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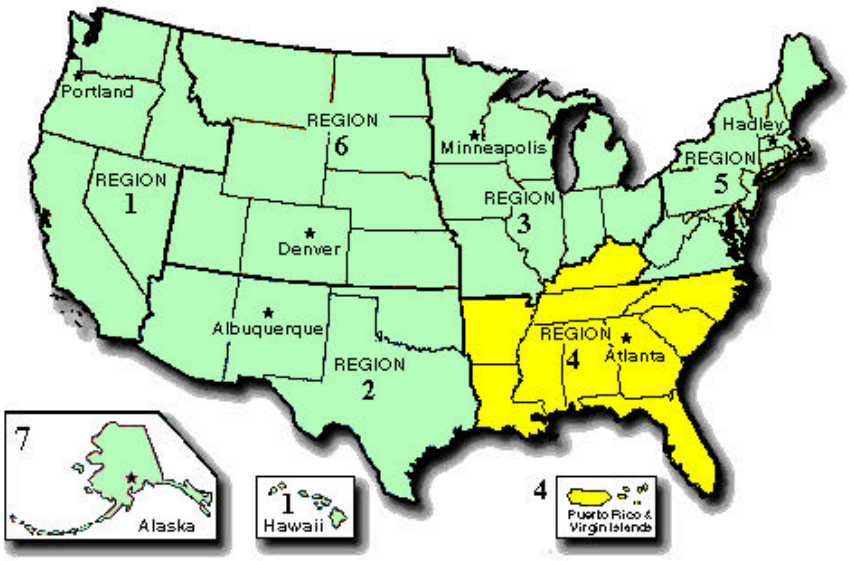
Summary Report of Nonindigenous Aquatic Species in U.S. Fish and Wildlife Service Region 4



U. S. Geological Survey
Florida Caribbean Science Center

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Summary Report of Nonindigenous Aquatic Species in U.S. Fish and Wildlife Service Region 4

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Cover photos:

Pterygoplichthys disjunctivus (vermiculated sailfin catfish)
Marsilea minuta (small water-clover)
Corbicula fluminea (Asian clam)

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INTRODUCTION

The Southeastern region of the United States, with its temperate and subtropical climates and abundance of surface waters, has the largest number of nonindigenous aquatic species having been introduced into its often hospitable waters. In addition, over a thousand miles of coastline and many large commercial ports increase the probably for introductions from ship hull fouling and ballast water dumping. Four of the top ten US ports by tonnage are located in this region, more specifically in Louisiana. Other high-ranking large ports in the region include Mobile, Alabama, Savannah, Georgia, and Tampa and Miami, Florida. Ship hull fouling and ballast water dumping are most likely responsible for a majority of the marine introductions. Other methods of introduction include stock contamination, bait bucket releases, escapes from aquaculture facilities, and stocking of gamefish for sportfishing. It is generally recognized that many introductions occur where organisms do not survive because of inhospitable environments. Some of the introductions in this report fall into that category while others become established and can have large or small impacts.

Fishes (P.L. Fuller)

Overview

A total of 231 fish species have been introduced into the 11 states within USFWS Region 4. Of these, 133 are species native to the United States but have been transplanted outside their native range (Appendix A; Table 1), and 98 are species introduced from other countries (exotic) (Appendix A; Table 2). Eighty-two percent of the native transplants and 49% of the exotic species have resulted in established populations (Appendix B).

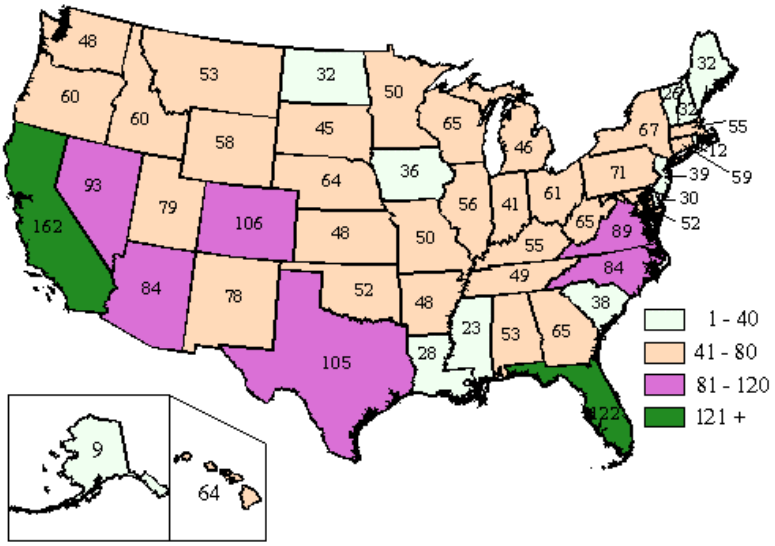

Figure 1. Number of fish species introduced into each state (Fuller et al. 1999).

Florida has more species of fishes introduced than any of the other states in USFWS Region 4 (Appendix B and Figure 1). The majority of these introductions are aquarium species that were either released by hobbyists or escaped tropical fish farms.

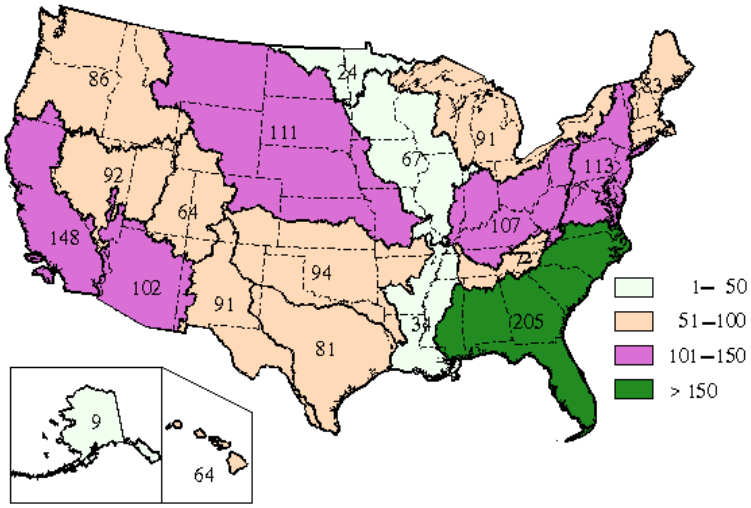

Figure 2. Number of fish species introduced into regional drainages (Fuller et al. 1999).

When divided into regional drainages, the South Atlantic-Gulf has the greatest number of introduced fish species of any of the regional drainages in the country (Figure 2).

Numbers of Introduced and Established Species in Each State

In the Southeast, Florida and North Carolina have the most species introduced and the most species established (Figure 3). However, the dominant pathway in each state is different (Appendix B). The majority of Florida's introductions are related to the aquarium trade; North Carolina's are the result of stockings, mainly for sportfishing. An average of 72% of all fish species introduced in the Southeast become established (Appendix B). Puerto Rico's high establishment rate may be artificially high due to the lack of reporting of failed introductions.

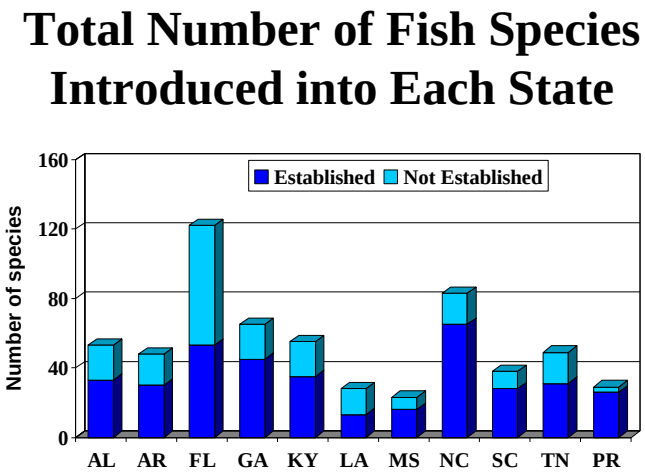

Figure 3. Total number of species introduced to each state.

Tables 1 and 2 in Appendix A contain a complete list of species introduced into each state.

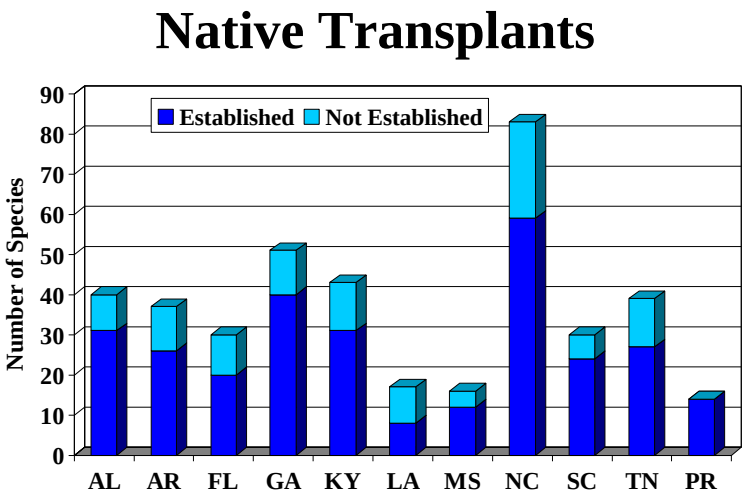

Figure 4. Number of native fish species transplanted in each state.

