3.B Species

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. The definition of "aquatic species" has been expanded for this management plan to include species that arrived through aquatic pathways. Therefore, the Louisiana Aquatic Invasive Species Management Plan will address some species that are not traditionally considered aquatic, such as cogongrass and Formosan termites.

3.B.1 Aquatic Plants

Aquatic invasive plants of Louisiana are categorized in this management plan as Extensively Established Species, Locally Established Species, and Potential Arrivals, based on range data from the USGS Nonindigenous Aquatic Species Program. Aquatic invasive plants found in eight or more of the 13 drainage basins spanning Louisiana and adjacent area were categorized as "Extensively Established Species." Those that occur in three to seven drainages were categorized as "Locally Established Species," and plants found in two or fewer drainages were listed as "Potential Arrivals."

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 eight drainages may be listed as "extensively established", whereas another species could be extensively established in only one drainage basin but listed only as a "locally established species".

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

3.B.1.a Extensively Established Species

According to USGS, the following aquatic plants occur in eight or more drainage basins in Louisiana:

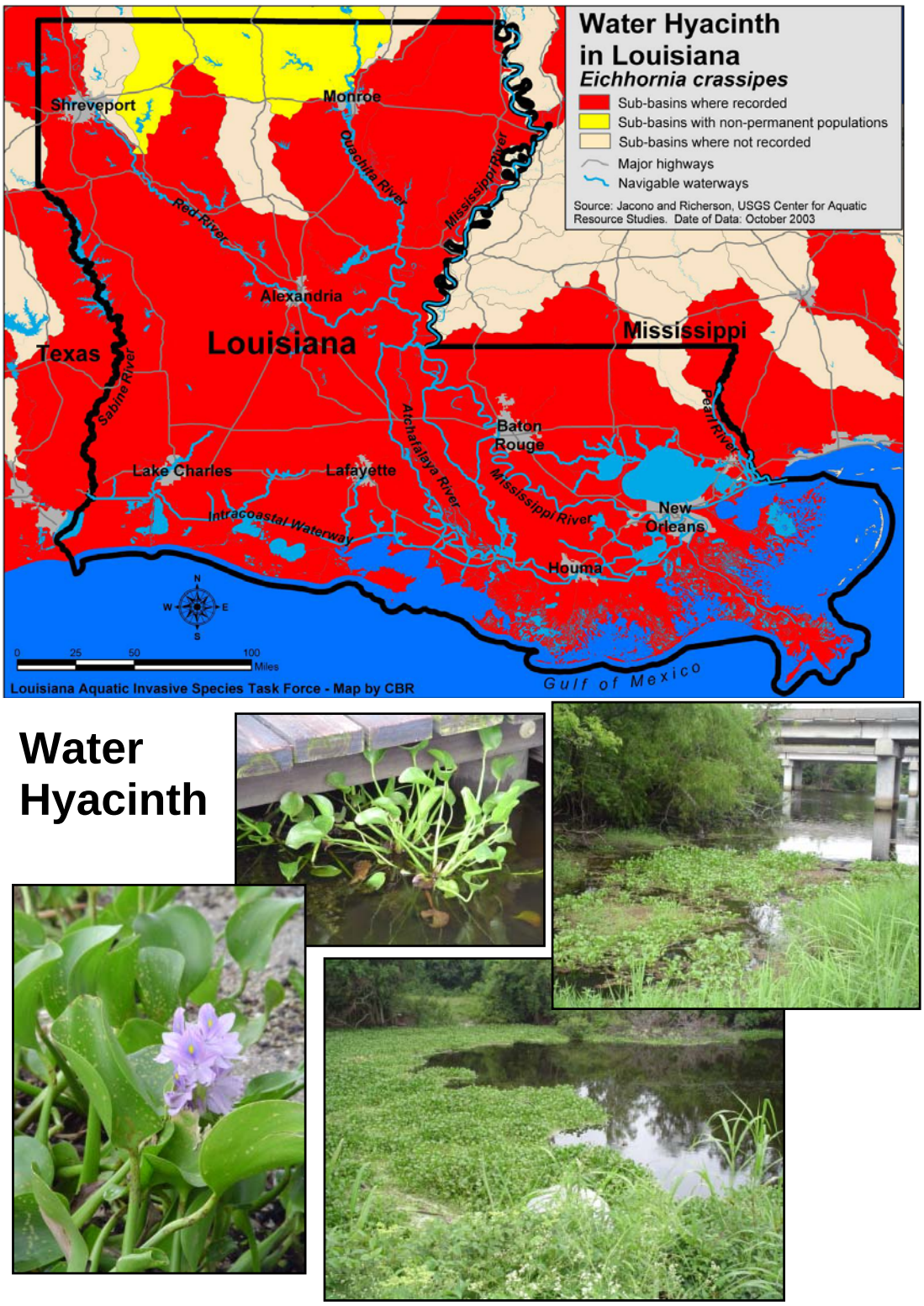
3.B.1.a.i Water Hyacinth (*Eichhornia crassipes*)

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 1884-1885. 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, hyacinth can be found in almost every drainage basin in Louisiana.[68]

3.B.1.a.ii Chinese Tallow Tree (*Sapium sebiferum*)

Benjamin Franklin first introduced Chinese tallow trees to the United States in 1772 as ornamentals.[69] Widely sold by nurseries and promoted by landscapers for its attractive red and green foliage, the hardy Chinese tallow — a source of tallow oil and wax — was also planted throughout the Gulf South in the early 20th century in hopes of establishing a local soap industry.[70] Tallow trees escaped tree farms when natural processes (animal interaction, bird consumption, wind, etc.) spread the seeds over long distances. Today, these trees are considered nuisances in many Louisiana prairies, parks, and wetlands.

[68] Jacono and Richerson 2003.
[69] McQuaid 1998.
[70] USGS 2000a.



Water Hyacinth

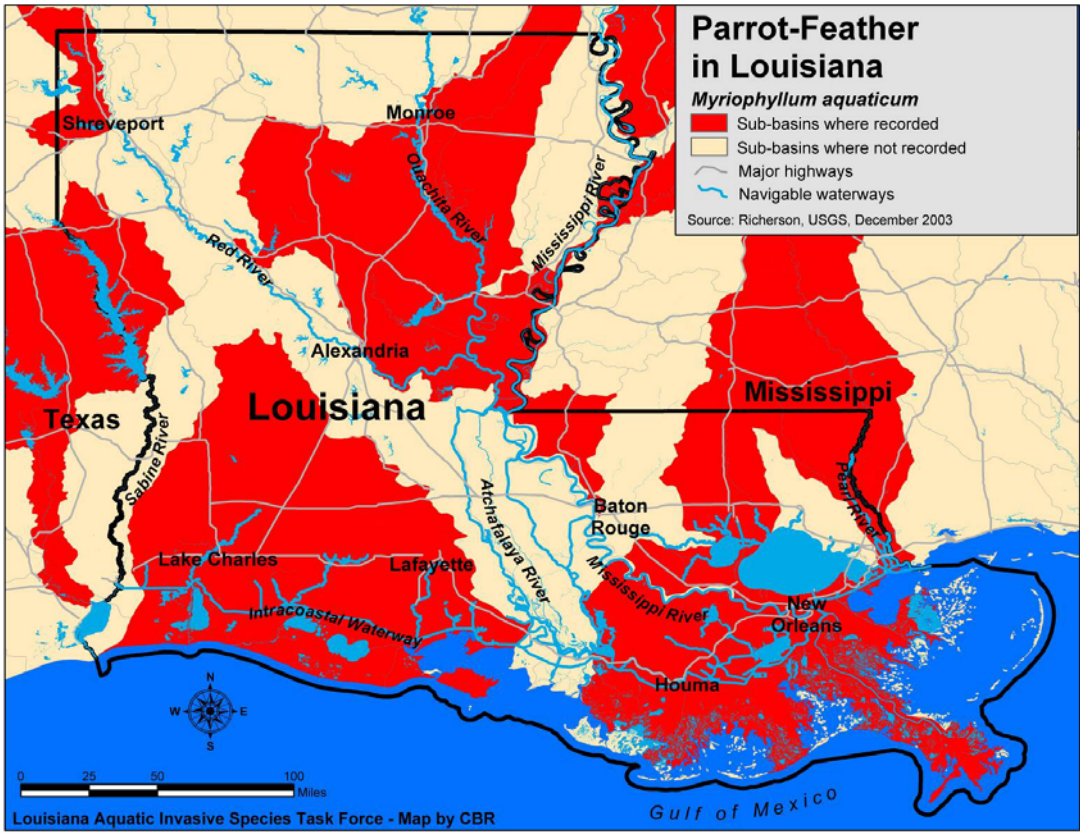
Distribution of water hyacinth in Louisiana (map, top), aggregated by drainage basin. First introduced to the U.S. as an ornamental plant at an exposition in New Orleans in 1884-1885, this South American native frequently clogs waterways, impedes boat traffic, slows water currents, and blocks light to submerged vegetation, which degrades water quality and harms wildlife. Because of its attractive purple flowers, water hyacinth quickly became popular among gardeners and landscapers. Many invasive species are aesthetically appealing, which aids their spread and exacerbates their ecological and economic harm. This invasive plant infests nearly 200,000 acres of Louisiana's waters. *Map and photos by CBR, 2003-2004.*

Chinese Tallow

Chinese tallow trees can reach up to 30 feet in height and form dense monocultures in wooded areas, affecting the growth of native trees and shrubs. *Photo by CBR, 2004.*

Parrot Feather

Distribution of parrot feather in Louisiana (map, below), aggregated by drainage basin. A popular plant in aquatic gardens and aquariums, parrot feather probably escaped through aquarium releases into open water bodies. It can reproduce vegetatively, so boat traffic or the natural flow of water may serve as a pathway. Parrot feather is also known as Brazilian watermilfoil and is sometimes mistaken for Eurasian watermilfoil. *Map by CBR, 2004.*



Still sold by some plant nurseries, Chinese tallow trees grow quickly and resist many pests. Sometimes called "popcorn trees," they can grow to a height of 30 feet, tend to form thick stands, and can easily shade-out native plants. Chinese tallow trees are dispersed throughout almost every Louisiana parish. [71]

The Louisiana Department of Agriculture and Forestry runs a state-wide cost-share program with private landowners to combat Chinese tallow trees. Tallow trees can be controlled with fire and some chemical spraying in pine stands, but these methods are not effective in bottomland hardwood forests because fire and chemicals kill deciduous trees.[72]

3.B.1.a.iii Parrot feather (*Myriophyllum aquaticum*)

Parrot feather is a submerged aquatic plant that can grow in riparian areas and at water surfaces. Sold at gardening centers, and frequently under an incorrect name,[73] parrot feather is also known as Brazilian watermilfoil and is sometimes mistaken for its "cousin", Eurasian watermilfoil (*Myriophyllum spicatum*).

This aquatic weed is a native of the Amazon River basin in South America, but is now found worldwide. Its exact date of introduction to the U.S. is unknown, but it was first discovered here in a Washington, D.C., pond in 1890. A popular plant in aquatic gardens and indoor and outdoor aquariums, parrot feather probably escaped cultivation through aquarium releases into open water bodies. It can reproduce vegetatively, so boat traffic or the natural flow of water may serve as a pathway in spreading it.

