries, Atlanta, Georgia. US Geological Survey, Mississippi Cooperative Fish and Wildlife Research Unit.

Terhune, J.S., D.J. Wise, J.L. Avery, L.H. Khoo, and A.E. Goodwin. 2003. Infestations of the trematode *Bolbophorus* sp. in channel catfish. Southern Regional Aquaculture Center, SRAC Publication No. 1801. Stoneville, Mississippi. Retrieved 10 August 2011 from (https://srac.tamu.edu/index.cfm/event/getFactSheet/whichfactsheet/151/).

US Fish and Wildlife Service. 2007. Injurious Wildlife Species; Black Carp (*Mylopharyngodon piceus*): Final Rule by the Department of the Interior. 72 Federal Register 59019-59035.

13.I Appendix I. Species Banned by the Federal Lacey Act *as of May 2012

Only the aquatic species listed as injurious are provided in this appendix.

(i) Live fish or viable eggs of walking catfish, family Clariidae;

(ii) Live mitten crabs, genus *Eriocheir,* or their viable eggs;

(iii) Live mollusks, veligers, or viable eggs of zebra mussels, genus *Dreissena* ;

(iv) Any live fish or viable eggs of snakehead fishes of the genera *Channa* and *Parachanna* (or their generic synonyms of *Bostrychoides, Ophicephalus, Ophiocephalus,* and *Parophiocephalus*) of the family Channidae, including but not limited to:

(A) *Channa amphibeus* (Chel or Borna snakehead).
(B) *Channa argus* (northern or Amur snakehead).
(C) *Channa asiatica* (Chinese or northern green snakehead).
(D) *Channa aurantimaculata.*
(E) *Channa bankanensis* (Bangka snakehead).
(F) *Channa baramensis* (Baram snakehead).
(G) *Channa barca* (barca or tiger snakehead).
(H) *Channa bleheri* (rainbow or jewel snakehead).
(I) *Channa cyanospilos* (bluespotted snakehead).
(J) *Channa gachua* (dwarf, gaucha, or frog snakehead).
(K) *Channa harcourtbutleri* (Inle snakehead).
(L) *Channa lucius* (shiny or splendid snakehead).
(M) *Channa maculata* (blotched snakehead).
(N) *Channa marulius* (bullseye, murrel, Indian, great, or cobra snakehead).
(O) *Channa maruloides* (emperor snakehead).
(P) *Channa melanoptera.*
(Q) *Channa melasoma* (black snakehead).
(R) *Channa micropeltes* (giant, red, or redline snakehead).
(S) *Channa nox.*
(T) *Channa orientalis* (Ceylon or Ceylonese green snakehead).
(U) *Channa panaw.*
(V) *Channa pleurophthalmus* (ocellated, spotted, or eyespot snakehead).
(W) *Channa punctata* (dotted or spotted snakehead).
(X) *Channa stewartii* (golden snakehead).
(Y) *Channa striata* (chevron or striped snakehead).
(Z) *Parachanna africana* (Niger or African snakehead).
(AA) *Parachanna insignis* (Congo, square-spotted African or light African snakehead).
(BB) *Parachanna obscura* (dark African, dusky, or square-spotted snakehead).
(CC) *Python molurus* (Burmese python).
(DD) *Python sebae* (North African python).
(EE) *Python natalensis* (South African python).
(FF) *Eunectes notaeus* (Yellow anaconda).

(v) Any live fish, gametes, viable eggs, or hybrids of the species silver carp, *Hypophthalmichthys molitrix,* and largescale silver carp, *Hypophthalmichthys harmandi*; and

(vi) Any live fish, gametes, viable eggs, or hybrids of the species black carp, *Mylopharyngodon piceus.*

(3) Notwithstanding §16.32, all federal agencies shall be subject to the requirements stated within this section. Live or dead uneviscerated salmonid fish (family Salmonidae), live fertilized eggs, or gametes of salmonid fish are prohibited entry into the United States for any purpose except by

direct shipment accompanied by a certification that, as defined in paragraph (e)(1) of this section, the fish lots from which the shipments originated have been sampled; virus assays have been conducted on the samples according to methods described in paragraphs (e)(2) through (4) of this section; and *Oncorhynchus masou* virus and the viruses causing viral hemorrhagic septicemia, infectious hematopoietic necrosis, and infectious pancreatic necrosis have not been detected in the fish stocks from which the samples were taken. In addition, live salmonid fish can be imported into the United States only upon written approval from the Director of USFWS.

13.J Appendix J. Aquatic/Wetland Species on Federal Noxious Weed List

Scientific Name	Common Name
Azolla pinnata	mosquito fern, water velvet
Caulerpa taxifolia	killer algae (Mediterranean strain)
Eichornia azurea	anchored waterhyacinth, rooted waterhyacinth
Hydrilla verticillata	hydrilla
Hygrophila polysperma	Miramar weed, Indian swampweed
Ipomoea aquatica	water spinach, swamp morning-glory
Lagarosiphon major	oxygen weed
Limnophila sessiliflora	ambulia
Melaleuca quinquenervia	melaleuca, punktree, broadleaf paper bark tree
Monochoria hastata	arrow-leaf falsepickerelweed
Monochoria vaginalis	heart-shape falsepickerelweed
Ottelia alismoides	duck lettuce
Sagittaria sagittifolia	arrowhead
Salvinia auriculata	giant salvinia
Salvinia biloba	giant salvinia
Salvinia herzogii	giant salvinia
Salvinia molesta	giant salvinia
Solanum tampicense	wetland nightshade
Sparganium erectum	exotic bur-reed, simplestem bur-reed

Current as of May 2010. Accessed 14 September 2011 at
<http://www.aphis.usda.gov/plant_health/plant_pest_info/weeds/downloads/weedlist-2010doc.pdf>

13.K Appendix K. Mississippi Noxious Weed List

Scientific Name	Common Name
Commelina benghalensis	Benghal dayflower
Hydrilla verticillata	hydrilla
Imperata brasiliensis	Brazilian satintail
Imperata cylindrica	cogongrass
Pueraria montana var. lobata	kudzu
Rottboellia cochinchinensis	itchgrass
Salvinia molesta	giant salvinia
Sapium sebiferum	Chinese tallow tree
Solanum viarum	tropical soda apple

Established January 2004; amended March 2007.

13.L Appendix L. Public Comments Received and Responses

The Mississippi State Management Plan for Aquatic Invasive Species went to Public Notice in January 2010 and March 2013. Notices were placed in The Clarion Ledger, The Sun Herald, and The Northeast Mississippi Daily Journal. NO COMMENTS WERE RECEIVED FROM THE PUBLIC.