North Carolina and Georgia are the two states in Region 4 with the highest number of native transplants (Figure 4). North Carolina has a large number of minnow species that are thought to have been introduced outside their native range as the result of bait releases. A small portion of the Tennessee drainage falls within these two states. The Tennessee drainage has many species that differ from the other drainages in these states. Many of the native species have been moved between the Tennessee drainage and into other drainages in these states. Puerto Rico has no native fish fauna but has been stocked with sport fish from the mainland – largely bass, sunfish, and bullheads. In the Southeast, an average of 82% of native species transplanted outside their native range became established (Appendix B).

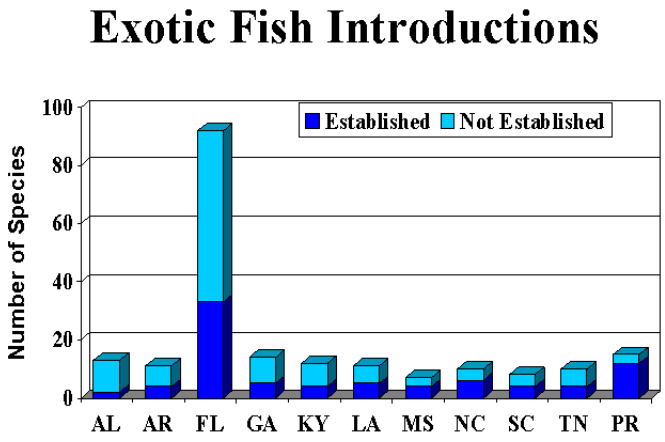

Figure 5. Number of exotic fish species introduced into each state.

The state of Florida has, by far, the most exotic fish species introduced and established (Figure 5). In the Southeast, roughly half of all the exotic species introduced became established (Appendix B and Figure 5). A list of species and their status is provided in Appendix A: Table 2.

Introduction Trends Over Time

Introductions in the Southeast mirror the nation-wide trend of an increase in the number of species introduced since the 1950s (Figure 6).

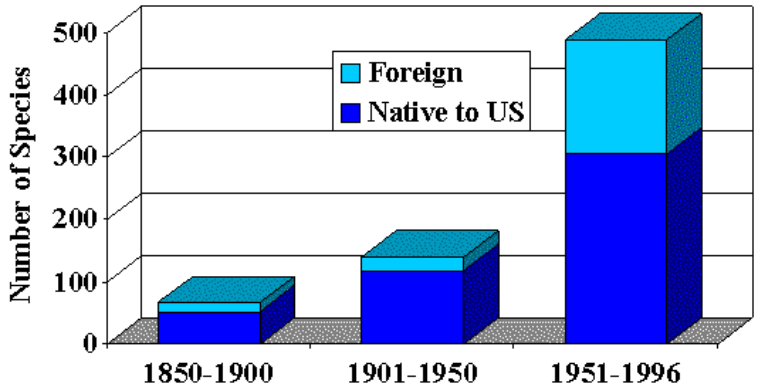

Figure 6. Cumulative number of fish species introduced into the United States (Fuller et al. 1999).

Most of the increase in the Southeast has occurred since the 1970s (Figure 7). The total number of species that have been introduced in the Southeast is 400% higher in 2000 than it was in 1950. Much of this is the result of aquarium fish introductions in Florida. These are attributable to the growing human population in the state and the increased interest in aquariums as a hobby in recent decades.

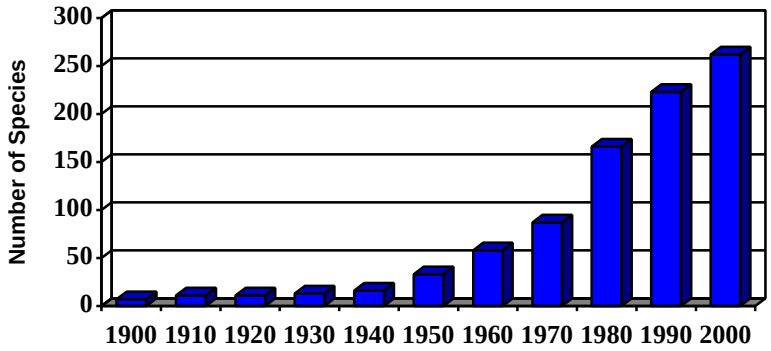

Figure 7. Cumulative number of fish species introduced into the Southeast by decade.

Pathways

The major pathway of fish introductions for all states in Region 4, except Florida, is intentional stocking for sportfishing or forage (Appendix B). Species stocked in these states include: various species of sunfish and bass, pike, muskellunge, bullheads, catfish, yellow perch, walleye, sauger, white bass, and several species of trout and salmon (Appendix A; Table 1). The dominant pathway in Florida is the release or escape of animals associated with the aquarium trade.

Nationally, stocking for sport or forage is the most dominant pathway for introduced fishes. The aquarium trade is next and accounts for ~25% (Figure 8). Bait releases are believed to be responsible for another ~16%. Fewer introductions are attributable to ballast water releases, stocking for biocontrol, stocking of endangered species for conservation purposes, and miscellaneous methods such as canal connections, research releases, and escapes from aquaculture that are not related to aquarium fishes.

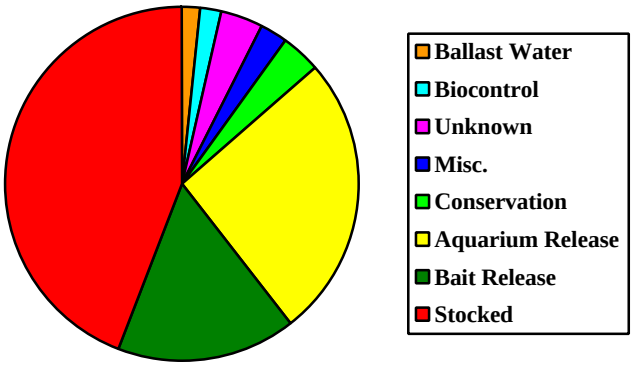

Figure 8. Pathways of fish introductions in the United States (Fuller et al. 1999).

In the Southeast, stocking, bait release and aquarium releases (or escapes from tropical fish farms) are of roughly equal importance (Figure 9). However, the proportion of aquarium releases in the Southeast is heavily skewed by the dominance of this method of introduction in Florida (Figure 10).

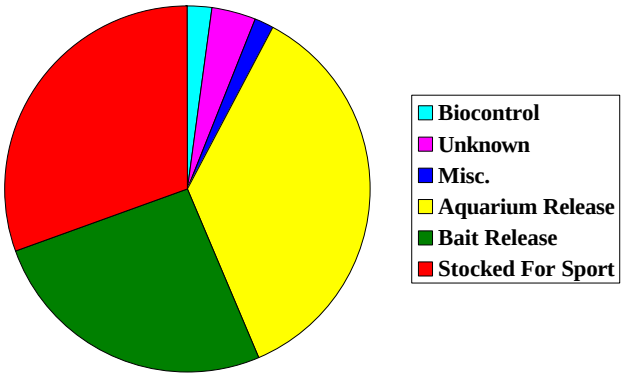

Figure 9. Pathways of fish introductions in the Southeast.

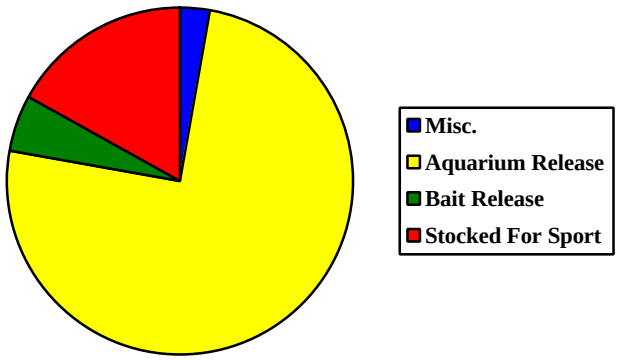

Figure 10. Pathways of fish introductions in Florida.

An analysis of the three main pathways in the Southeast shows that although all three have increased dramatically in strength (Figure 11). This analysis also shows that the dominant pathway has shifted from stocking in the late 1800s and early 1900s, to introductions associated with the aquarium hobby (releases and escapes from tropical fish farms) in recent decades. However, this shift is heavily influenced by the number of aquarium introductions in Florida. If Florida were excluded, stocking would be the dominant pathway in the Southeast just as it is nationwide.

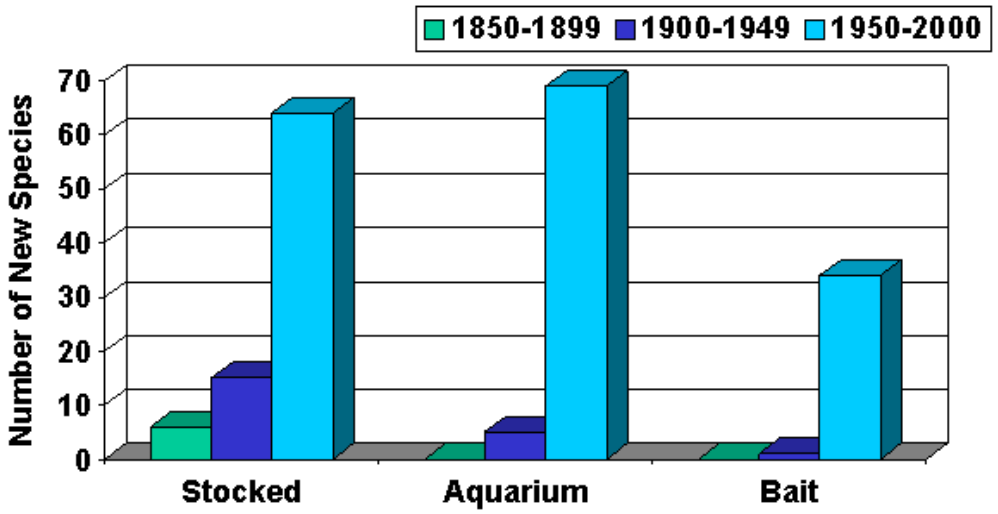

Figure 11. Number of new species introduced via the three major pathways over the course of the last 150 years.