Brazilian watermilfoil shades out native submerged aquatic vegetation and seriously disrupts the aquatic food chain. This aquatic weed can block waterways, suspending boat traffic and fishing, and could potentially clog irrigation and drainage canals. Thick growth at the water surface can also provide ideal mosquito breeding habitat.[74]

3.B.1.a.iv Hydrilla (*Hydrilla verticillata*)

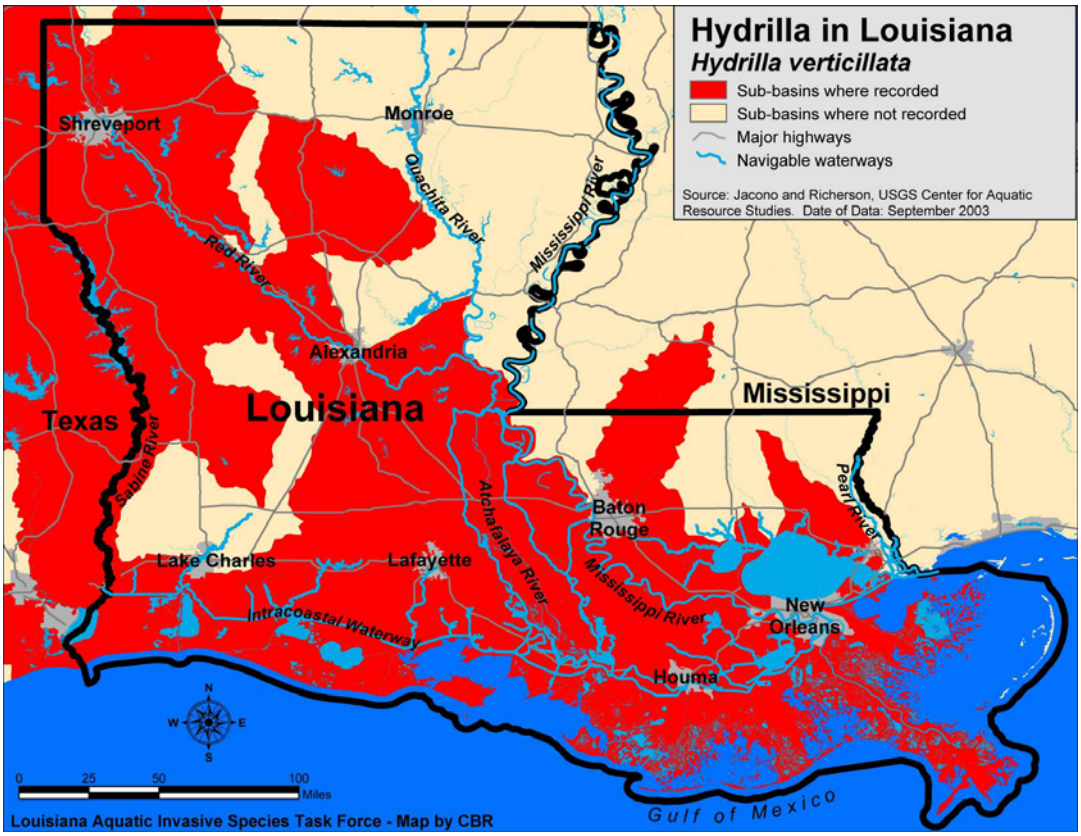
Originally from Asia, hydrilla is a rooted, aquatic weed that inhabits both deep and shallow waters. In shallower areas, hydrilla forms thick mats that impede boat traffic and swimming. It adversely affects water quality by shading out native vegetation, lowering dissolved oxygen concentrations, and can result in fish kills.[75]

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. Hydrilla is appearing more frequently in Louisiana drainages, particularly in the Atchafalaya Basin and along Highway 1. In Bayou Lafourche, Louisiana, hydrilla clogged an intake pipe for a drinking water treatment plant, causing public health concerns. At times, it made several water bodies virtually unusable for aquatic recreation, in particular the Spring Bayou Wildlife Management Area and Henderson Lake in the Atchafalaya Basin.[76]

3.B.1.a.v Wild Taro (*Colocasia esculenta*)

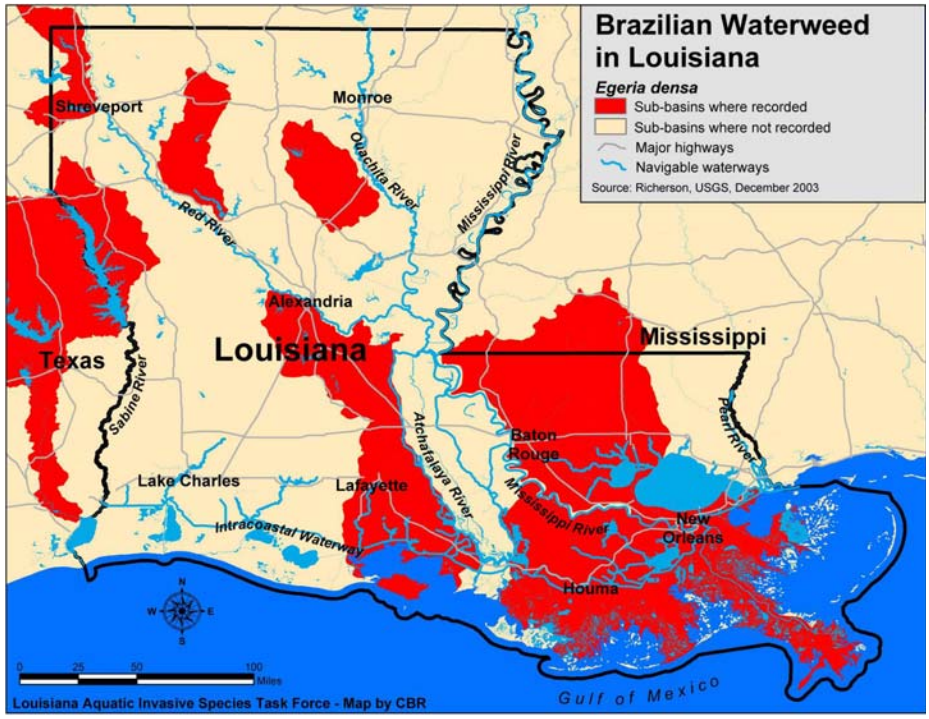
Wild taro was initially introduced to North America in association with the slave trade, but spread when the U.S. Department of Agriculture promoted it as a substitute for potatoes in the early 1900s. Wild taro forms dense growth stands in riparian zones and displaces native vegetation.[77] Many types of taro are sold at garden stores as ornamental plants.

[71] University of Florida Center for Aquatic and Invasive Plants 2001a.
[72] Frey 2003.
[73] University of Florida Center for Aquatic and Invasive Plants 2001b.
[74] Washington State Department of Ecology 2003.
[75] Jacono 2002a.
[76] Jacono 2002a; Lovell and Bahlinger 2002.
[77] University of Florida Center for Aquatic and Invasive Plants (no date).

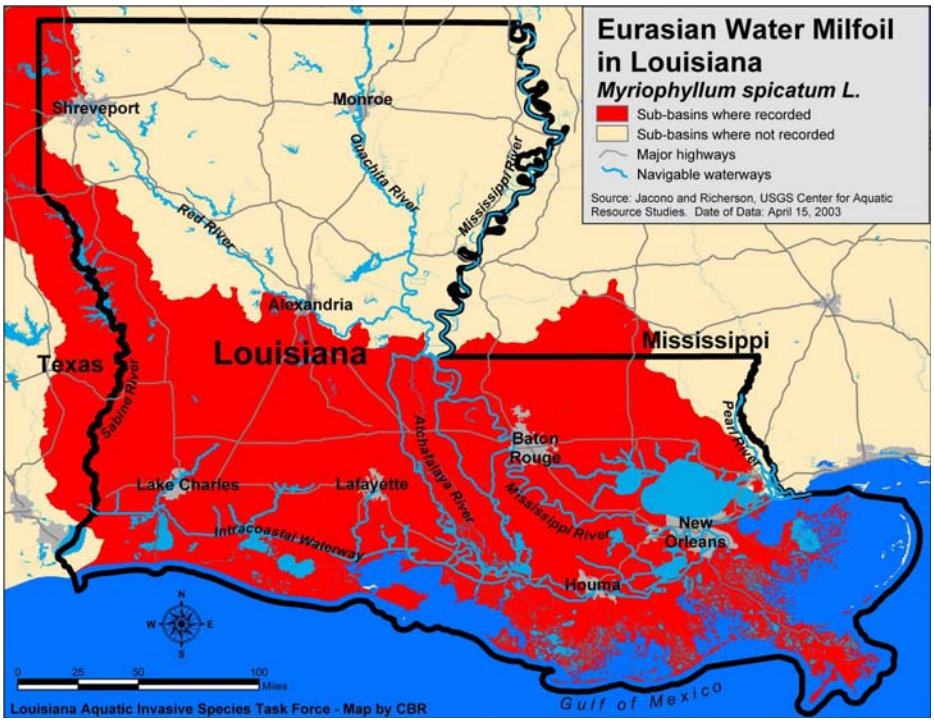


Hydrilla

Distribution of hydrilla in Louisiana, aggregated by drainage basin. This rooted aquatic weed from Asia forms thick mats which can impede boat traffic and swimming, diminish water quality, and kill fish. In Bayou Lafourche, hydrilla clogged an intake pipe for a drinking water treatment plant (A), causing public health concerns. To alleviate the infestation, a hydrilla mower clears a mat on Bayou Lafourche (B). *Map by CBR, 2003-2004. Photos by BTNEP, 2003.*



Distribution of Brazilian water weed in Louisiana, aggregated by drainage basin. Deliberately introduced by the aquarium trade, this aquatic weed became established in the wild most likely through aquarium releases. It may also have been planted for malaria eradication, as its oxygenating properties led researchers to believe it could control mosquito larvae. *Map by CBR, 2004.*



Distribution of Eurasian water milfoil in Louisiana, aggregated by drainage basin. Eurasian watermilfoil was first recorded in the U.S. in Washington, D.C. in 1942, possibly introduced intentionally by federal authorities. It has since spread throughout the U.S. as a disposed packing material for baitworms, and as vegetative debris attached to boats and boat trailers. It is still sold by some pet stores and on the Internet as an aquarium plant. *Map by CBR, 2004.*

3.B.1.a.vi Brazilian Waterweed (*Egeria densa*)

Since as early as 1915, Brazilian waterweed has been a popular aquarium plant for its rapid growth and oxygenating properties. Pet and aquarium stores sometimes sell this plant under the name "Anacharis". To date, it is one of the most widely distributed and utilized aquarium oxygenator plants. Also known as common waterweed and Brazilian elodea, *Egeria densa* prefers the slow-moving waters of streams, ponds, and lakes.

The aquarium trade deliberately introduced this aquatic weed, but its establishment in natural ecosystems is likely due to aquarium releases. It may also have been planted for malaria eradication: its oxygenating properties led researchers to believe it could control mosquito larvae.[78]

Brazilian waterweed forms thick mats at the water surface, impeding recreational activities such as swimming, boating, and fishing. The weed chokes out native vegetation and degrades water quality and fish habitat. *Egeria densa* can reproduce vegetatively and is therefore prone to spreading through boat traffic and water currents. [79]

3.B.1.a.vii 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 can tolerate brackish waters. It forms thick, dense mats at the water surface and impedes recreational activities, such as boating and swimming.[80]

Myriophyllum spicatum was first recorded in the United States in Washington, D.C., 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.[81]

3.B.1.a.viii Water Lettuce (*Pistia stratiotes*)

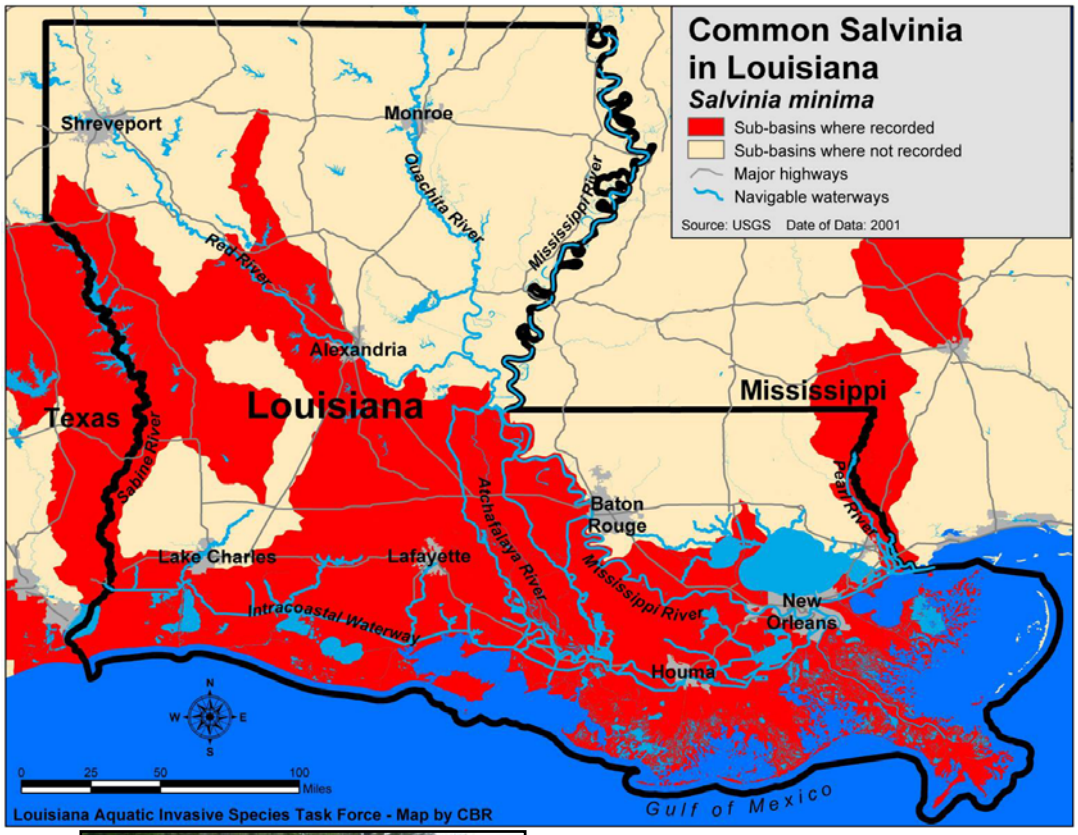
Water lettuce is a floating plant resembling a head of lettuce with thick green leaves. A perennial, water lettuce infestations impede boat traffic, swimming, fishing, and other recreational activities. It degrades water quality for native vegetation and adversely affects fish and bird populations.