Geographic Origin of the Introduced Species

The majority of species introduced in the Southeast are native to the United States but transplanted outside their native ranges (Figure 12). Included are various species of minnows, sunfishes, bullheads and catfishes, salmon, and darters. Of the exotic species, most are associated with the aquarium trade. South America is the source region that provides the largest number of species to the Southeast. These include several groups of catfishes (Callithyidae, Doradidae, Loricariidae, Pimelodidae),

cichlids, and characins (pacus, piranhas, tetras) from South America. Asia is the next largest contributor to the Southeast, and is the source of the introduced barbs, grass carp *Ctenopharyngodon idella*, bighead carp *Hypophthalmichthys nobilis*, silver carp *H. molitrix*, common carp *Cyprinus carpio*, and Asian swamp eel *Monopterus albus*. Some species belonging to the family Cichlidae, such as the blue tilapia *Oreochromis aureus*, and Mozambique tilapia *O. mossambicus*, have come from Africa. Other cichlid species and species of livebearers such as the mollies, platys, and swordtails originated from Central America. Only a few species have come from Europe, and all were introduced as either sport fish or bait. These include the brown trout (*Salmo trutta*), tench (*Tinca tinca*), and rudd (*Scardinius erythrophthalmus*).

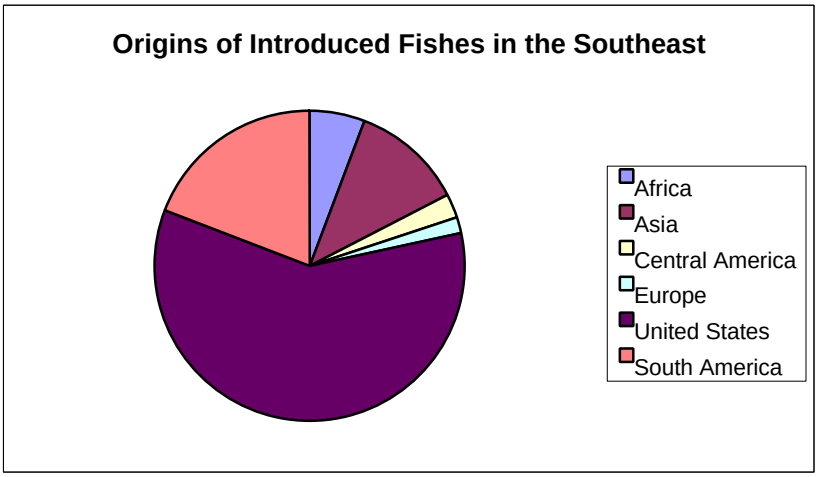

Figure 12. Geographic origin of introduced fishes in the Southeast.

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Figure 13 shows the continental origin of fish species introduced in 50-year increments. Although North America (the United States) has always been the major source of introductions, those from other continents have grown in recent decades.

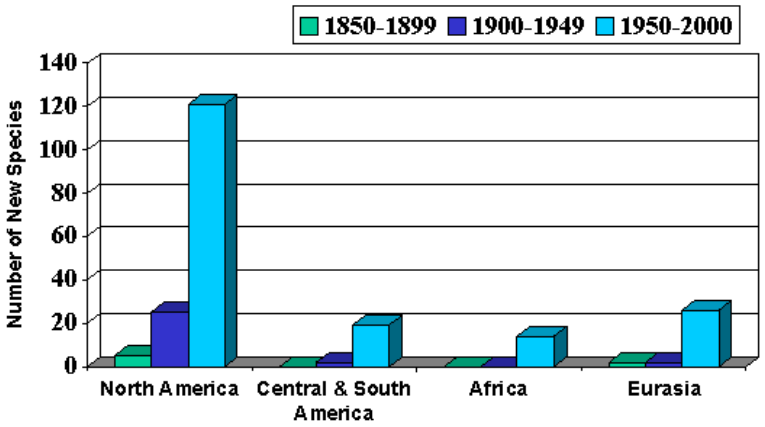


Figure 13. Origins of introduced fish species through time.

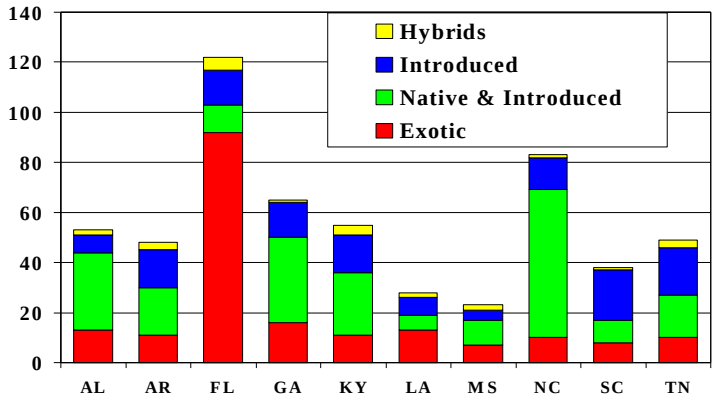


Figure 14. Composition and origin of introduced fishes in southeastern states. Introduced = native to the US, but not to that state; Native and Introduced = native to part of the state, but introduced outside its native range in the state; Exotic - species not native to the US; Hybrids - stocked hybrids (wipers, tiger muskie, etc.)

When the origin of introductions are examined on a state by state basis, the predominant origination varies (Figure 14). As previously mentioned, Florida has a high number of foreign species introduced. These are primarily species from the aquarium trade that either escaped tropical fish farms or were released by hobbyists. North Carolina has a high percentage of species native to the state but moved outside of their native range (usually across the Appalachian Divide). It is believed that this large percentage is the result of numerous bait releases. Georgia has numerous species that have been moved from Atlantic to Gulf Slope drainages or visa versa. Tennessee includes several species stocked from other states. The state also contains the Tennessee and Ohio drainages, each with a unique fauna. Some of these species have been moved between the two drainages. Similarly, the state of Alabama has experienced faunal interchange between the Gulf and Tennessee drainages.

Vulnerable Areas

As a general rule, lakes and reservoirs near metropolitan areas throughout the Southeast are areas vulnerable to introductions. These waters are the most likely to be stocked with sport and forage fish for recreational fishing for nearby city residents. Also, they are the waterbodies most likely to receive unwanted pet and aquarium releases.

Other specific examples of vulnerable areas include:

- Florida - South Florida, Tampa (Figure 15). Most of the tropical fish farms are in the Tampa region. South Florida already harbors a large number of species, and is hospitable to many tropical species because of the climate. These regions are also densely populated with humans, making introductions more likely. South Florida, in particular, is home to a variety of ethnic groups that often import foods of their native homelands. Some of these are sold live in markets and can escape or be released into the wild.

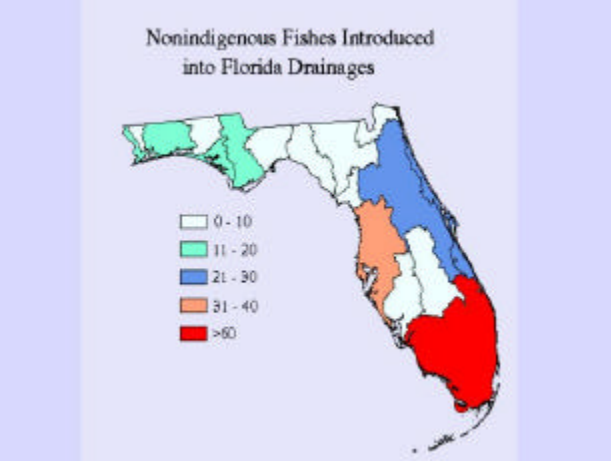


Figure 15. Number of fish species introduced into Florida drainages.

- Georgia - Atlantic slope drainages have gained a number of transplants from across the Appalachian Divide. Reservoirs surrounding the Atlanta area are also vulnerable because of the large human population that makes recreational use of them.
- Kentucky - reservoirs on the Cumberland and Tennessee Rivers
- Tennessee - reservoirs on the Cumberland and Tennessee Rivers
- The Mississippi River acts as a conduit to allow the spread of large-river species such as the bighead, silver, common, and grass carps.

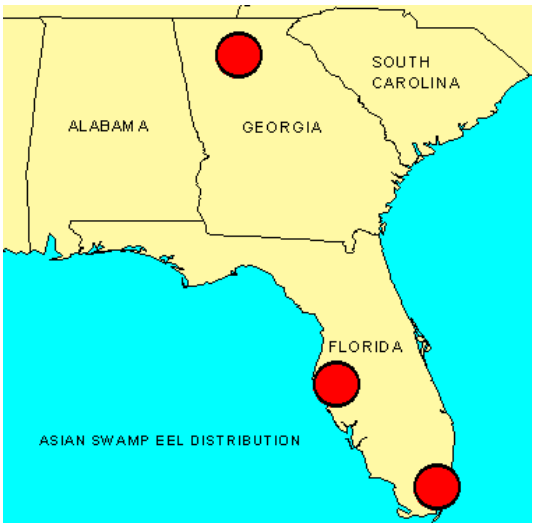
Updates on Recent Introductions

Asian Swamp Eel *Monopterus albus*
This species is native to Asia, from northern India and Burma to China, and perhaps to Asiatic Russia, Japan, the Indo-Malayan Archipelago (Bailey and Gans 1998) and northeastern Australia (Merrick and Schmida 1984). This eel reaches a length of up to 100 cm.


USGS

The Asian swamp eel was first discovered in the Southeast in Georgia. It was first collected in 1996 (although it was likely present since 1990 or before) from three ponds at the Chattahoochee Nature Center in Roswell, Fulton County, Georgia (Starnes et al. 1998). The population in this location was probably the result of an aquarium release. In Florida, the Asian swamp eel occurs in the Miami (three distinct populations) and Tampa (one population) areas (L.G. Nico, unpublished data). One population of particular concern is immediately adjacent to the Everglades National Park. Its introduction into Florida may have resulted from an aquarium release, a fish farm escape or release, or a combination of all of the above (L.G. Nico, personal communication).

The impacts of these eels are largely unknown. Because they are generalized predators, this species is a potential threat to native fishes, frogs, and aquatic invertebrates. Based on sampling in 1996, the Georgia population had apparently eliminated local native sunfishes *Lepomis* species (Starnes et al. 1998). In both Georgia and Florida there is concern that the species will spread to adjacent water bodies. The Georgia impoundments where this eel has been taken are connected to the Chattahoochee River. Although it has not been collected from the Chattahoochee River, its occurrence there would not be surprising because the impoundments have been heavily flooded since the population was discovered there. The Miami populations are in a network of interconnected canals and are expanding their range through these canals.



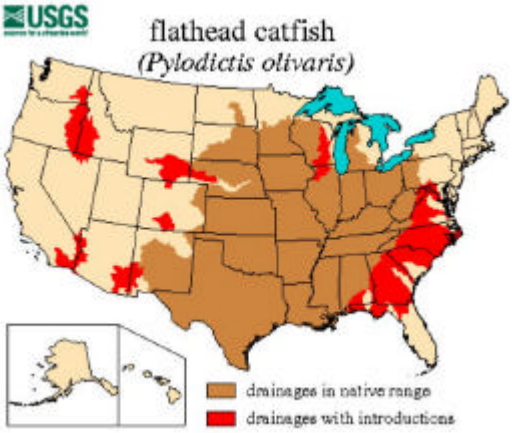
This eel is a capable of living out of water for a considerable length of time (Day 1958). The Georgia population has shown some cold tolerance, as evidenced by having survived air temperatures below freezing and ice cover over the pond they inhabit (Starnes et al. 1998). The distribution, biology, and impacts of Florida populations are being investigated by USGS Florida Caribbean Science Center researchers in conjunction with university biologists.

Flathead catfish *Pylodictis olivaris*

The flathead catfish is native to the Mississippi, Ohio, and the western Gulf drainages. It has been introduced both legally and illegally for sport fishing. The state of Georgia is now trying to control them in the Altamaha River, and has taken an enormous amount of flathead biomass out of the river.

USGS

Biologists have noted that native sunfish, madtoms, and bullheads disappear in areas where the flathead is introduced. This species may also be a factor in the decline of the Gulf sturgeon *Acipenser oxyrhynchus desotoi* through predation on young fish.



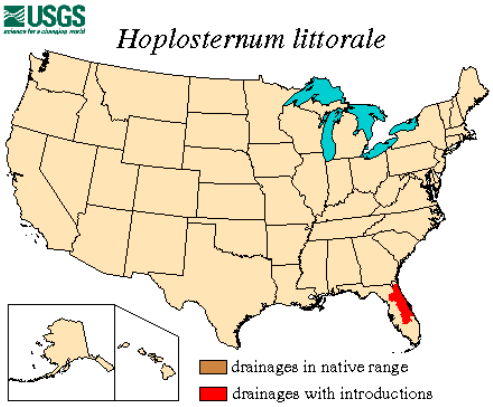
Brown holpo *Hoplosternum littorale*

The brown hoplo is native to tropical America and is widespread in South America east of the Andes and north of Buenos Aires (Reis 1997).

This species is established in peninsular Florida (Nico et al. 1996) and has recently expanded its range into several new drainages within the state (L.G. Nico, unpublished data). The first population was discovered in ditches of the Indian River lagoon system in Florida in late 1995 (Nico et al. 1996). Recently, populations have been found in the St. Johns and Kissimmee River drainages (L. G. Nico, unpublished data). It is unknown how the species was introduced.

USGS

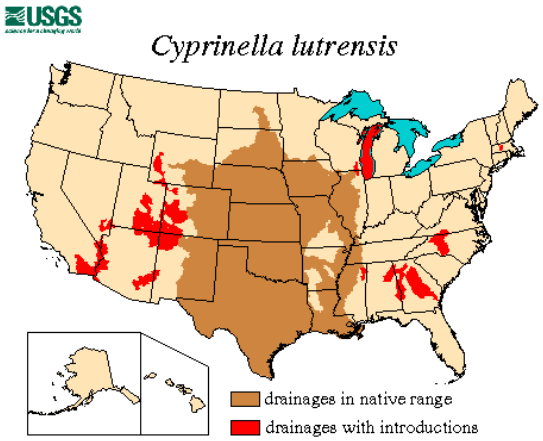
Impacts of this species are largely unknown. In several Florida waterbodies the brown hoplo is locally abundant. Because it feeds heavily on benthic invertebrates and detritus, the species may be causing significant changes in food web structure, negatively impacting native invertebrates, and competing with native fishes for food (L.G. Nico, unpublished data). It is capable of breathing air and can tolerate a wide range of environmental conditions (e.g., fresh and brackish waters). There is concern that it will eventually invade many natural freshwater wetlands, and coastal marshes in Florida (Nico et al. 1996).



The distribution, biology, and impacts of introduced populations in Florida are being investigated by U.S. Geological Survey researchers.

Red shiner *Cyprinella lutrensis*

In degraded streams in Georgia, introduced red shiners have become one of the most abundant species (Devivo and Freeman 1995). The red shiner was discovered in northwest Georgia in the upper Coosa River system in the early 1990s. In the past two years, red shiner populations have significantly increased in density and spatial occurrence. There is particular concern the red shiner may hybridize with the threatened blue shiner *Cyprinella caerulea*; it is already massively hybridizing with the indigenous blacktail shiner *C. venusta* (N. Burkhead, pers. comm.).

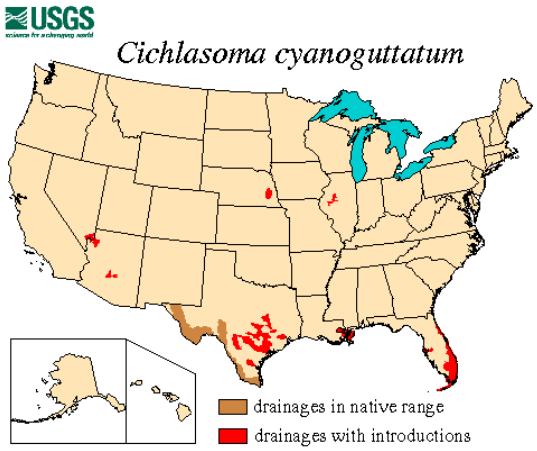


The origin of most introduced red shiner populations can be attributed to bait releases; however, initial introduction is often followed by the species' rapid multiplication, dispersal, and aggressive colonization (e.g., Hubbs and Lagler 1958; Minckley and Deacon 1968; Minckley 1973). The red shiner is very aggressive and where introduced may dilute the gene pools of native *Cyprinella* via hybridization (Mayden 1989). The red shiner is probably hybridizing with the blacktail shiner *C. venusta* in Alabama (Mettee et al. 1996). This species has also affected the distribution and abundance of native fishes in areas in the West where it has been introduced (Holden and Stalnaker 1975b; Moyle 1976a; Deacon 1988; U.S. Fish and Wildlife Service 1990a, 1995).

Rio Grande cichlid *Cichlasoma cyanoguttatum*

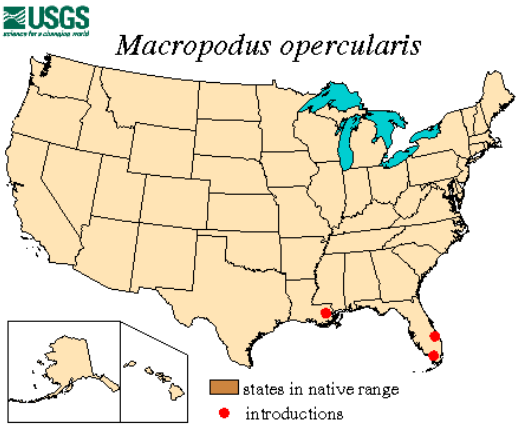
The Rio Grande cichlid is native to northeastern Mexico and southern Texas. It is the only cichlid species native the United States.