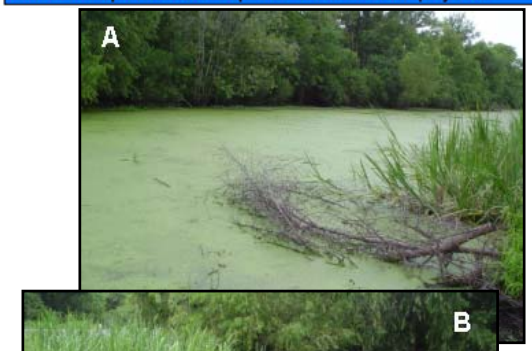
Some experts believe the plant is native to Africa and was introduced in ballast water by early explorers (there are records of *Pistia stratiotes* in Florida as early as 1765). Though this plant is on the Federal Noxious Weed List, water lettuce is still available through aquarium suppliers and on the Internet.[82]

3.B.1.a.ix Common Salvinia (*Salvinia minima*)

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.[83]

[78] University of Florida Center for Aquatic and Invasive Plants 1996.
[79] Washington State Department of Ecology (no date)a.
[80] Jacono 2002b; University of Florida Center for Aquatic and Invasive Plants 2001c.
[81] University of Florida Center for Aquatic and Invasive Plants 2001c; Jacono 2002b.
[82] Ramey 2001.
[83] Jacono 2002c.





Common Salvinia

Distribution of common salvinia in Louisiana, aggregated by drainage basin. This Central and South American native has been cultivated in water gardens in the United States since the 1880s. First recorded in Louisiana in 1980 in the Bayou Teche area of St. Mary Parish, common salvinia has since spread into rice and crawfish farms via irrigation systems and is now considered a nuisance throughout the state. Common salvinia frequently spreads when boaters fail to wash their boats and trailers before launching at new ramps. In photo A, taken in St. John the Baptist Parish, salvinia covers the surface of a canal, hindering boat traffic; in photo B, it lines the edge of a boat ramp. Photo C shows common salvinia in swamp waters of Tangipahoa Parish. Salvinia and other aquatic weed mats provide ideal habitat for mosquitoes and other disease-carrying organisms. *Map and photos by CBR, 2004.*

LSU researchers release Florida-strain salvinia weevils in an experiment to control common salvinia at Cypress Lake. Biocontrol can be an effective method for curbing the spread of invasive species, but risks introducing new species which can prove even more harmful. *Photo by LSU Agricultural Center*.

This Central and South American native has been cultivated in the United States since the 1880s for water gardens. Researchers believe *Salvinia minima* escaped from cultivation into Florida's St. Johns River in 1928, probably when a water garden flooded, but possibly from an intentional release. It was first recorded in Louisiana in 1980 in the Bayou Teche area of St. Mary Parish, and is now considered a nuisance throughout the state. Introduction into rice and crawfish farms via irrigation practices has caused problems for farmers. One of the most common *Salvinia minima* pathways is boat traffic traversing Louisiana's waterways. [84]

The USDA Agricultural Research Service, in cooperation with the National Park Service, is experimenting with the Florida salvinia weevils (*Cyrtobagous salviniae*) as a form of biocontrol for common salvinia. Tests began in June 2002 at Jean Lafitte National Historical Park and Preserve. The sites are monitored regularly for survival of the weevils and for salvinia damage. Despite additional weevil releases in August and December 2002, the March 2003 surveys did not find any adult weevils. However, a July 2003 survey resulted in the discovery of one adult. It is believed that this weevil, though solitary, is part of a new generation from a reproducing population. An additional 1,000 salvinia weevils were released at the experiment sites in June and July 2003.[85]

3.B.1.b Locally Established Species

According to USGS, the following aquatic invasive plants occur in three to seven drainage basins in Louisiana:

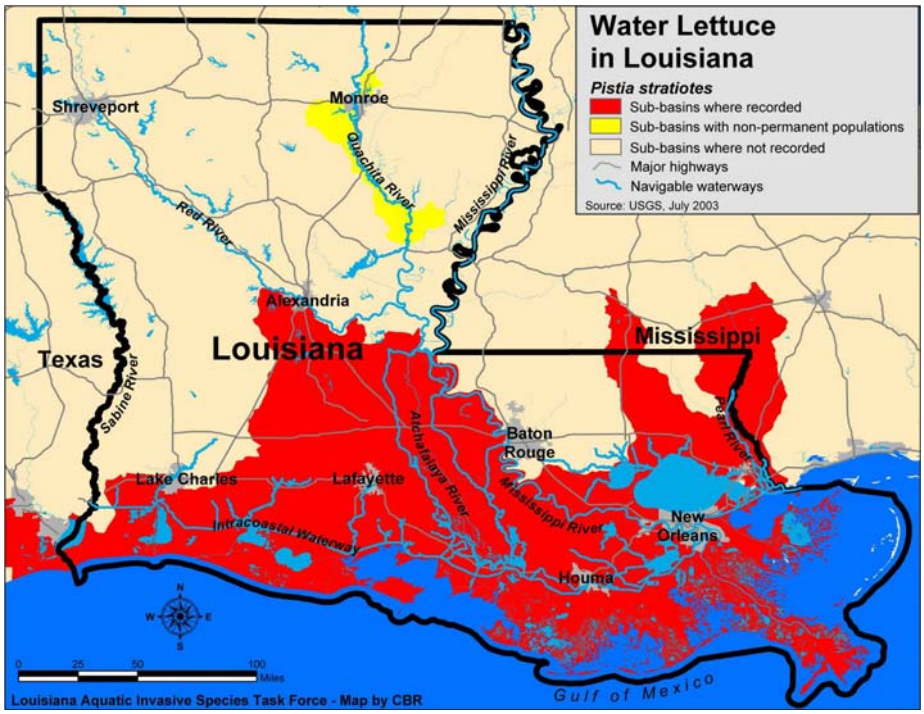
3.B.1.b.i Giant Salvinia (*Salvinia molesta*)

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.[86] Giant salvinia expands its range through reproduction, wind transport, and boaters and fishermen who do not rinse their gear.

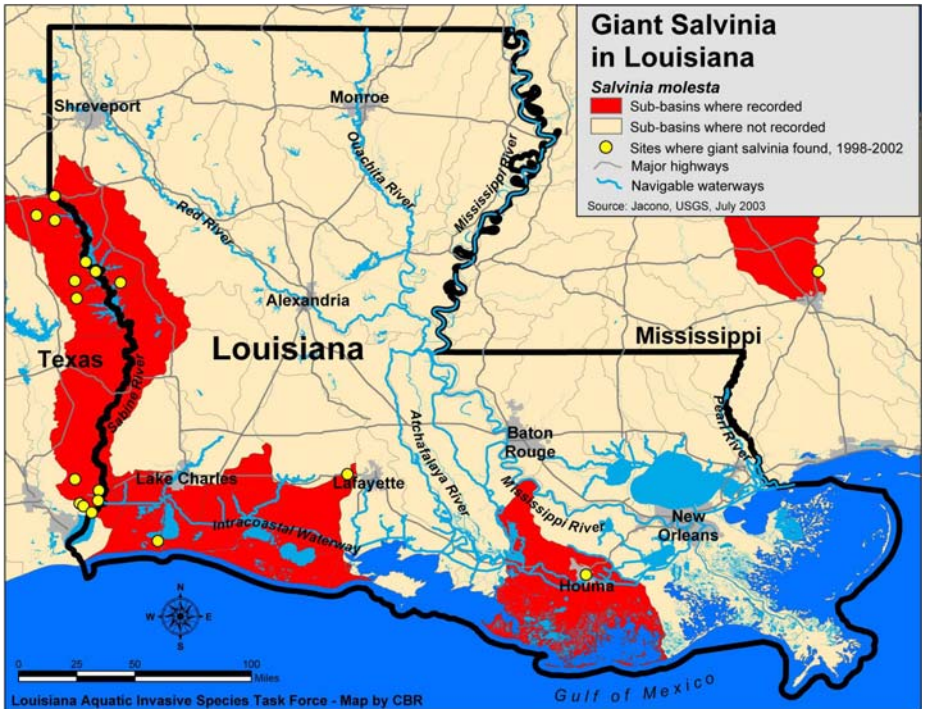
Giant salvinia first appeared in Louisiana in 1998 in the Toledo Bend Reservoir on the Texas-Louisiana border. Since then, it expanded into at least 15 locations throughout southern Louisiana. It is a free-floating, rootless plant that reproduces quickly; under ideal conditions, *Salvinia molesta* can double its biomass every seven to ten days. It chokes bayous and canals, and can cover large portions of lakes and reservoirs, degrading water quality, harming wildlife, and impeding boat traffic. In Cameron Parish, Louisiana, giant salvinia posed a public health threat because it blocked the operation of floodgates.[87]

The USDA Agricultural Research Service is working with Texas Parks and Wildlife to determine the success of the Florida salvinia weevil (*Cyrtobagous salviniae*) as a biocontrol for *Salvinia molesta*. Experiments begun in 2001 are ongoing. March 2003 surveys found the adult weevils over-wintered at all release sites, and numbers of weevils appeared larger than in 2002. Biomass of *Salvinia molesta* appeared to be decreasing. In June 2003, surveys found adult weevils at all sites, but in smaller numbers than were found in March. Researchers state, "The reason for this is simple and very exciting: much of the giant salvinia is no longer suitable for feeding."[88] Researchers observed rotting and sinking mats of *Salvinia molesta* vegetation, and no healthy, undamaged buds were found. Overall, water coverage was down from 100 percent in March to 60 percent in June.

[84] Jacono 2002c.
[85] Tipping, Center, Hulslander, and Muth 2003.
[86] Jacono 2002d.
[87] Jacono 2002d; Louisiana Aquatic Invasive Species Task Force 18 September 2002.
[88] Tipping, Center, Helton, and Findeisen 2003.



Distribution of water lettuce in Louisiana, aggregated by drainage basin. Water lettuce infestations impede boat traffic, swimming, fishing, and other recreational activities. Some experts believe this perennial is native to Africa and was introduced in ballast water by early explorers. Though on the Federal Noxious Weed List, water lettuce is still available through aquarium suppliers and on the Internet. *Map by CBR, 2004.*



Distribution of giant salvinia in Louisiana, aggregated by drainage (red) as well as individual sites (yellow). Giant salvinia first appeared in Louisiana in 1998 in the Toledo Bend Reservoir on the Texas-Louisiana border. Since then, it expanded into at least 15 locations throughout southern Louisiana. It chokes bayous and canals, and can cover large portions of lakes and reservoirs, degrading water quality, harming wildlife, and impeding boat traffic. *Map by CBR, 2004.*

In Cameron Parish, control efforts included introducing saltwater from the Gulf Intracoastal Waterway into the infested water body located on private property. This method appears to have been successful, as the giant salvinia has not reappeared in the marsh where saltwater was introduced.[89]

3.B.1.b.ii Cogongrass (*Imperata cylindrica*) [90]

Cogongrass is a hardy species tolerant of shade, drought, and high salinities, which tends to invade disturbed ecosystems such as roadway shoulders. Its dense growth pattern creates unsuitable habitat for native plants, insects, mammals, and birds. Johnson and Shilling (1998) report that "large infestations of cogongrass can alter the normal fire regime of a fire-driven ecosystem by causing more frequent and intense fires that injure or destroy native plants."[91]

Cogongrass was accidentally introduced to the United States in Mobile, Alabama, as a packing material in shipping crates. The USDA also intentionally introduced it for controlling soil erosion and as a foraging grass. Its hardiness and attractive leaves have made it a popular grass sold by plant nurseries.[92]

In Louisiana, cogongrass is rapidly spreading along roads and right-of-ways through the relocation of soil containing cogongrass rhizomes. Sometimes called "Red Baron" or "Blood Grass" for its striking red foliage, cogongrass is becoming prominent in the Florida parishes (West Feliciana, East Feliciana, East Baton Rouge, St. Helena, Livingston, Tangipahoa, Washington, and St. Tammany).[93]

3.B.1.c Potential Arrivals

According to USGS, the following aquatic plants occur in fewer than three drainage basins in Louisiana:

3.B.1.c.i Purple Loosestrife (*Lythrum salicaria*)

Purple loosestrife 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 ships' ballast. Loosestrife stalks can grow up to nine feet tall, and just one mature 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, and affect agriculture by clogging irrigation systems or destroying grazing pastures by replacing range grasses.[94]

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.[95]

While the U.S. Fish and Wildlife Service reports that purple loosestrife is present in every state except Florida, the USDA and USGS have no record of purple loosestrife Louisiana.[96] Conflicting reports about the presence of *Lythrum salicaria* in Louisiana may be due to two native loosestrife species, *Lythrum lineare* and *Lythrum alatum*.

---

[89] Savoie 2003.
[90] Cogongrass is not listed by USGS as an aquatic invasive plant. The LAIS Task Force, however, has chosen to classify cogongrass as an aquatic invasive because it occurs in areas that experience some flooding, and it was introduced through an aquatic pathway.
[91] Johnson and Shilling 1998.
[92] University of Florida Center for Aquatic and Invasive Plants 2001d; Johnson and Shilling 1998.
[93] Frey 2003.
[94] Swearingen 1997; Thompson, Stuckey, and Thompson 1987; Washington State Department of Ecology (no date)b.
[95] Urbatsch and Skinner 2000.
[96] Swearingen 1997; USDA Natural Resources Conservation Service 2002; USGS 2001.