In addition to being established in a few areas of Florida, the species was most recently found to be well established in the Lake Pontchartrain area. A single specimen was collected in 1996 and several more in 1997 (R. Cashner, pers. comm.). Since then it has become very common in the area and is spreading.



Paradisefish *Macropodus opercularis*

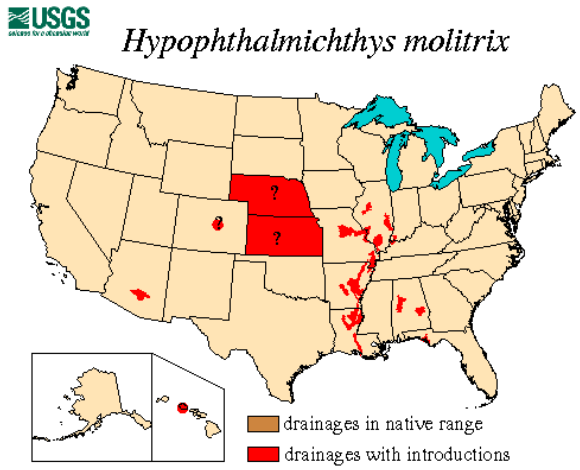
This Asian air-breathing species of gourami is popular in the aquarium trade. It has been collected at least twice in Florida and is rumored to have been reproducing in the Everglades circa 1940. Several specimens were collected from a marsh in Orleans Parish, Louisiana, in 1997. The status of this species in Louisiana is uncertain. Biologists should be on the look-out for this species in that area.

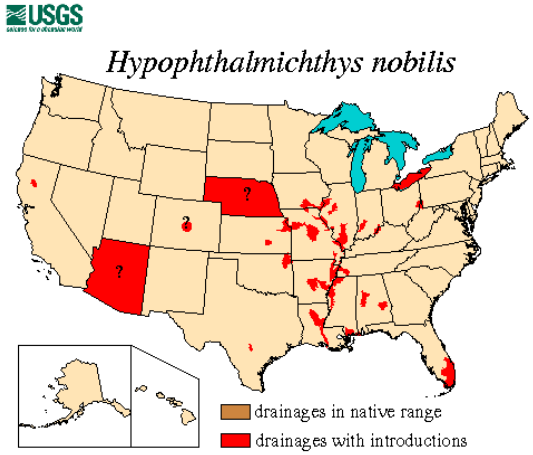


Bighead carp *Hypophthalmichthys nobilis*
Silver carp *H. molitrix*

These two species of Asian carp were originally imported to control algal blooms in aquaculture facilities. Since then they have become established in the wild through stocking and escapes from aquaculture facilities. These species are becoming

increasingly more common in the Mississippi River. There is concern that they may compete with other phytoplankton-feeding fish such as the paddlefish *Polyodon spathula* and native larval fishes.





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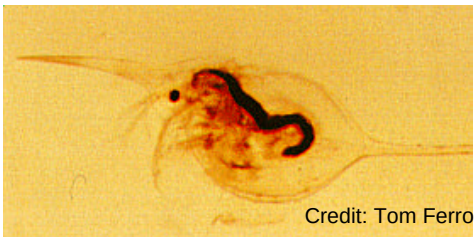
Crustaceans (A. J. Benson)

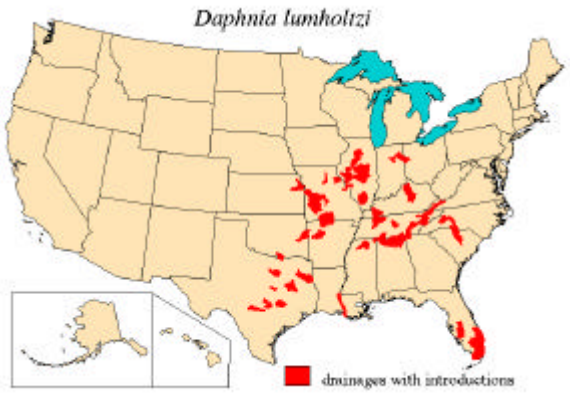
In the Southeast region, there are at least 33 nonindigenous species of crustaceans that have been introduced into freshwater as well as marine ecosystems (Table 1). Freshwater organisms include several species of crayfish, a freshwater prawn, and a daphnia. The marine organisms include barnacles, crabs, shrimps, amphipods, isopods, and tanaids.

Crayfish are the largest contributor of nonindigenous aquatic species in freshwater systems of the Southeast. Ten species have been introduced outside their historical native ranges. The most notable being the red swamp crayfish, *Procambarus clarkii*, which has been introduced in Georgia, North Carolina, South Carolina, and Virginia (Hobbs 1989). It is native to the south-central part of the US. Its introduction is probably the result of either aquaculture escapes or bait bucket releases as are most of the crayfish introductions. Burrowing activities of the red swamp crayfish can cause damage to water control structures such as earthen dams and levees**.** It can also be a pest in rice agriculture. On the positive side, they will feed on snails that often are vectors for human pathogens (Hobbs et al. 1989). Another crayfish that may be of concern is the virile crayfish, *Orconectes virilis*. This species is native to the northern section of the US and has been introduced into Alabama, Mississippi, Tennessee, and Virginia (Hobbs 1989). It may be impacting aquatic macrophytes and displacing native crayfish.


Credit: Tom Ferro

There is one species of daphnia, *Daphnia lumholtzi,* which has spread quickly since its discovery about 1990. It is native to tropical and subtropical freshwater lakes in east Africa, east Australia, and the Asian subcontinent of India (Havel and Hebert 1993). The most distinguishing characteristics of this daphnia are the long helmet and tailspines. The helmet is spine is normally as long as the body length. Other distinct characteristics are the fornices that extend to a sharp point instead of being rounded and the ventral carapace margin, which has approximately 10 prominent spines (Havel and Hebert 1993).

Daphnia lumholtzi has been detected in 56 reservoirs in the southern and mid-western United States. The earliest record is from Texas in 1990 (Havel, pers. comm.). It has since been found in localized waters leading into major river drainages such as the: Arkansas, Cumberland, Illinois, Mississippi, Missouri, South Atlantic-Gulf, Tennessee, and Texas-Gulf. Known occurrences of *D. lumholtzi* in the Southeast are in the following waters: Guntersville Lake (Tennessee River) in Alabama, Lake Dardanelle (Arkansas River) in Arkansas, Lake Okeechobee in Florida, Kentucky Lake (Tennessee River) in Kentucky, Atchafalaya River in



Louisiana, Sardis Lake (Tallahatchie River) in Mississippi, Lake Norman (Catawba River) in North Carolina, Lake Wylie (Catawba River) in South Carolina, and Norris Reservoir (Clinch River) in Tennessee.

It is uncertain how *D. lumholtzi* was introduced into the U.S. It is suspected that it may have been transported with shipments of Nile perch from Lake Victoria in Africa where it is a dominant zooplankter. Nile perch were originally introduced into Texas in 1983 (Havel and Hebert 1993). The continuing discovery of *D. lumholtzi* in new locations could be due to contaminated stockings of fish through international commercial trade. At the same time, the close proximity of affected reservoirs in Missouri and in Texas might lead to the conclusion that *D. lumholtzi* may have spread by recreational fishing and boating from the initially infested reservoirs.

Daphnia lumholtzi is well established and has been collected for several consecutive years in Norris Reservoir, part of the Tennessee River system in Tennessee. Any impacts of this invader are not yet known. Presently, one study indicates it does not appear to be displacing other daphnia in Norris Reservoir (Goulden et al. 1995). However, it could become a dominant zooplankter because of its many tailspines being a deterrent to predators. Stomach samples of fish from Norris Reservoir contained no *D. lumholtzi* (Goulden et al. 1995). It is most likely that *D. lumholtzi* has become a successful invader because of its ability to avoid predation, not because it is a better competitor for the available food supply. Because of its rapid widespread introductions, *D. lumholtzi* may become a dominant zooplankter in the southern U.S. (Havel et al. 1995).

The marine species are more diverse and include six crabs, five shrimps, three barnacles, four isopods, two amphipods, and one tanaid. Nearly all the marine species are foreign to North American waters and were introduced by either ship hull fouling or ballast water dumping (Table 2). Several crabs species were suspected to have arrived in more unusual pathways such as hiding under the bark of cedar trees imported from Mexico, in interstate shipments of seed clams for culturing, and intentional stocking to create a new fishery.

Impacts vary greatly in the marine environment. Barnacles are notorious biofoulers of most any substrate, especially man-made structures such as bridges, docks, seawalls, and industrial water intakes. There is the threat of several diseases with the introduction of nonindigenous shrimp. Shrimp farms in Texas and South Carolina have suffered high mortalities because of one of these diseases known as Taura Syndrome. Fortunately, this disease has not been detected in wild stocks in the U.S. Information on the impacts of some of the smaller organisms like the amphipods and isopods is hard to find or does not exist.

Mammals (A. J. Benson)

The nutria, *Myocastor coypus*, has been a long time resident of the southeast region. This semi-aquatic, beaver-like rodent is established in all of this region's states except for Kentucky and South Carolina. Populations may be on the increase in Alabama, Arkansas, North Carolina and Tennessee. Surprisingly, nutria occur on over one million acres of land managed by the National Wildlife Refuge system (Bounds 2000).

We can assume that much of that land is in this region because nutria occur in only seven other states not in the Southeast. This voracious herbivore is capable of causing extensive damage to native wetland plants, reducing food and cover for migratory waterfowl, degrading water quality, displacing muskrat populations, and encouraging the spread of purple loosestrife (Bounds 2000).

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Hobbs, H. H. III, J. P. Jass, and J. V. Huner. 1989. A review of global crayfish introductions with particular emphasis on two North American species (Decapoda, Cambaridae). Crustaceana 56(3):299-316.

Table 1. Crustaceans introduced into states with U.S. Fish and Wildlife Service Region 4.

SPECIES NAME	AL	AR	FL	GA	KY	LA	MS	NC	PR	SC	TN
Balanus amphitrite (striped barnacle) marine			x								
Balanus reticulatus (a barnacle) marine			x								
Balanus trigonus (a barnacle) marine			x								
Charybdis hellerii (an Indo-Pacific crab) marine			x								
Eriocheir sinensis (Chinese mitten crab) marine						x					
Hemigrapsus sanquineus (Japanese shore crab) marine								x			
Petrolisthes armatus (green porcelain crab) marine			x							x	
Platychirograpsus spectabilis (saber crab) marine			x								
Scylla serrata (serrate swimming crab) marine			x								
Macrobrachium olfersi (bristled river shrimp) marine			x								
Macrobrachium rosenbergii (freshwater prawn)									x		
Palaemon africanus (African prawn) marine			x								
Penaeus monodon (Asian tiger shrimp) marine			x	x						x	
Penaeus stylirostris (blue shrimp) marine										x	
Penaeus vannamei (Pacific white shrimp) marine										x	
Ligia exotica (an isopod) marine			x								
Sphaeroma terebrans (an isopod) marine			x								
Sphaeroma walkeri (an isopod) marine			x								
Synidotea laticauda (an isopod) marine										x	
Chelura terebrans (an amphipod) marine			x								
Corophium lacustre (an amphipod) marine			x								x
Zeuxo maledivensis (a tanaid) marine			x								
Cambarellus shufeldtii (Cajun dwarf crayfish)				x							
Cambarus cumberlandensis (a crayfish)											x
Cambarus longirostris (a crayfish)										x	
Cherax quadricarinatus (Australian redclaw crayfish)									x		
Faxonella clypeata (ditch fencing crayfish)				x							
Orconectes placidus (a crayfish)				x							x
Orconectes virilis (virile crayfish)	x						x	x			x
Procambarus acutus (white river crawfish)				x							
Procambarus clarkii (red swamp crayfish)			x	x				x		x	
Procambarus seminolae (a crayfish)				x							
Daphnia lumholtzi (a daphnia)	x	x	x		x	x	x	x		x	x

Table 2. Year first documented, origin, pathway of introduction, and status of crustaceans introduced into states in Region 4.

SPECIES NAME	YEAR FIRST DOCUMENTED	ORIGIN	PATHWAY OF INTRODUCTION	STATUS
Balanus amphitrite (striped barnacle) marine	1940s	Indo-Pacific	Ship hull fouling	Established
Balanus reticulatus (a barnacle) marine	1979*	Western Pacific	Ship hull fouling	Established
Balanus trigonus (a barnacle) marine	1992*	Western Pacific	Ship hull fouling	Established
Charybdis hellerii (an Indo-Pacific crab) marine	1995	Indo-Pacific	Ballast water	Established
Eriocheir sinensis (Chinese mitten crab) marine	1987	Western Pacific	Ballast water	Not Established
Hemigrapsus sanquineus (Japanese shore crab) marine	1995	Western Pacific	Ballast water ?	Established ?
Petrolisthes armatus (green porcelain crab) marine	1975	Atlantic	In shipments of seed clams for culture ?	Established
Platychirograpsus spectabilis (saber crab) marine	1936	Western Gulf of Mexico	Contaminated imported cedar logs	Established
Scylla serrata (serrate swimming crab) marine	1995	Southwestern Pacific	Stocked for commercial fishery	Not established
Macrobrachium olfersi (bristled river shrimp) marine	1933	Atlantic	Intentional release	Not established
Macrobrachium rosenbergii (freshwater prawn)	2001*	Asia	Aquaculture escapes ?	Established ?
Palaemon africanus (African prawn) marine	1995	Eastern Atlantic	Intentional release	Not established
Penaeus monodon (Asian tiger shrimp) marine	1988	Western Pacific	Aquaculture escapes	Not established
Penaeus stylirostris (blue shrimp) marine	1997	Southern Atlantic	Aquaculture escapes	Not established
Penaeus vannamei (Pacific white shrimp) marine	1986	Southeastern Pacific	Aquaculture escapes	Not established
Ligia exotica (an isopod) marine	1936*	Eastern Atlantic	Ship hull fouling	Unknown
Sphaeroma terebrans (an isopod) marine	1897*	Indian	Ship hull fouling	Established
Sphaeroma walkeri (an isopod) marine	1968*	Indian	Ship hull fouling	Established
Synidotea laticauda (an isopod) marine	1998	Pacific	Ship hull fouling	Established
Chelura terebrans (an amphipod) marine	1973*	Atlantic	Ship hull fouling	Unknown
Corophium lacustre (an amphipod) marine	1988	Eastern Atlantic	Ballast water ?	Established
Zeuxo maledivensis (a tanaid) marine	1981*	Pacific	Ship hull fouling	Unknown
Cambarellus shufeldtii (Cajun dwarf crayfish)	1942*	So. Mississippi R. Basin	Bait bucket release ?	Unknown
Cambarus cumberlandensis (a crayfish)	1989*	Cumberland River Basin	Bait bucket release ?	Unknown
Cambarus longirostris (a crayfish)	1989*	Tennessee River Basin	Bait bucket release ?	Unknown
Cherax quadricarinatus (Australian redclaw crayfish)	1998	Australia	Aquaculture escapes	Established
Faxonella clypeata (ditch fencing crayfish)	1942*	Southern US	Bait bucket release ?	Unknown
Orconectes placidus (a crayfish)	1976*	Tennessee River Basin ?	Bait bucket release ?	Unknown
Orconectes virilis (virile crayfish)	1989*	Northern US	Bait bucket release ?	Unknown
Procambarus acutus (white river crawfish)	1938	Southeast US	Bait bucket release ?	Unknown
Procambarus clarkii (red swamp crayfish)	1989*	Southcentral US	Aquaculture escape ?	Unknown
Procambarus seminolae (a crayfish)	1981	Southeast US ?	Bait bucket release ?	Unknown
Daphnia lumholtzi (a daphnia)	1991	Africa, Australia	Shipping water of stocked gamefish ?	Established

* Year represents publication date of the source document when the year of the actual introduction was unknown.

Mollusks (A. J. Benson)

There have been at least 22 species of mollusks introduced into the southeast region including bivalves (clams, mussels) and gastropods (snails, nudibranchs)(Table 3). Of these 22 species, one-half are freshwater inhabitants and the other half marine. Many of these introduced species are established and have spread to surrounding waters while others have failed to establish populations for one reason or another. Florida leads the other states in the region with 20 species of nonindigenous mollusks. The probability of species becoming established in Florida over the states could be attributed to its climate, abundance of water, and many ports of entry. A majority of Florida's nonindigenous mollusks would not be expected to survive elsewhere in the Southeast because of habitat requirements such as temperature for example.

Although for many species the pathway of the introduction cannot be precisely documented, it can be assumed for most species based on life history traits or known anthropogenic movements (Table 4). Most of the marine species are introduced by either ship hull fouling or ballast water dumping. The freshwater species, particularly the snails, have been introduced through the aquarium trade where they have been sold in retail pet stores for years. No other vectors have been documented to show a large importation of freshwater snails to this country. Therefore, the assumption has been made that the majority of freshwater snails were initially introduced by the aquarium trade and the subsequent release of unwanted specimens. Other human and natural vectors have since taken over to distribute them further. Of all the introduced mollusks, freshwater snails may be the greatest threat to biodiversity because of their ability to denude vegetation, displace native snails, and act as intermediate hosts for trematode parasites that can infect humans.

The following section gives a brief description of some selected organisms.

Bivalves

***Corbicula fluminea* (Müller, 1774) Asian clam**

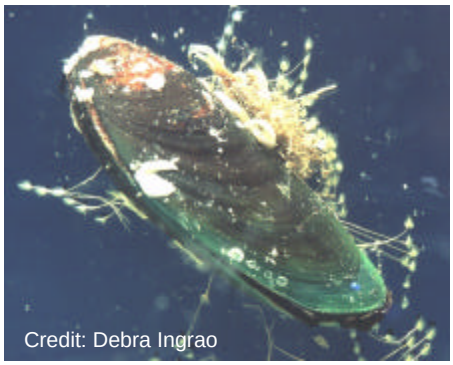
Since the introduction of *Corbicula fluminea* to the United States in 1938 in the Pacific Northwest, this species has spread into many of the major waterways across the country. The Asian clam has become established in all of the states in Region 4 including most recently, Puerto Rico. Corbicula are so widespread in Alabama, Arkansas, Florida**,** Georgia, Kentucky, and Mississippi that specimens can be found in most counties. In the other states, the distribution is more limited such as in Louisiana (Pearl, Atchafalaya, Mississippi, and upper Red drainages), North Carolina (Cape Fear, Catawba, Chowan, Eden, Little,

Meherrin, Neuse, Roanoke, Rocky, Tar, Uhwarrie and Waccamaw rivers and Richardsons Creek), South Carolina (Savannah, Cooper, Santee, Pee Dee, Little Pee Dee, Edisto, Waccamaw, and Salkahatchie rivers; the Intracoastal waterway; and several industrial facilities in Aiken and Pickens counties), and Tennessee (Tennessee drainage). Possible pathways of introduction include the bilge waters of pleasure boats, fishing bait, or aquarium hobbyists releases, waterfowl and dredging activity.