Invasive Species in Disturbed Habitats

Invasive species often thrive in disturbed habitats, thus further altering the area and possibly "enabling" the establishment of additional invasives. Multiple invasive plant species often grow together in disturbed habitats, such as in A and B, where alligator weed and common salvinia clog a bayou in St. John the Baptist Parish, and C, where common salvinia, wild taro (heart-shaped leaves), and alligator weed (narrow leaves; center right) co-exist in Jean Lafitte National Historical Park and Preserve. *Photos by CBR, 2004.*

Records from Tulane University's Herbarium in New Orleans indicate two *Lythrum salicaria* samples were collected and identified in the mid- to late-1980s. The first sample was collected in 1986 from Plaquemines Parish, approximately eight miles south of Venice, Louisiana, and about two miles east of the Mississippi River. The second specimen was collected from a cultivated garden at Longue Vue House and Gardens in 1988 in New Orleans.[97]

3.B.1.c.ii A Blue-Green Algae, *Cylindrospermopsis raciborskii* ("Cylindro")

Cylindrospermopsis raciborskii, or "Cylindro" for short, is an invasive, subtropical, microscopic blue-green alga. Researchers believe it was introduced to Florida about 30 years ago and has spread rapidly across North America over the last 10-15 years. It is likely that this alga occurs in a wide range of North American water bodies, but, due to its size, it is difficult to identify and easily confused with other blue-green algae. It is unclear how this species arrived in the United States, but it is probably spreading to new U.S. water bodies by boats, boat trailers, and waterfowl. According to St. Amand (2002), this species has been identified in water bodies throughout Florida, parts of Alabama, and central Texas. Unconfirmed reports indicate that this species was found in waters near the Caernarvon Freshwater Diversion in summer 2002.[98]

Like most blue-green algae, Cylindro has no serious adverse effect on water quality or wildlife when found in small concentrations. In fact, blue-green algae are beneficial in small concentrations because they fix nitrogen and add nutrients to the water. However, in higher concentrations, Cylindro can be very detrimental. In some Florida lakes, Cylindro outcompeted other blue-green algae species and now comprises 95 percent of the total algal biomass. When an alga species reaches high concentrations, it is called an algae bloom. Cylindro blooms in Florida can last for months at a time, although sometimes they are difficult to identify. Unlike other blue-green algae species, *Cylindrospermopsis* does not form scum on the water surface. St. Amand says Cylindro "often stays well-distributed throughout the water column and has the highest concentrations below the surface. In fact, other than a deep green-brown color, it's often difficult to determine that a serious blue-green bloom is occurring at all."[99]

Cylindro is known to produce at least three toxins — cylindrospermopsin, anatoxin-a, and saxitoxin, of which the first is the best documented. Cylindrospermopsin is a hepatotoxin which harms the liver and kidneys. Anatoxin-a and saxitoxin are neurotoxins which cause lethargy, muscle aches, confusion, memory impairment, and, at sufficiently high concentrations, death.[100] During Cylindro algae blooms, the concentration of these toxins can reach high levels and adversely impact the ecosystem, agriculture, and human health. For example, researchers suspect that *Cylindrospermopsis* may be linked to the deaths of more than 200 alligators in Lake Griffin, Florida, between 1998 and 2000. Cylindro comprises 90 percent of all microscopic algae in Lake Griffin, and researchers observed the Lake Griffin alligators behaving erratically and sluggishly, a symptom consistent with neurotoxicity.[101]

In 1997, three cows and 10 calves were found dead near a dam on a cattle farm in Queensland, Australia. Cyanobacteria blooms near the dam consisted of "a virtual monoculture of the cyanobacterium *Cylindrospermopsis raciborskii*."[102] An autopsy on one of the calves and an examination of several of the calf's organs showed damage consistent with hepatotoxin poisoning.[103]

In 1979, 150 people (mostly children) were hospitalized after ingesting from a drinking water reservoir in Australia. The water had been treated with copper sulfate to remove cyanobacteria that were blooming in the reservoir at the time, but this caused *Cylindrospermopsis*, the dominant

[97] White 1986; Darwin and Wolf 1988.
[98] St. Amand 2002; Chronic Neurotoxins 2002; St. Amand 2002, page 36; Rick 2003.
[99] Chronic Neurotoxins 2002; St. Amand 2002, page 37.
[100] St. Amand 2002, page 36; Chronic Neurotoxins 2002.
[101] Hunter 2000; Chronic Neurotoxins 2002.
[102] Saker, Thomas, and Norton 1999.
[103] Saker, Thomas, and Norton 1999, page 179.

cyanobacterial species in the reservoir, to release even more cylindrospermopsin toxin into the water. Symptoms of the cylindrospermopsin poisoning included liver enlargement, constipation, bloody diarrhea, kidney damage, and dehydration.[104]

In Brazil, a water reservoir was treated with chlorine to kill blooming cyanobacteria, but when the algae cells died, they released more toxin into the water. More than 50 patients at a dialysis clinic died from hepatotoxin poisoning, and more than 50 more became severely ill with liver and nerve damage.

In Florida, the Cylindro seems to be resistant to copper sulfate and benomyl, a fungicide, and is non-responsive to other algae poisons.[105]

3.B.2 Finfish

The categories of "extensively established species" and "locally established species" were combined for the Finfish section of the management plan. Mobility of fish blurs the distinction between "extensively established" and "locally established." Also, the network of interconnected waterways within the state makes it easy for fish to relocate, constantly changing their ranges.

3.B.2.a Extensively Established Species

3.B.2.a.i Rio Grande Cichlid (*Cichlasoma cyanoguttatum*)

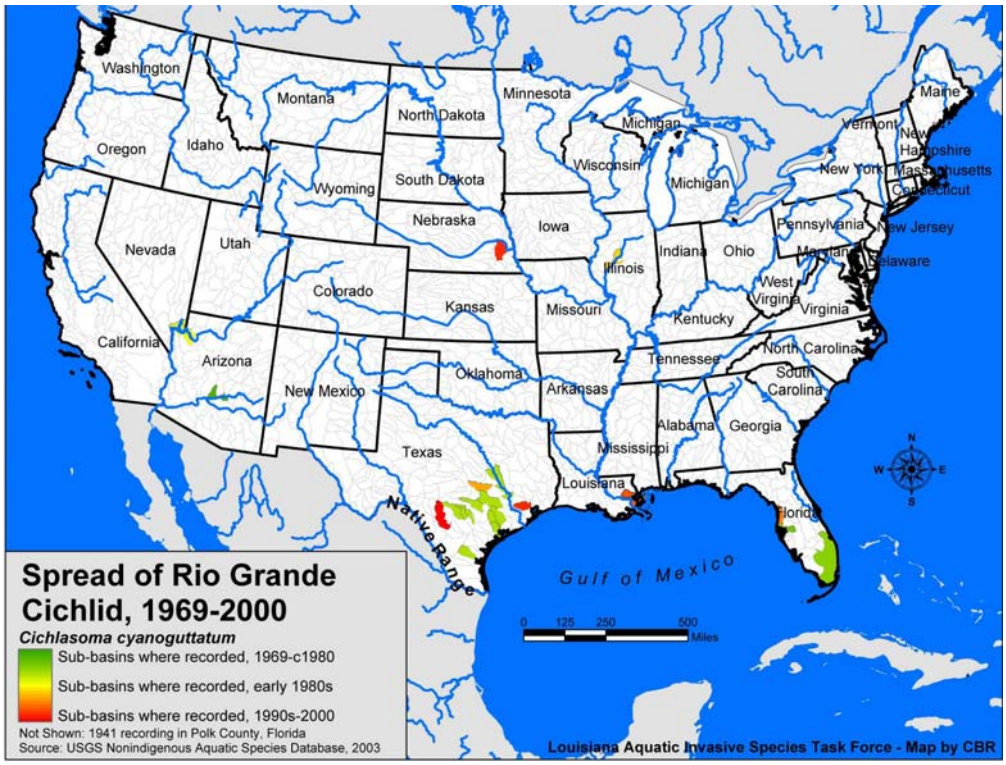
The Rio Grande cichlid, also sometimes called the Rio Grande perch or the Texas cichlid, is native to parts of southern Texas and northeastern Mexico, but its range is expanding due to human activities. Researchers speculate that the Rio Grande cichlid was introduced to Louisiana in the late 1980s or early 1990s through aquarium releases into freshwater bayous and canals on the south shore of Lake Pontchartrain. Less than 20 years after its initial introduction, this fish has been collected in numerous habitats surrounding greater New Orleans, including urban canals, freshwater marshes and bayous, and the Lake Pontchartrain estuary. Reproductive populations have been observed in many of these locations, so clearly aquarium releases are no longer the main cause of range expansion.[106]

An omnivorous fish, the Rio Grande cichlid poses a threat to aquatic vegetation and possibly commercially valuable species such as shrimp. The cichlids also may harbor parasites or diseases that can harm native fish. Recent collection locations indicate this freshwater fish is becoming tolerant of salinities of at least 5 ppt, causing concern that increased salinity tolerance will enable the Rio Grande cichlid to penetrate farther into the Lake Pontchartrain estuary, causing further displacement of native fish.[107]

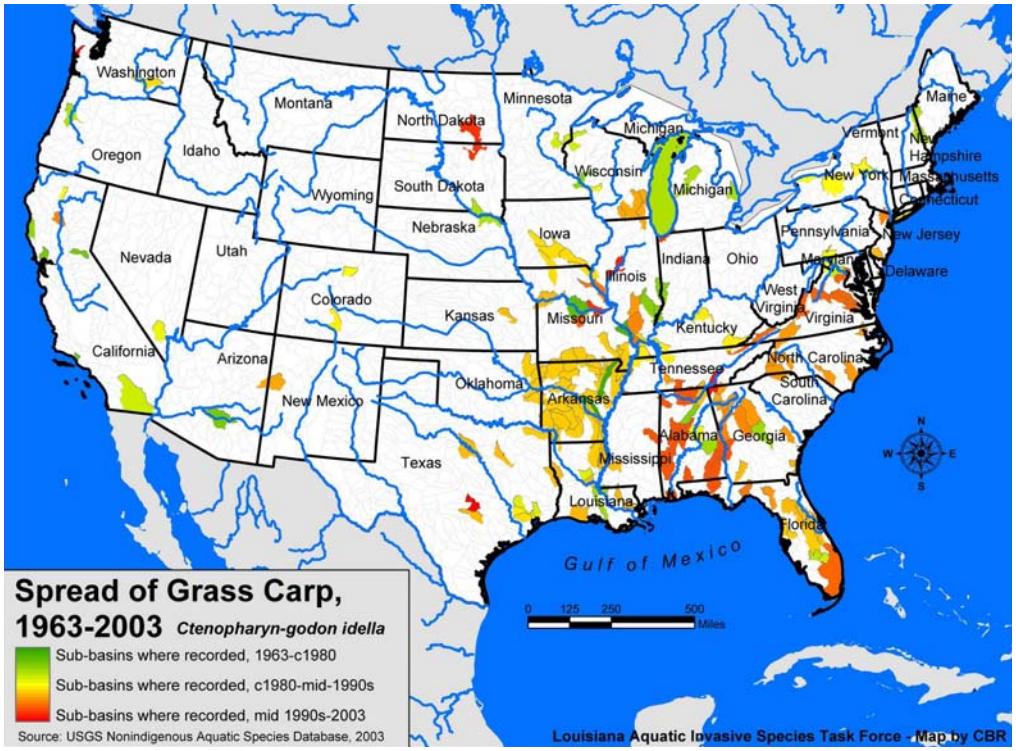
3.B.2.a.ii Common Carp (*Cyprinus carpio*)

Common carp were introduced to the United States so long ago, and are so widespread, 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 U.S. 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 sometimes are kept as pets. It must be noted that only a small portion of common carp introductions have resulted from this pathway.[108]

[104] Falconer 1999; St. Amand 2002, page 37; Falconer 1999, page 9.
[105] Chronic Neurotoxins 2002.
[106] Nico 2000b; Cashner 2001; Aguirre and Poss 1999a; O'Connell, Cashner, and Fuentes 2002, page 16.
[107] O'Connell 2001; Cashner 2001; O'Connell, Cashner, and Fuentes 2002, page 16.
[108] Nico 1999.



Researchers suspect the Rio Grande cichlid was introduced to Louisiana around 1990 through aquarium releases into freshwater bayous and canals on the south shore of Lake Pontchartrain. An omnivore, the Rio Grande cichlid poses a threat to aquatic vegetation and possibly commercially valuable species such as shrimp. *Map by CBR, 2004.*



Grass carp were first imported to the U.S. 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 Louisiana, grass carp are established in the Mississippi and Red rivers, Atchafalaya Basin, Lake Pontchartrain, and drainages on the Louisiana-Arkansas border. *Map by CBR, 2004.*

Cyprinus carpio is a freshwater fish but is able to withstand brackish waters in its native range. Its non-native 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 zoo- 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.[109]

Most abundant in man-made water bodies, common carp are also plentiful in waters polluted by sewage and agricultural runoff.[110] Common carp are widely distributed throughout Louisiana.