Impacts in man-made system include the restriction of water flow in power plants, water treatment facilities, and irrigation systems. In natural systems, high densities of Corbicula most likely stress native benthic communities through competition for food and space. Corbicula is a prey species for some fish and waterfowl, but not significant enough to control populations.

***Perna viridis* (Linnaeus, 1758) green mussel (MARINE)**

The green mussel is a native of tropical marine waters of the Indo-Pacific region surrounding the continent of Asia. It was discovered inside water intake tunnels by power plant workers in the Tampa, Florida area in 1999. This mussel can grow to about six inches, making it a potentially serious biofouler in made-made systems as well as natural systems. Its range in Florida extends from Tampa Bay southward to Charlotte Harbor. The green mussel was probably a ballast water introduction from the Caribbean region where green mussels arrived there in the early 1990s.


Credit: Debra Ingrao

Gastropods

***Pomacea bridgesi* (Reeve, 1856) spiketop applesnail**

Another native of South America, the spiketop applesnail was introduced into southern Florida where is also established probably as the result of unwanted aquarium animals. The significant impact of this introduction is that is may be displacing the native *Pomacea paludosa*, a primary food of the rare Everglades kite (Hale 1964).

***Pomacea canaliculata* (Lamarck, 1822) channeled applesnail**

The channeled applesnail is native to South America and was introduced to Florida again as the probable result of unwanted aquarium animals.


USGS

***Pomacea paludosa* (Say, 1829) Florida applesnail**
This species of applesnail is native to Florida and Cuba. It has been reported from single localities in both Georgia and Alabama.


USGS

***Marisa cornuarietis* (Linnaeus, 1758) giant rams-horn snail**
A native of South and Central Americas, this freshwater snail has been introduced into many canals in southern Florida where it is established. It is a probable aquarium release. Impacts include the ability to completely denude vegetated areas and negatively interact with native snails through competition and direct predation of eggs and young (Hunt, 1958). It is not a host for trematodes, which can later infect humans or animals.


USGS

***Melanoides tuberculatus* (Müller, 1774) red-rim melania**
The red-rim melania is native to subtropical and tropical regions in Africa, Asia, and Australia. It is now distributed nearly statewide in Florida possibly due to aquarium releases. Densities reached 10,000/m2 in the St. Johns River in 1976 (Thompson 1984). Populations were also discovered in New Orleans (Dundee and Paine, 1977). This species of snail is capable of replacing native species and can be a vector for human parasites.


USGS

***Tarebia granifera* (Lamarck, 1758) quilted melania**
The quilted melania is native from India to eastern Asia, Japan, and Hawaii. It is established in Florida waters near Tampa and Miami most likely from discarded aquarium animals. Abbott (1950) reported densities of 400/m2 in one spring. This species can serve as an intermediate host for trematode parasites that can eventually infect humans.

***Cipangopaludina chinensis* (Reeve, 1863) Chinese mysterysnail**
The Chinese mysterysnail is native in much of eastern Asia. It has been introduced into several locations in Florida, North Carolina, and South Carolina. Again, this was probably another aquarium introduction. This species could be a vector for some human infections.


USGS

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Thompson, F.G. 1984. The freshwater snails of Florida. A manual for identification. The University of Florida Press. Gainesville. 93 pp.

Table 3. Mollusks introduced into states with U.S. Fish and Wildlife Service Region 4.

SPECIES NAME	AL	AR	FL	GA	KY	LA	MS	NC	PR	SC	TN
Cuthona perca (Lake Merritt cuthona) marine			X								
Ercolania fuscovittata (a nudibranch) marine			X								
Mytella charruana (charru mussel) marine			X								
Perna viridis (green mussel) marine			X								
Tridacna crocea (a giant clam) marine			X								
Tridacna maxima (a giant clam) marine			X								
Lyrodus medilobatus (an Indo-Pacific shipworm) marine			X								
Pinctada margaritifera (black-lipped pearl oyster) marine			X								
Myosotella myosotis (marsh snail) estuarine			X								
Mytilopsis leucophaeta (dark false mussel) estuarine	X		X		X						X
Rangia cuneata (Atlantic rangia) estuarine			X								
Corbicula fluminea (Asian clam)	X	X	X	X	X	X	X	X	X	X	X
Biomphalaria glabrata (bloodfluke planorb)			X								
Cipangopaludina chinensis (Chinese mysterysnail)			X					X		X	
Marisa cornuarietis (giant rams-horn snail)			X								
Melanoides tuberculatus (red-rim melania)			X			X					
Melanoides turriculus (fawn melania)			X								
Tarebia granifera (quilted melania)			X						X		
Pomacea bridgesi (spiketop applesnail)			X								
Pomacea cumingii (an applesnail)									X		
Pomacea paludosa (Florida applesnail)			X	X							
Radix auricularia (big-ear radix)					X						

Table 4. Year first documented, origin, pathway of introduction, and status of crustaceans introduced into states in Region 4.

SPECIES NAME	YEAR FIRST DOCUMENTED	ORIGIN	PATHWAY OF INTRODUCTION	STATUS
Balanus amphitrite (striped barnacle) marine	1940s	Indo-Pacific	Ship hull fouling	Established
Balanus reticulatus (a barnacle) marine	1979*	Western Pacific	Ship hull fouling	Established
Balanus trigonus (a barnacle) marine	1992*	Western Pacific	Ship hull fouling	Established
Charybdis hellerii (an Indo-Pacific crab) marine	1995	Indo-Pacific	Ballast water	Established
Eriocheir sinensis (Chinese mitten crab) marine	1987	Western Pacific	Ballast water	Not Established
Hemigrapsus sanquineus (Japanese shore crab) marine	1995	Western Pacific	Ballast water ?	Established ?
Petrolisthes armatus (green porcelain crab) marine	1975	Atlantic	In shipments of seed clams for culture ?	Established
Platychirograpsus spectabilis (saber crab) marine	1936	Western Gulf of Mexico	Contaminated imported cedar logs	Established
Scylla serrata (serrate swimming crab) marine	1995	Southwestern Pacific	Stocked for commercial fishery	Not established
Macrobrachium olfersi (bristled river shrimp) marine	1933	Atlantic	Intentional release	Not established
Macrobrachium rosenbergii (freshwater prawn)	2001*	Asia	Aquaculture escapes ?	Established ?
Palaemon africanus (African prawn) marine	1995	Eastern Atlantic	Intentional release	Not established
Penaeus monodon (Asian tiger shrimp) marine	1988	Western Pacific	Aquaculture escapes	Not established
Penaeus stylirostris (blue shrimp) marine	1997	Southern Atlantic	Aquaculture escapes	Not established
Penaeus vannamei (Pacific white shrimp) marine	1986	Southeastern Pacific	Aquaculture escapes	Not established
Ligia exotica (an isopod) marine	1936*	Eastern Atlantic	Ship hull fouling	Unknown
Sphaeroma terebrans (an isopod) marine	1897*	Indian	Ship hull fouling	Established
Sphaeroma walkeri (an isopod) marine	1968*	Indian	Ship hull fouling	Established
Synidotea laticauda (an isopod) marine	1998	Pacific	Ship hull fouling	Established
Chelura terebrans (an amphipod) marine	1973*	Atlantic	Ship hull fouling	Unknown
Corophium lacustre (an amphipod) marine	1988	Eastern Atlantic	Ballast water ?	Established
Zeuxo maledivensis (a tanaid) marine	1981*	Pacific	Ship hull fouling	Unknown
Cambarellus shufeldtii (Cajun dwarf crayfish)	1942*	So. Mississippi R. Basin	Bait bucket release ?	Unknown
Cambarus cumberlandensis (a crayfish)	1989*	Cumberland River Basin	Bait bucket release ?	Unknown
Cambarus longirostris (a crayfish)	1989*	Tennessee River Basin	Bait bucket release ?	Unknown
Cherax quadricarinatus (Australian redclaw crayfish)	1998	Australia	Aquaculture escapes	Established
Faxonella clypeata (ditch fencing crayfish)	1942*	Southern US	Bait bucket release ?	Unknown
Orconectes placidus (a crayfish)	1976*	Tennessee River Basin ?	Bait bucket release ?	Unknown
Orconectes virilis (virile crayfish)	1989*	Northern US	Bait bucket release ?	Unknown
Procambarus acutus (white river crawfish)	1938	Southeast US	Bait bucket release ?	Unknown
Procambarus clarkii (red swamp crayfish)	1989*	Southcentral US	Aquaculture escape ?	Unknown
Procambarus seminolae (a crayfish)	1981	Southeast US ?	Bait bucket release ?	Unknown
Daphnia lumholtzi (a daphnia)	1991	Africa, Australia	Shipping water of stocked gamefish ?	Established

Vascular Plants (C. C. Jacono)

Nonindigenous aquatic plants often act as stressors of aquatic ecosystems. Many form large colonies that alter the abundance and diversity of the native flora or disturb physical and biological functions such as water flow, light penetration and dissolved oxygen content. Although not all introduced aquatic plants share these extreme abilities, the consequences of most introductions have yet to be understood. Fundamentally, the establishment of nonindigenous plants preempts habitat for native species. As new taxa are introduced and the range of previously established species increases, detailed knowledge of their distribution and potential range is imperative for resource management.