3.B.2.a.iii 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. In Louisiana, grass carp are established in the Mississippi River, Red River, Atchafalaya Basin, Lake Pontchartrain, and other drainages on the Louisiana-Arkansas border.[111]

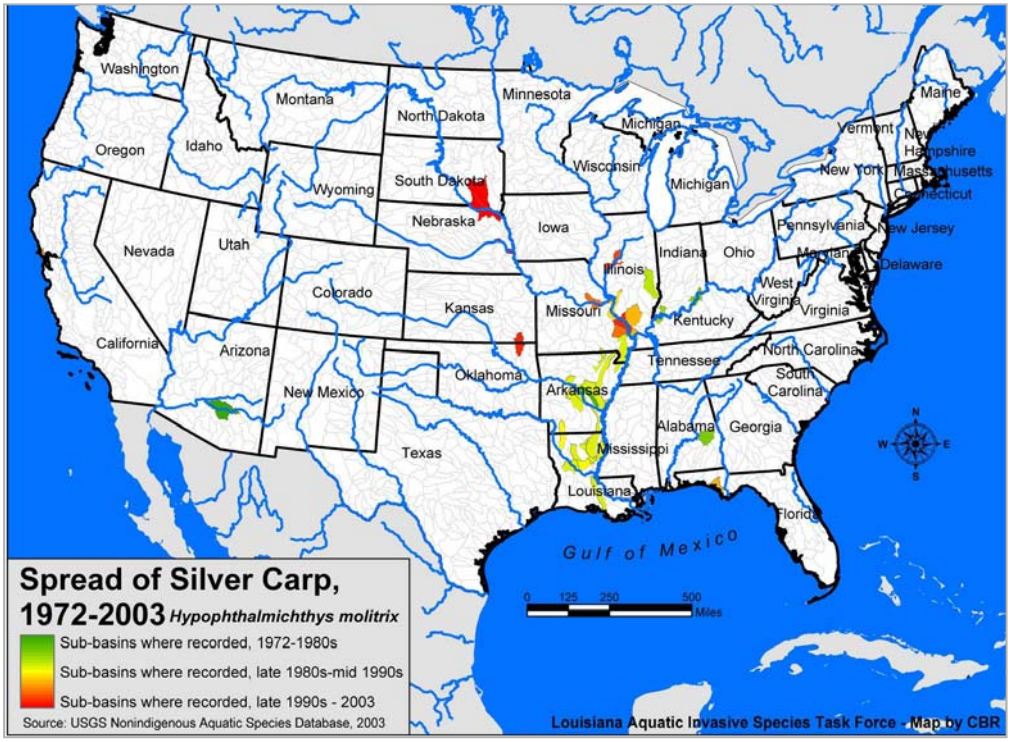
Grass carp can have serious detrimental effects on riverine, limnetic, and littoral ecosystems. They decrease available habitat and food, and change macrophyte and phytoplankton community composition, ultimately altering an ecosystem's food web. According to Nico and Fuller (2001), "although grass carp are often used to control selected aquatic weeds, these fish sometimes feed on preferred rather than on target plant species."[112] 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.[113]

In Louisiana, it is illegal to at any time to possess, sell, or transport live carp without written permission from LDWF.[114] This statute applies to all species of carp, including diploid and triploid grass carp. Triploid grass carp are generally sterile, but some researchers are questioning the effectiveness of triploidy as a sterilization tool. Nico and Fuller (2001) state that "techniques used to induce triploidy are not always totally effective and every individual needs to be genetically checked."[115] Other states, however, including Arkansas and Mississippi, have no restrictions.[116]

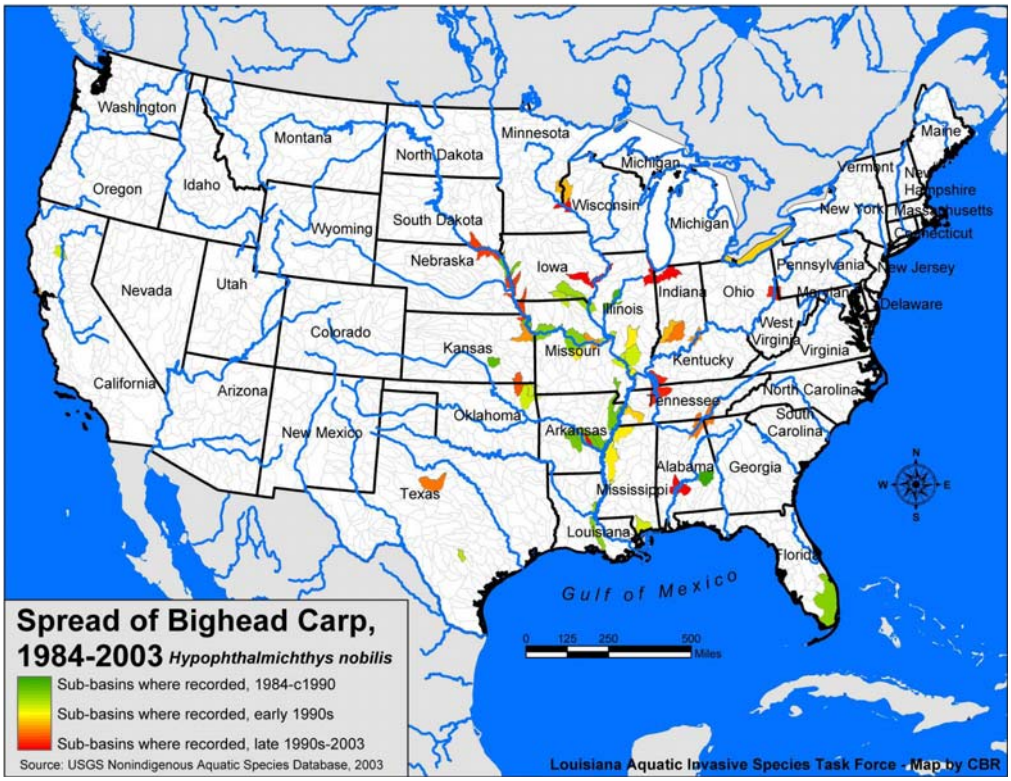
3.B.2.a.iv Silver Carp (*Hypophthalmichthys molitrix*)

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 water bodies.[117]

[109] Aguirre and Poss 2000a.
[110] Nico 1999.
[111] Poss and Aguirre 2000; Nico and Fuller 2001.
[112] Nico and Fuller 2001.
[113] Poss and Aguirre 2000; Nico and Fuller 2001.
[114] *Louisiana Revised Statutes, Title 56 §319* (no date).
[115] Nico and Fuller 2001.
[116] Nico and Fuller 2001.
[117] Aguirre and Poss 1998; Nico and Fuller 2000.



Native to East Asia, silver carp were first introduced to the U.S. in Arkansas in the early 1970s for phytoplankton control in aquaculture ponds and for human consumption. In Louisiana, silver carp have been reported in the Mississippi, Atchafalaya, Red, Boeuf, Ouachita, and Little rivers, plus connecting water bodies. *Map by CBR, 2004.*



Bighead carp, a zooplanktivore from Asia, was introduced by fish farmers to improve water quality and increase production in aquaculture ponds. *Map by CBR, 2004.*

In Louisiana, silver carp have been reported in the Mississippi River and its tributaries and distributaries, such as the Atchafalaya, Red, Boeuf, Ouachita, and Little rivers. Silver carp have also been collected from the Lafourche Canal, Miller Lake, and Loggy Bayou.[118]

Unlike grass carp, silver carp are planktivorous fishes that sometimes also consume detritus.[119] 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 land can in boats, and some significant injuries to fishermen and boaters have been documented.

3.B.2.a.v 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 1994, researchers collected more than 1,600 bighead carp larvae from the Black River in Louisiana. To date, several water bodies in Louisiana have reported bighead carp sightings, including the Atchafalaya River, Turkey Creek, and the Red-Ouachita River.[120]

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.[121]

3.B.2.b Locally Established Species

See fish species above.

3.B.2.c Potential Arrivals

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

3.B.2.c.i Black Carp (*Mylopharyngodon piceus*)

Recent black carp collections from the Red River 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 crawfish. In large numbers, black carp could threaten native shellfish and mollusks, including snails and mussels. 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.[122]

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.[123] 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

[118] Nico and Fuller 2000.
[119] Aguirre and Poss 1998.
[120] Nico 2000c.
[121] Aguirre and Poss 2000b; Nico 2000c.
[122] U.S. Fish and Wildlife Service 2002, pages 49281 – 49282.
[123] U.S. Fish and Wildlife Service 2002, page 49281; Nico 2000a.

the Osage River.[124] According to the U.S. Fish and Wildlife Service, 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."[125]

In April 2004, a 43-inch black carp was caught by a commercial fisherman in the upper Atchafalaya / lower Red rivers region of Louisiana. A second specimen was caught nearby in early May. Researchers felt that the Osage River population was too far removed from these two Louisiana specimens to explain their origin and suspected a new source. One possible explanation is that the carp escaped from a second aquaculture facility, possibly one to which LDWF had previously issued a permit to evaluate triploid black carp effectiveness for snail control. LDWF had permitted one catfish producer for this evaluation in 1996 and a second producer in 2000. 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 eight years."[126] LDWF is working with the fisherman to monitor the river.[127]

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.[128]

On July 30, 2002, the U.S. Fish and Wildlife Service published a proposed rule in the *Federal Register* which, if finalized, would add the black carp to the federally maintained list of injurious species, prohibiting "the importation of any live animal or viable egg of the black carp into the United States … live black carp or viable eggs could 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 would also be required for the interstate transportation of live black carp or viable eggs currently held in the United States for scientific, medical, educational, or zoological purposes." Furthermore, the rule would prohibit "interstate transportation of live black carp or viable eggs."[129]

3.B.2.c.ii 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 are increasingly common in aquaculture production in the United States, second only to carp production. Louisiana Department of Wildlife and Fisheries, the permitting agency for aquaculture fish species, allows Blue tilapia (*Tilapia aurea*), Mozambique tilapia (*Tilapia mossambica*), Nile tilapia (*Tilapia nilotica*), and Wami tilapia (*Tilapia hornorum*) in Louisiana.[130]

Though there are no known tilapia species established in the wild in Louisiana, LDWF officials are concerned that potential tilapia fish farm "escapees" could become established and degrade native fisheries. In addition to competing with natives, most tilapia species are aggressive toward other fish. Tilapia are omnivores, consuming detritus, algae, phytoplankton, zooplankton, insects,

[124] Nico 2000a; U.S. Fish and Wildlife Service 2002, page 49281.
[125] U.S. Fish and Wildlife Service 2002, page 49282.
[126] USGS 2004.
[127] McElroy 2004.
[128] Maher 2003.
[129] U.S. Fish and Wildlife Service 2002, page 49280.
[130] Lutz 1998; McElroy 2003.

vascular plant fragments, small fish, and crustaceans. Several tilapia species are established in parts of Florida, Texas, and Alabama.[131]

Others, however, question whether tilapia pose a threat to Louisiana wildlife if they escape cultivation. Though tilapia have wide salinity tolerances, they are not cold-tolerant. According to Lutz, "growth is generally limited at water temperatures below 70 degrees Fahrenheit (F), and most tilapia become severely distressed at 65 degrees F. Death begins to occur at 60 degrees F, with few surviving temperatures below 50 degrees F for any period of time."[132]

To prevent escapes from aquaculture facilities, in Louisiana, tilapia cultivation is prohibited in outdoor ponds. All water utilized in the tilapia production must be accounted for, and must be screened and / or sterilized before allowed to leave the aquaculture facility.[133]

3.B.3 Mollusks

The two known invasive mollusks in Louisiana, the zebra mussel (*Dreissena polymorpha*) and the Asian clam (*Corbicula fluminea*), are predominantly freshwater mollusks, and, in general, are confined to river drainages.

The largest rivers in Louisiana are the Mississippi, Red, and Atchafalaya; zebra mussels and Asian clams are established in all three and, therefore, are considered extensively established.

The brown mussel, *Perna perna*, is a marine species from the Gulf of Mexico near the Texas-Louisiana border. The green mussel, *Perna viridis*, is currently established in Tampa Bay, but specimens have been found in Pensacola, St. Augustine, and New Smyrna Beach, Florida, as well as on the Atlantic coast of Georgia. Louisiana waters would be suitable habitat for this species. The channeled apple snail, *Pomacea canaliculata*, is established in Texas close to Louisiana and may be here already. Unconfirmed reports indicate that this species has been found in St. Martin Parish. Pacific and Asian oysters (*Crassostrea gigas* and *Crassostrea ariakensis*, respectively) are being considered for introduction into the Chesapeake Bay to attempt to rebuild oyster stocks decimated by disease. As these potential introductions may impact Louisiana's native oyster, *Crassostrea virginica*, descriptions of the non-native oysters are provided below.

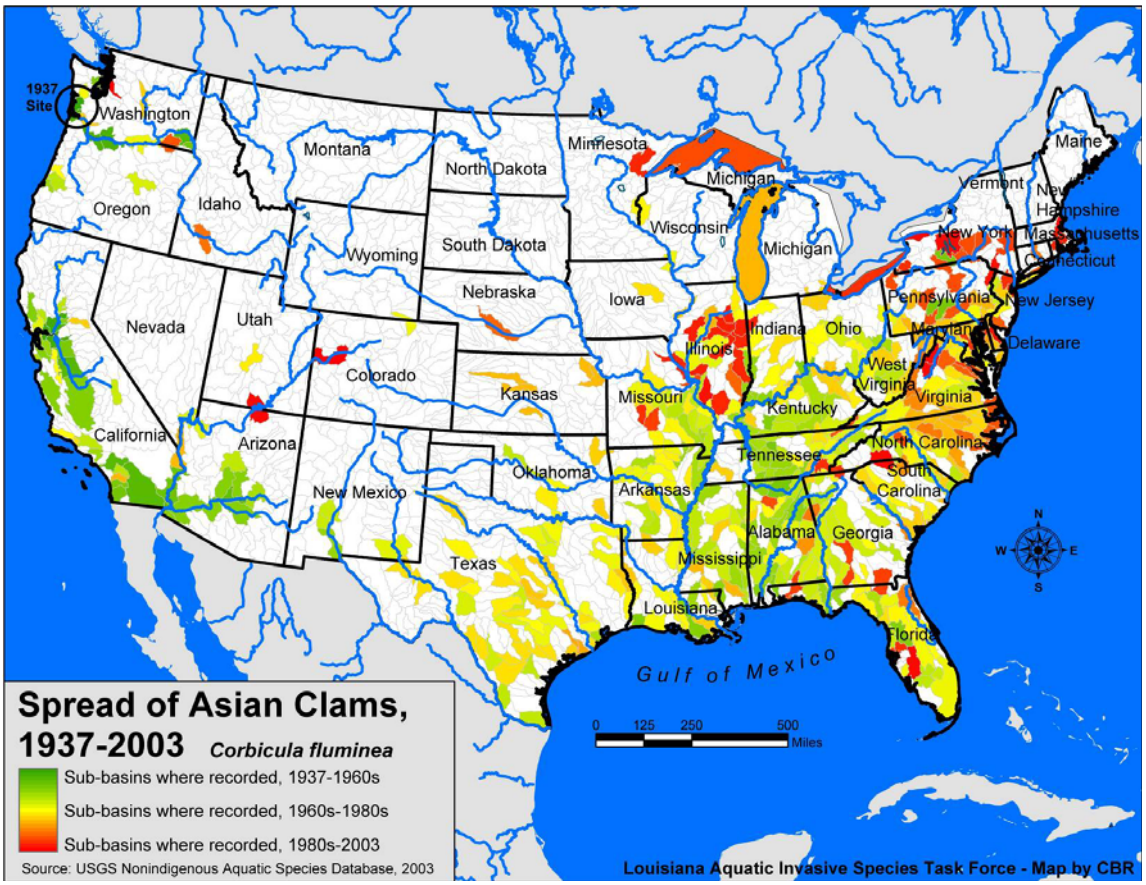
3.B.3.a Extensively Established Species

3.B.3.a.i Asian Clam (*Corbicula fluminea*)

Asian clams were likely introduced to the United States as a food source for Chinese immigrants on the West Coast, possibly as early as the mid 1800s. The clams were first discovered in Washington in 1938. Now established in at least 38 states and Washington, D.C., *Corbicula fluminea* spread mostly through human activities, such as bait bucket dumping, aquaria releases into streams or canals, and intentional releases by people who bought the clams at food markets. Asian clams may also have been a contaminant in an imported aquaculture species. Another pathway for dispersal is the passive movement of larvae in water currents. In Louisiana, *Corbicula fluminea* has been reported in 13 parishes touched by the Mississippi, Red, Pearl, and Atchafalaya rivers.[134]

The Asian clam typically measures less than 25 millimeters (one inch), although some can reach 65 millimeters (2.5 inches.) Optimum growth occurs at low salinities and in freshwater, but this species can tolerate salinities up to 24 ppt when acclimatized.[135] This may be cause for concern because the freshwater river diversions (see page 19) could serve as pathways for an Asian clam range expansion into the coastal wetlands and Lake Pontchartrain, an estuary with salinities ranging from 0 ppt to 25 ppt.

[131] McElroy 2003; Aguirre and Poss 1999b.
[132] Lutz 1998, page 1.
[133] Lutz 1998, pages 1, 4.
[134] Aguirre and Poss 1999c; Foster, Fuller, and Benson 2000.
[135] Aguirre and Poss 1999c.



Asian clams were likely introduced to the West Coast as a food source for Chinese immigrants in the mid-1800s, but were not recorded until 1938 in Washington. Now established in at least 38 states, the clams spread mostly through human activity, such as bait bucket dumping and aquaria releases. *Map by CBR, 2004.*

Ecological impacts of Asian clam infestations include the altering of benthic substrate and increased competition with native species for food and habitat resources. Asian clams also serve as a food source for many species favored by fishermen, including largemouth bass and freshwater drum. But this benefit is outweighed by the economic burden borne by industries and municipalities. Asian clams are "biofoulers" that clog power plant intake pipes and other industrial water systems. In some parts of the United States, *C. fluminea* also causes problems in irrigation canals and pipes.[136]

3.B.3.a.ii 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.[137]

In Louisiana, zebra mussels are established in the Mississippi River between Baton Rouge and New Orleans, while localized colonies exist below New Orleans near the river's mouth, and upriver near Vicksburg. In addition to the Mississippi, zebra mussels are moving northwest up the Red River toward Shreveport, while several sightings have been reported in the Atchafalaya River, Bayou Teche, Bayou Lafourche, and the Intracoastal Waterway near Houma.[138] The freshwater diversion structures and the Bonnet Carré Spillway on the Mississippi River are

[136] Foster, Fuller, and Benson 2000; Aguirre and Poss 1999c.
[137] Hard, Allen, and Poss 1999.
[138] New York Sea Grant 2003; USGS (no date)d.

potential pathways by which zebra mussels may spread to new waterways. (See section 3.A.4 on River Diversions for more information.)

In addition to other environmental problems, zebra mussels are notorious biofoulers and colonizers of water intake/outtake pipes at industrial facilities located along rivers. Entergy Corporation, the region's premier energy and gas utility, operates at least six facilities affected by zebra mussels on the Mississippi River. Entergy has implemented various monitoring and control programs. These include heating the water in a closed system to 35-36.7 degrees Celsius (95-98 degrees Fahrenheit) for several hours and chemical treatment using oxidizing and nonoxidizing chemicals. Costs associated with these treatments vary by location, but typically range from $15,000 to $100,000 per treatment.[139]

On the federal level, the U.S. Army Corps of Engineers performs periodic zebra mussel monitoring surveys at locks and other structures during dewatering or when gates are removed for maintenance. The U.S. Fish and Wildlife Service's 100th Meridian Initiative aims to prevent the westward spread of zebra mussels by trailered boats. The agency's Southeast Region Office is working with Louisiana to implement an outreach program aimed at boaters visiting the Atchafalaya and other locations of confirmed or potential zebra mussel sightings.[140]

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 temperate rises. Mussels expend energy to prevent overheating, causing them to decrease their consumption and subsequently starve to death.[141]

3.B.3.b Locally Established Species

See above.

3.B.3.c Potential Arrivals

3.B.3.c.i Brown Mussel (*Perna perna*)

In 1990, for the first time in U.S. waters, two juvenile edible brown mussels were discovered on jetty rocks at Port Aransas, Texas. Native to selected coasts of the Indian and South Atlantic oceans, the *P. perna* population in Texas seems to have originated from Venezuela, according to recent DNA tracking research. The mussels were likely carried on the hulls or in the ballast water of ships calling at Venezuelan ports.[142] Brown mussels "now occur on other isolated hardshores along 1,700 km [1,056 miles] of coast from Freeport, Texas, to southern Veracruz, Mexico,"[143] and brown mussels have been found on offshore oil rigs in the Gulf of Mexico. Reports that *P. perna* are established near the Texas-Louisiana border are unconfirmed. Researchers from Texas A&M University at Corpus Christi and Texas Parks and Wildlife Department have no knowledge of *P. perna*'s existence any farther east than Freeport, Texas.[144] However, Hicks et al. (2001) suggest that, based on analyses of *P. perna* in its native ranges, the coastal Gulf of Mexico is a suitable habitat for brown mussel colonization. They predict the non-native range of *P. perna* could "spread beyond the species' present Texas/Mexico range,"[145] including the northern Gulf of Mexico coast. Probable pathways for brown mussel range expansion are ocean

[139] Stoma 2003.
[140] Saucier 2003; Carter 2003.
[141] Dietz 1995.
[142] Hicks, Tunnell, and McMahon 2001, page 181; McGrath, Hyde, and Tunnell 1999.
[143] Hicks, Tunnell, and McMahon 2001, page 181.
[144] Howells 2003; Hicks 2003.
[145] Hicks, Tunnell, and McMahon 2001, page 190.

currents or shipping routes between Texas and Louisiana ports. *P. perna* larvae in ballast water or adults attached to ship hulls could introduce this mussel to Louisiana.

The brown mussel is predominantly a marine mussel, though a colony was discovered in a bay environment in Port O'Conner, Texas. In their natural range, adult brown mussels tolerate salinities from 19 ppt to 44 ppt, and veligers (larvae) tolerate salinities of 15 ppt to 55 ppt. The Texas *P. perna* populations withstand salinities from 15 ppt to 50 ppt. However, the lowest end of this salinity range may be below their tolerance. According to Hicks (2003), *P. perna* can survive but cannot form byssal threads (strong protein "ropes" that a mussel produces to attach and anchor itself to substrate) at 15 ppt. Nevertheless, *P. perna* can survive the more saline waters of coastal Louisiana. Though no negative environmental effects have been attributed to the brown mussel in Texas, researchers believe this species can form such dense colonies that an infestation could sink navigation buoys and affect shipping safety.[146]

3.B.3.c.ii Green Mussel (*Perna viridis*)

The Asian green mussel, also sometimes called the green-lipped 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."[147] 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.[148] 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.[149]

Green mussels prefer estuarine environments with salinities similar to Louisiana estuaries. The lower limit of *Perna viridis'* salinity tolerance is 16 ppt and researchers have shown that *P. viridis* can survive in turbid waters.[150] 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.[151] 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 *Perna viridis*, which attach to and suffocate native oysters. Florida's oyster reefs consist of the species *Crassostrea virginica*, which is also commercially valuable to Louisiana'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.[152]

---

[146] Crochet, Hicks, and Poss 1998; Hicks 2003.
[147] Benson, Marelli, Frischer, Danforth, and Williams 2002.
[148] Benson et al. 2002; USGS 2003; Miller 2003.
[149] Power 2003.
[150] Florida Caribbean Science Center 2001; Crochet, Hicks, and Poss 1999.
[151] 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.
[152] Benson et al. 2002; Baker, Fajans, and Bergquist 2003.

Recreational boat traffic and commercial shipping lanes between Florida (particularly Tampa Bay and Pensacola) and Louisiana could serve as a pathway for *P. viridis* into Louisiana waters. If introduced, *P. viridis* could become established in Louisiana coastal waters. According to Hicks, *P. viridis*, with its lower salinity tolerances, is probably a greater threat than *P. perna*, despite the latter's greater proximity to Louisiana. [153]

3.B.3.c.iii Channeled Apple Snail (*Pomacea canaliculata*)

Native to Central and South America, the channeled apple snail is currently established in Texas, California, Florida, and has been reported in North Carolina. This snail was first found in the Texas Gulf Coast in mid 2000 and has since spread via interconnected canals and with the help of Tropical Storm Allison in June 2001. Unconfirmed reports indicate that this species was found in St. Martin Parish, Louisiana, in 2001. Though no confirmed sightings of *Pomacea canaliculata* in Louisiana exist, its range in Texas is expanding north and east. Texas wildlife managers claim that if the snail is not already established in Louisiana, its current non-native range approaches the Texas-Louisiana border.[154]

Sold in North American pet and aquarium stores, *Pomacea canaliculata* introductions are probably the result of aquarium releases. Aquarium dealers sometimes mislabel the apple snail species; *P. canaliculata* has been sold under the names "giant Peruvian apple snail," "South American apple snail," and "mystery snail."[155]

An edible snail, *P. canaliculata* was introduced to Taiwan and other parts of Asia as a food source. The snail escaped cultivation and spread to Hong Kong, Thailand, southern China, Japan, and Indonesia, destroying rice crops in those countries. Texas rice farmers worry that a population explosion of *P. canaliculata* could have similarly devastating effects on their crops. Adults of this species are voracious eaters and prefer the soft vegetation of young rice plants.

The channeled apple snail is a hardy species that tolerates poor water quality, including pollutants or low dissolved oxygen. A shell door enables it to close itself off from harsh external conditions, so the channeled apple snail can survive droughts and can even hibernate in the mud for up to six months, reemerging when water and temperature conditions are favorable. *Pomacea canaliculata* can endure cold temperatures and a broad range of salinities. In their native environments, *P. canaliculata*'s ideal habitats include swamps, marshes, and canals, all of which are common throughout southern Louisiana.[156]

3.B.3.c.iv Pacific Oyster (*Crassostrea gigas*)

Native to Japan, this oyster was introduced to the west coast of the U.S. in the early 1900s and quickly became an important part of the aquaculture industry, particularly in Washington, where it remains the state's most valuable shellfish species. When diseases decimated the native eastern oyster (*Crassostrea virginica*) of Chesapeake Bay in the late 20th century, some researchers suggested introducing the Pacific oyster as a substitute, but it proved inadequate for reasons of growth rates, taste, and disease tolerance. Should entities suggest the introduction of the Pacific oyster into Louisiana waters, the Task Force notes that LDWF maintains jurisdiction over this matter and urges that a risk assessment be conducted on its potential impacts. Currently, the North American distribution of the Pacific oyster spans from southeast Alaska to Baja California, primarily on coastal oyster farms, though some wild populations exist in Washington, British Columbia, and Hawaii.[157]

The two diseases that devastated the native Chesapeake Bay oyster are MSX (Multinucleated sphere unknown, *Haplosporidia nelsoni*) and Dermo (*Perkinsus marinus*). Scientists believe MSX

[153] Hicks 2003.
[154] Gaudé 2002; Howells 2000.
[155] U.S. Rice Producers 2002; Howells 2000.
[156] U.S. Rice Producers 2002; Aguirre and Poss 1999d.
[157] Maryland Sea Grant 2003; Pacific States Marine Fisheries Commission 1996; USGS 2005.

arrived to the east coast via the introduction of *Crassostrea gigas* in the 1930s, which failed to establish a population.[158]

3.B.3.c.v Asian Oyster (*Crassostrea ariakensis*)

When the Pacific oyster *Crassostrea gigas* proved unsuitable for culture in the Chesapeake Bay, scientists investigated introducing the Asian (or Suminoe) oyster, *Crassostrea ariakensis*, instead. In comparative studies with the native *Crassostrea virginica*, the Asian oyster proved to be faster growing and more resistant to MSX and Dermo diseases. It was found to reach market size in only nine months, whereas native eastern oysters may require almost two years before they are large enough to harvest.[159]

Resulting pressure from the seafood industry to introduce *Crassostrea ariakensis* to the Chesapeake is causing much controversy, as scientists and natural resource managers are still unsure of the long-term ecological impacts of such introductions. Triploid (sterile) oysters are offered to control introductions, but triploids can sometimes revert to diploidy and reproduce. Ecological and economic concerns include possible adverse food web impacts, new parasites and pathogens, and a potential biofouling problem if the oysters reproduce too effectively.[160]

A final decision on the introduction has not yet been made, but the U.S. Army Corps of Engineers, Norfolk, Virginia district is currently seeking public comment on an Environmental Impact Statement. If the introduction is authorized, it may set a precedent for similar introductions in other coastal regions, including the Gulf of Mexico.

3.B.4 Mammals

Although nutria are not distributed throughout Louisiana, their numbers and environmental impact in coastal Louisiana are so great that they warrant consideration as extensively established and extremely problematic. Feral hogs (*Sus scrofa*) are established sporadically throughout the Gulf Coast and southern United States, and thus are considered extensively established for this management plan. The problems caused by feral hogs in Louisiana, however, are dwarfed by those caused by nutria. Feral hogs also provide some social and economic benefit for local hunters and trappers, whereas nutria no longer offer any benefit to Louisiana residents.

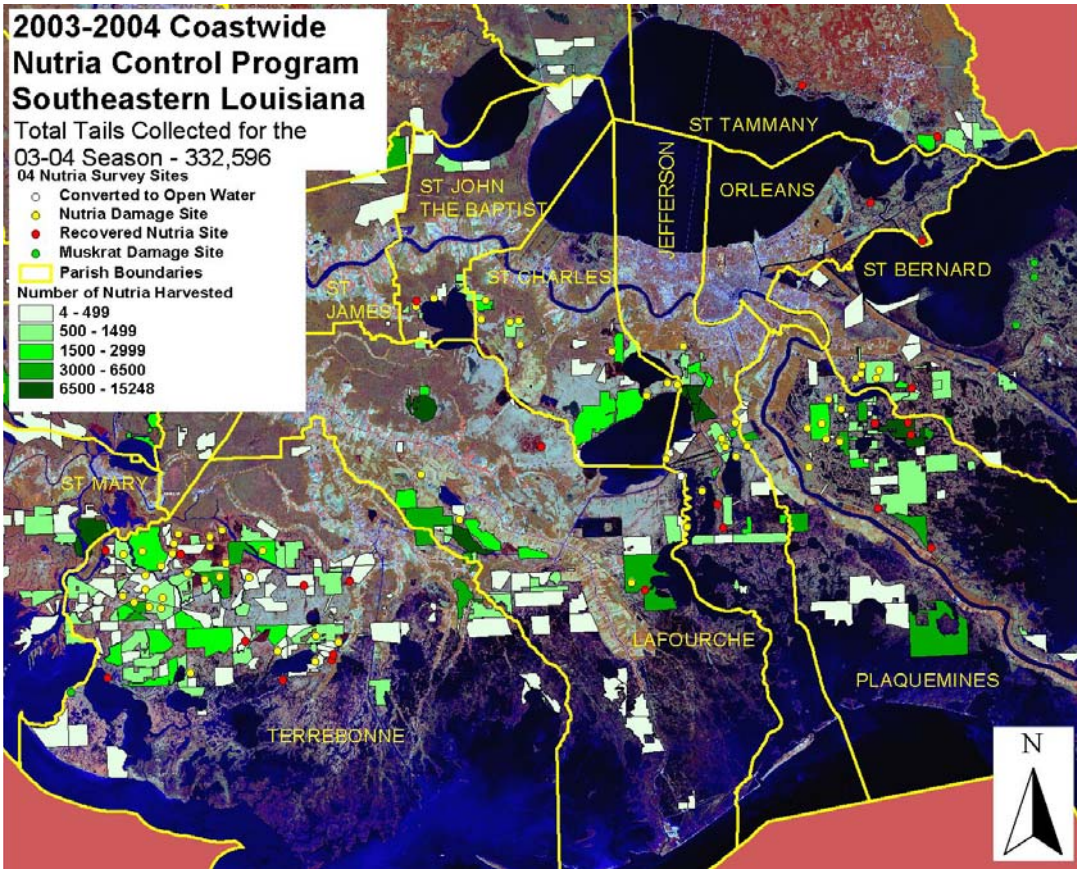
These two species are the only mammals identified as invasive in Louisiana.

3.B.4.a Extensively Established Species

3.B.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 four 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.[161]

[158] Chesapeake Bay Program 2004.
[159] Leffler 2002; Chesapeake Bay Program 2004.
[160] Leffler 2002; Chesapeake Bay Program 2004.
[161] LeBlanc 1994.



Coastwide Nutria Control Program

In 2002, LDWF and LDNR launched an incentive payment plan, the Coastwide Nutria Control Program, to reduce vegetative damage by increasing nutria harvest through a bounty. Registered trappers and hunters are paid $4 for every nutria taken south of the I-10/I-12 corridor. To receive payment, participants must bring well-preserved nutria tails (A) to designated collection sites, where officials tabulate them and issue vouchers (B). The program collected 308,160 and 332,596 nutria in its first two years, for which about $2.5 million was paid to participants. The above map shows number of nutria harvested by property in a portion of the program area, during the second season. *Map and photos by LDWF, 2003-2004.*

Coypu 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 Louisiana; 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 Louisiana today. (For more information on nutria harvests for fur, see the "Fur Industry" section under "Deliberate Introductions," section 3.A.7.f.) By 1988, landowners complained of nutria-caused vegetative damage to coastal areas, for which the Louisiana Department of Wildlife and Fisheries began conducting vegetative surveys to document the damage.[162]

The table below, from the Louisiana Department of Wildlife and Fisheries Fur and Refuge Division, indicates the number of sites surveyed for nutria-related vegetative damage between 1998 and 2002, the number of those sites with vegetative damage, and the number of sites that showed vegetative recovery:

Year	Total Sites Surveyed	Sites with Vegetative Damage	Sites Experiencing Vegetative Recovery
1998	204	170	34
1999	184	150	34
2000	170	132	38
2001	142	123	19
2002	108	94	12

Overall, the area of coastal marsh with vegetative damage is increasing, and the numbers of sites recovering from nutria damage are decreasing. While it appears that nutria damage is decreasing overall because the number of vegetation-damaged sites is declining, many of the sites surveyed during this period in fact enlarged and merged to form the "eat-outs" mentioned earlier. Merged sites, regardless of size, were thence counted as one site instead of multiple sites.[163]

In late 2002, LDWF and the Louisiana Department of Natural Resources jointly launched an incentive payment plan called the Coastwide Nutria Control Program (CNCP). The purpose of the bounty program is to reduce vegetative damage by increasing nutria harvest. Registered trappers and hunters are paid $4 per tail (as proof of harvest) for every individual nutria taken within the project boundaries. Registered participants must obtain a valid Louisiana trapping license, complete an application, and obtain written permission from the landowner to take the nutria from his/her land. The trappers then receive a specific Nutria Control Program Registration Number. To receive the $4-per-tail bounty, trappers must bring well-preserved (fresh, frozen, salted, etc.) tails at least seven inches long to designated collection sites and must present their assigned registration numbers. As long as the nutria are taken between November and March, trappers meeting the above requirements receive vouchers for the tails, and a check is mailed to them shortly.[164]

The CNCP is funded through the Coastal Wetlands Planning, Protection, and Restoration Act for five years, for as many as 400,000 nutria per year. Program boundaries cover those coastal areas most affected by nutria, from the Interstate 10 — Interstate 12 corridor south to the coast, from the Texas border to the Mississippi border. Every year, transects along the coast are inspected from aircraft to determine nutria-caused vegetative damage. Photographs from the fly-overs will help assess the impact of the bounty program.[165]

Wildlife officials collected 308,160 and 332,596 nutria tails in the first two years of the program, for which about $2.5 million was paid to trappers.[166]

[162] USGS 2000b; Wilson 2002; Linscombe 2003a.
[163] Linscombe 2003a.
[164] Linscombe 2003a.
[165] Linscombe 2003a.
[166] Linscombe 2003b; Marshall 2004.

3.B.4.a.ii Feral Hogs (*Sus scrofa*)

Feral hogs, *Sus scrofa*, are sometimes hybrids of wild boars and domestic livestock. Domestic hogs were deliberately introduced as livestock to North America during colonial times; some escaped farms and established feral populations. In the 1940s, sportsmen deliberately introduced Russian black boars to the southeastern United States as a new game animal. Interbreeding between the boars and the feral hogs may have produced the hybrid feral hogs present in Louisiana today.[167]

Sus scrofa prefers wooded areas, flat coastal plains, swamps, marshes, and other habitats with plentiful water. Louisiana's warm and moist subtropical climate allows for reproduction almost year round, and nutrient-rich soils and diverse ecosystems abundantly produce the hogs' favorite foods: roots, leaves, nuts, tubers, snails, insects, frogs, snakes, and rats.[168]

Besides competing with deer, bears, rabbits, and other native species for habitat and food, *Sus scrofa* can pose a risk to humans. In their quest for food, feral hogs have been known to tear up hurricane protection levees with their snouts and hooves, causing scars which could erode, expand, and weaken the flood-prevention structures.[169] Feral hogs are also vectors for bovine tuberculosis and swine brucellosis, a potential human pathogen which could affect agriculture.

3.B.4.b Locally Established Species

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

3.B.4.c Potential Arrivals

No potential invasive mammals are foreseen.

3.B.5 Insects

Due to the prolific nature of insects and their ability to rapidly adapt to a new environment, all insect species established in Louisiana are considered extensively established.

3.B.5.a Extensively Established Species

3.B.5.a.i Red Imported Fire Ant (*Solenopsis invicta*)

Red imported fire ants (RIFA) are thought to be native to Paraguay and the Parana river region in South America and were brought to the United States in the 1930s, probably in soil used as ballast or dunnage in commercial shipping vessels. RIFA were first detected in Mobile, Alabama but quickly spread throughout the southeastern United States, through the transport of nursery stock and earth-moving equipment. A federal quarantine was implemented in 1958 to prevent the spread of RIFA by restricting the movement of potentially infested hay, sod, soil, equipment, and nursery stock.[170]

RIFA cause a variety of adverse economic and environmental effects by outcompeting and preying on native species, feeding on agricultural crops (such as okra, cucumbers, corn, and soybeans), sometimes killing livestock, and nesting in electrical equipment such as air conditioners, traffic signal boxes, computers, airport landing lights, and telephone junctions. The estimated structural and electrical damage caused by RIFA every year is about $11.2 million, and the estimated damage to livestock, wildlife, and public health in Texas alone is $300 million per year. Medical treatment of fire ant stings costs approximately $7.9 million annually. The total cost associated with fire ants in the southern United States is estimated at $1 billion per year.[171]

[167] Aguirre and Poss 1999e; Jensen 2001.
[168] Aguirre and Poss 1999e.
[169] Jensen 2001.
[170] Morisawa 2000.
[171] Morisawa 2000.

3.B.5.a.ii Formosan Termite (*Coptotermes formosanus*)

Formosan termites were introduced to the United States during and shortly after World War II, via wooden shipping palettes on ships returning from East Asia. The termites were introduced at various ports along the Gulf Coast, including Houston, Galveston, Lake Charles, and New Orleans, as well as Charleston, South Carolina. Formosan termites were not detected at the military bases until 1966, and the extent and impact of Formosan termite populations was not fully appreciated until the 1980s. By this time, this "super termite" was well established and spreading throughout Louisiana and the Gulf Coast.[172]

Formosan termites cause an estimated $500 million in damage to Louisiana every year, with $300 million in damages to New Orleans alone. In addition to damaged houses and other buildings, particularly historical structures, Formosan termites infest and structurally weaken native trees, including live oaks and other hardwoods, rendering them more vulnerable to wind damage and other threats. Even cypress are not immune to Formosan termites.[173]

For more information on Formosan termites, visit the Louisiana Department of Agriculture and Forestry website (www.ldaf.state.la.us) or contact Operation Fullstop at the USDA Southern Regional Research Center (http://www.ars.usda.gov/is/br/fullstop).

3.B.5.a.iii Asian Tiger Mosquito (*Aedes albopictus*)

Aedes albopictus, the Asian tiger mosquito, was accidentally introduced to the United States in 1985 when used tires containing larvae-infested water were shipped from Japan to Houston, Texas. Further transport of used tires spread *Aedes albopictus* to other Southern cities. Within the first year of its introduction, the Asian tiger mosquito was reported in New Orleans, Lake Charles, Baton Rouge, and Shreveport; today it is found in almost every parish in Louisiana.[174]

Aedes albopictus breeds in stagnant water pools found in outdoor containers, especially in shady areas. For this reason, this species does particularly well in urban residential settings. This mosquito threatens public health as a known vector of the viruses that cause dengue fever, eastern equine encephalitis, and the agent that causes dog heartworm. *Aedes albopictus* is a suspected vector of other viral diseases, including West Nile virus, yellow fever, and other types of encephalitis.[175]

3.B.5.b Locally Established Species

All invasive insects are considered "Extensively Established" in this plan.

3.B.5.c Potential Arrivals

3.B.5.c.i Africanized Honeybee (*Apis mellifera scutellata*)

Nicknamed "killer bees," Africanized honeybees were imported to Brazil with the intention of genetically improving European honeybees and making them more suitable for South America. Some were accidentally released from research facilities in 1956, and they hybridized with European varieties, thus becoming "Africanized honey bees." The bees spread through South America, into Central America, and arrived in Texas in October 1990. Since their arrival in Texas, the bees have spread primarily west, into New Mexico, Arizona, and California. Currently, no known populations of Africanized honeybees exist in Louisiana, although the bees have been found as close as Houston.

Africanized honeybees grow more quickly from egg into adult, swarm more often, and are more aggressive than their European counterparts. They are known to completely abandon a colony and move on to another location. They may decrease and even replace European honeybees in parts of the United States.[176]

[172] Agricultural Research Service 2002a and b; Louisiana Formosan Termite Initiative 2003.
[173] Louisiana Formosan Termite Initiative 2003.
[174] Maryland Department of Agriculture (no date); Centers for Disease Control and Prevention 2001.
[175] Maryland Department of Agriculture (no date); Lounibos 2002.
[176] National Agricultural Pest Information System 1993, 2004.

3.B.6 Other Species

"Other species" are those that the Task Force decided are important and problematic, but do not fit into any of the above categories. These include coelenterates, crustaceans, and one cladoceran.

3.B.6.a Extensively Established Species

None to date.

3.B.6.b Locally Established Species

3.B.6.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. *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 is may have occurred when an eddy spun off of the Loop Current, which carries tropical water from the Caribbean to the Gulf of Mexico.[177]

During the *P. punctata* population explosion of 2000, researchers discovered the jellies from Mobile Bay in Alabama to the Texas-Louisiana border, with concentrations heaviest in the Mississippi Sound, the barrier islands off the coasts of Louisiana and Mississippi, and at the mouth of Lake Borgne, Louisiana.[178]

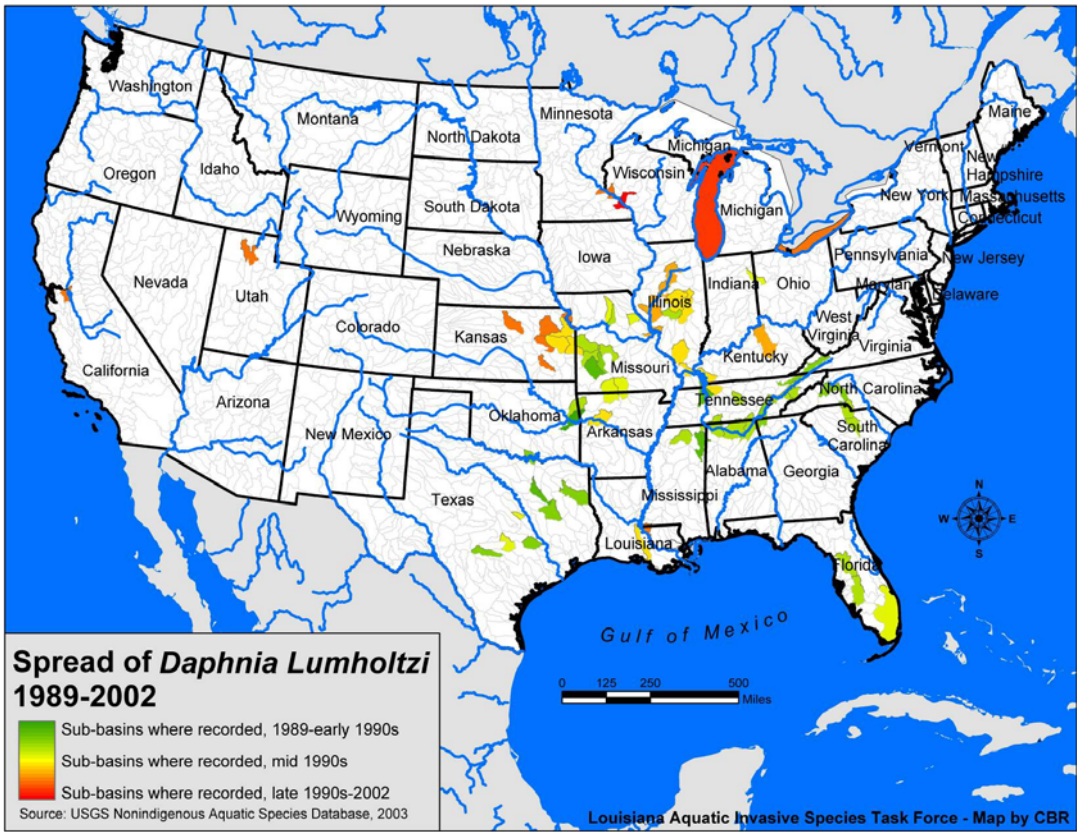
In summer 2000, when *Phyllorhiza punctata* populations were at their greatest, commercial fishermen, researchers, and environmental managers feared this species might have a significant impact on commercially valuable fisheries, specifically shrimp, menhaden, anchovies, crabs, and red snapper. Shrimpers complained that the gelatinous creatures were clogging their nets. Every summer, larval fish and eggs, particularly for the species mentioned above, are carried by tides to estuaries close to shore. The jellyfish in 2000 blocked the entrances to these estuaries. *Phyllorhiza punctata* is a filter-feeding omnivore that will consume every living organism smaller than a few millimeters across. Daily, each jellyfish can filter up to 50 cubic meters of water and eat approximately 2,400 fish and shellfish eggs.[179] According to Harriett Perry, Ph.D., 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."[180]

Though the spotted jellyfish population explosions of 2000 have not occurred since, recent evidence indicates *Phyllorhiza punctata* is established in the Gulf of Mexico, suggesting that a similar explosion could occur soon.

3.B.6.b.ii Zooplanktonic Water Flea (*Daphnia lumholtzi*)

Although several species in the Genus *Daphnia* are native to Louisiana and other parts of the United States, the water flea *Daphnia lumholtzi* is native to Africa, Asia, and Australia. It was first documented in Texas in 1990, and today can be found in Alabama, Arkansas, Florida, Illinois, Kansas, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, Ohio, South Carolina, Tennessee, Texas, and Utah. *D. lumholtzi* was first documented in Louisiana in 1994 when 19 zooplankton samples collected from 30 sites in the Atchafalaya Basin contained this water flea. Although its pathway is not known, scientists believe this daphnid species likely was brought to the U.S. in shipments of Nile perch from Lake Victoria in Africa. *D. lumholtzi* probably spread throughout the U.S. through contaminated water used to transport fish stocks, water

[177] Smithsonian Marine Station 2001; Dauphin Island Sea Lab (no date); Higgins 2001.
[178] Maynell 2000; Graham (no date).
[179] Raines 2000; Raines 2002.
[180] Raines 2000.



This water flea, native to Africa, Asia, and Australia, was first documented in Texas in 1990 and has since spread to at least 16 states. Although its pathway is not known, *Daphnia* was likely brought to the U.S. in shipments of Nile perch from Lake Victoria in Africa. *Map by CBR, 2004.*

drained from aquaculture ponds, and/or unwashed recreational boats trailered from one water body to another.[181]

The long-term effects of this species' introduction are currently unknown, but negative impacts are possible. Water fleas and other zooplankton are an important food source for many larval fish species, but because of *D. lumholtzi*'s head and tail spines, which are much longer and more numerous than those of native daphnid, this species of zooplankton is avoided by fish larvae, thus giving it an evolutionary advantage over natives. Stoeckel and Charlebois (1999) note "if this replacement occurs, the amount of food available to larval and juvenile fishes may be reduced."[182]

3.B.6.c Potential Arrivals

3.B.6.c.i Chinese Mitten Crab (*Eriochirus sinensis*)

Chinese mitten crabs are native to the coastal rivers and estuaries of the Yellow Sea region in China and Korea. This crab may have been introduced accidentally via ballast water discharges, or intentionally as a food source , or both. To date, there has been only one Chinese mitten crab sighting in Louisiana: in 1987, dead specimens were collected near the new St. Bernard Parish Highway-Highway 46 intersection in Bay Gardene, Louisiana.[183] Researchers believe they may have fallen off of a passing ship.

In Asia, Chinese mitten crabs are a host organism for several lung flukes (parasitic flatworms), one of which, *Paragonimus ringeri*, can affect humans. This crab species also burrows deep into

[181] Stoeckel and Charlebois 1999; USGS (no date)e.
[182] Stoeckel and Charlebois 1999.
[183] Washington Sea Grant 2000; Nates and Poss 2000.

soft river banks or levees. Burrowing could potentially weaken levees and cause ruptures, increasing flood hazards.[184]

3.B.6.c.ii Green Crab (*Carcinus maenas*)

The European green crab, *Carcinus maenas*, is native to coastal Europe and north Africa.[185] It was first introduced to the United States in the early 19th Century, primarily along the coast from New Jersey to Massachusetts and thence into Nova Scotia. *C. maenas*'s presence on the Pacific Coast of the United States was first documented in San Francisco Bay in 1998 and has since spread along coastal California, Oregon, Washington, and British Columbia. DNA tests indicate that the Pacific coast green crab population originated from the East Coast of North America, but the exact pathway of introduction is unknown.

C. maenas larvae may have been introduced to San Francisco Bay via ballast water discharges. Another likely pathway is packing material, probably seaweed containing live green crabs, used to protect live bait or live seafood during shipping from coast to coast. Improper disposal of the packing material, such as dumping it in San Francisco Bay, could have resulted in the introduction of this voracious predator.

Green crabs are a predatory species with a preference for bivalve mollusks such as clams, oysters, and mussels. They have also been observed eating polychaetes such as marine worms, and other small crustaceans. Green crabs will even prey on juvenile crabs and shellfish.[186]

If introduced to Louisiana waters, *C. maenas* could threaten Louisiana's lucrative commercial oyster, shrimp, and crab fisheries. Tolerant of wide range of temperatures and salinities—0 to 33 degrees Celsius (32-91 degrees Fahrenheit) and 4 ppt to 54 ppt—and able to live in a variety of habitats, from protected rocky shores to tidal marshes, the green crab would probably thrive in Louisiana waters.

California's Humbolt Bay experienced a 40 percent decline in its Manila clam harvest since the green crab became established there. According to the Washington Department of Fish and Wildlife, the green crab "is capable of learning and can improve its prey-handling skills while foraging."[187] This suggests that the green crab could adapt to Louisiana waters and prey on commercially important species.

3.B.7 Viruses, Bacteria, and Other Disease-Causing Microbes

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 Louisiana Aquatic Invasive Species Task Force decided not to address these microorganisms in the Louisiana Aquatic Invasive Species Management Plan. The Task Force decided that few management actions that are not either planned or 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.

The LDWF would like to draw particular attention to the oyster disease MSX ("multinucleated sphere unknown"), caused by the deadly protozoan parasite *Haplosporidium nelsoni*. The origin of the disease is unknown, but it has been documented in Korean and Japanese oyster populations. In the U.S., MSX ranges from Maine to Florida on the east coast, but it is not yet present in the Gulf of Mexico. This disease devastated native oyster populations on the east coast, particularly in the mid-Atlantic region. Transfer of ballast water or estuarine animals from the east coast to the Gulf of Mexico could potentially put Louisiana's native *Crassostrea virginica* oysters at risk.[188]

[184] Nates and Poss 2000.
[185] Copping and Smith 2001.
[186] Washington Department of Fish and Wildlife 2002; Copping and Smith 2001.
[187] Washington Department of Fish and Wildlife 2002.
[188] Virginia Institute of Marine Science (no date.)