The following summary provides an inventory of all freshwater aquatic vascular plants that have become established (i.e. naturalized) in the southeastern Region 4. It provides specific information on regional species included in the Nonindigenous Aquatic Species (NAS) database (http://nas.er.usgs.gov/plants), an online inventory developed for tracking introductions in the United States.

This report, like the NAS database, is based on occurrence data derived from monitoring programs, herbarium vouchers, published accounts and professional observations. The geographic distribution of many of the species is only superficially understood, mainly due to significant gaps in plant collection and monitoring data. Any increase in the collection and provision of spatial data would promote a better determination of the geographic coverage of aquatic plant introductions at both regional and national levels.

USFWS Region 4 is defined by hundreds of drainages categorized under the USGS Hydrologic Unit Code level 8 (HUC 8). In this report HUC 8 drainage names are commonly used to describe distribution. Temperate species from Europe and cooler Asian climates define the majority of introduced species in Kentucky, Tennessee and the Southern Appalachians. The more southerly states host a wider variety of plants, the majority being of subtropical and tropical origin. Many of these species are found to perenniate in the warm temperate zones of Georgia, Arkansas and North Carolina.

In this report, 60 vascular freshwater plants species, representing 29 families are catalogued as introduced in Region 4. The number of taxa would be much higher if the inventory were not restricted to true aquatics, i.e. those plants that grow with some of their photosynthetic portions submerged or floating in water.

All species considered not indigenous to the region are included. A few taxa, namely *Marsilea vestita* and *Nymphaea mexicana*, are native to other parts of North America. Geographic distributions differ greatly from species such as *Limnophila indica,* that have a limited occurrence in Region 4, to broadly ranging species like *Hydrilla verticillata*. New, potentially weedy plants such as *Salvinia molesta*, *Marsilea minuta,* and *Nymphoides hydrophyllum* are highlighted for Region 4, to assist resource managers with early detection. Well-established species such as *Najas minor*, *Egeria densa* and *Murdannia keisak* also merit attention for their potential to inhabit new regions.

This report is contained in three sections. Section 1 is a matrix listing all nonindigeous aquatic plant species recorded in ten states of Region 4.

Section 2 is of a list of plants known from USFWS refuges in Region 4. The species name is followed by the earliest date of known occurrence.

Section 3 provides the earliest records of plant species occurring in each state, along with origin notes, distribution summaries, and pertinent comments on individual species.

The early occurrence records provided in Section 3 fall into three categories. The categories are depicted in bold type, standard type, or standard type with an asterisk. Dates in bold type indicate the verified first occurrence of a species in a state. When an occurrence is not verified to be the first, standard type is used to indicate the earliest record known to the author. Standard type followed by an asterisk (i.e. 1986*) is used for literature citations, which document the earliest occurrence record known to the author, but do not represent a collection date.

Additional records of nonindigenous species from refuge or other lands and waters are welcomed at: http://nas.er.usgs.gov/reportcol.htm. Contact Colette_Jacono@usgs.gov for identification or verification of plant material.

Section 1. Nonindigenous Aquatic Plant Species in States of Region 4.

			AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
Acanthaceae	*Hygrophila*	*polysperma*			X							
Alismataceae	*Sagittaria*	*guyanensis*						X				
		montevidensis	X		X	X				X	X	
Amaranthaceae	*Alternanthera*	*philoxeroides*	X	X	X	X	X	X	X	X	X	X
Araceae	*Colocasia*	*esculenta*	X		X	X		X	X		?	
	Cryptocoryne	*wendtii*			X							
	Pistia	*stratiotes*			X			X	X		X	
Brassicaceae	*Nasturtium*	*officinale*	X	X	X	X	X	X	X	X	X	X
Butomaceae	*Hydrocleys*	*nymphoides*			X							
Callitrichaceae	*Callitriche*	*stagnalis*	X									X
Commelinaceae	*Murdannia*	*keisak*	X	X	X	X	X	X	X	X	X	X
Convolvulaceae	*Ipomoea*	*aquatica*			X							
Cyperaceae	*Cyperus*	*alopecuroides*			X							
		prolifer			X							
Haloragaceae	*Myriophyllum*	*aquaticum*	X	X	X	X	X	X	X	X	X	X
		spicatum	X	X	X	X	X	X	X	X	X	X
Hydrocharitaceae	*Blyxa*	*aubertii*						X				
	Egeria	*densa*	X	X	X	X	X	X	X	X	X	X
	Hydrilla	*verticillata*	X		X	X		X	X	X	X	X
	Ottelia	*alismoides*						X				
Iridaceae	*Iris*	*pseudacorus*	X	X	X	X	X	X		X		X
Lemnaceae	*Landoltia*	*punctata*	X	X	X	X	X	X	X	X	X	X
Lythraceae	*Lythrum*	*salicaria*	X	X			X		X	X		X
	Rotala	*indica*						X				
Marsileaceae	*Marsilea*	*ancylopoda*			X							
		hirsuta			X							
		macropoda	X		X			X				
		vestita			X							
		minuta			X	X						
		quadrifolia					X					
Menyanthaceae	*Nymphoides*	*hydrophyllum*			X							
		indica			X							
		peltata		X			X		X			
Najadaceae	*Najas*	*minor*	X	X	X	X	X	X	X	X	X	X
Nelumbonaceae	*Nelumbo*	*nucifera*	X	X	X	X		X	X	X	X	X
Nymphaeaceae	*Nymphaea*	*X daubeniana*			X							
		ampla			X							
		blanda			X							
		capensis			X							
		jamesoniana			X							
		lotus			X			X				
		mexicana								X	X	
Onagraceae	*Ludwigia*	*hexapetala*	X	X	X	X	X	X	X	X	X	X
Parkeriaceae	*Ceratopteris*	*thalictroides*			X			X				

Section 1. (continued)

			AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
Poaceae	*Brachiaria*	*mutica*			X						?	
	Hymenachne	*amplexicaulus*			X							
	Luziola	*peruviana*			X			X				
	Oryza	*sativa*						X		X	X	
	Panicum	*repens*	X		X			X	X	X	X	
Pontederiaceae	*Eichhornia*	*crassipes*	X	X	X	X	X	X	X	X	X	X
Potamogetonaceae	*Potamogeton*	*crispus*	X	X	X	X	X	X	X	X	X	X
Salviniaceae	*Salvinia*	*minima*	X	X	X	X		X	X		X	
		molesta	X		X	X		X	X	X		
Scrophulariaceae	*Bacopa*	*egensis*						X				
	Dopatrium	*junceum*						X				
	Limnophila	*indica*			X	X						
		x ludoviciana						X				
		sessiliflora			X	X						
Solanaceae	*Solanum*	*tampicense*			X							
Total # species			22	16	46	21	15	31	20	20	19	16

Section 2. Nonindigenous Aquatic Plant Species at Region 4 Refuges

AL	Weeks Bay National Estuarine Research Reserve	**Salvinia minima**	2000
AR	Ouachita National Forest, Lake Ouachita	*Myriophyllum spicatum*	1997
FL	Dry Tortugus National Park, Bush Key	*Alternanthera philoxeroides*	1977
FL	Ocala National Forest, branch of Juniper Creek	*Salvinia minima*	1982
FL	Ocala National Forest, toward east central boundary	*Salvinia minima*	1957
FL	Osceola National Forest, ditch at boundary	*Salvinia minima*	1999
GA	Piedmont National Wildlife Refuge	*Hydrilla verticillata*	1997
LA	Cameron Prairie National Wildlife Refuge	*Hydrilla verticillata*	1997
LA	Cameron Prairie National Wildlife Refuge	*Salvinia minima*	1998
LA	Delta National Wildlife Refuge, Goose Pond	*Potamogeton crispus*	1965
LA	Jean Lafitte National Historic Park	*Salvinia minima*	1997
LA	Kisatchie National Forest, Saline Lake	*Eichhornia crassipes*	1996
LA	Lacassine Bayou, Lacassine National Wildlife Refuge	*Salvinia minima*	1999
LA	Lacassine National Wildlife Refuge	*Landoltia punctata*	1983
LA	Lacassine National Wildlife Refuge	*Eichhornia crassipes*	1946
LA	Lacassine National Wildlife Refuge	*Ottellia alismoides*	1974
LA	Lacassine National Wildlife Refuge	*Pistia stratiotes*	1974
LA	Lacassine National Wildlife Refuge	*Alternanthera philoxeroides*	1959
LA	Lafitte National Historic Park and Preserve	*Salvinia minima*	1999
MS	Tombigbee National Forest, Davis Lake	*Myriophyllum spicatum*	1979
MS	Tombigbee National Forest, Davis Lake	*Potamogeton crispus*	1979
SC	Savannah National Wildlife Refuge, Pool 7	*Najas minor*	1969
TN	Busseltown Unit Tennessee National Wildlife Refuge	*Lythrum salicaria*	1987
TN	Cross Creeks National Wildlife Refuge, Cumberland River	*Najas minor*	1991
TN	Cross Creeks National Wildlife Refuge, Cumberland River	*Nasturtium officinale*	1991

Section 3. Summary of Nonindigenous Aquatic Plants in Region 4.

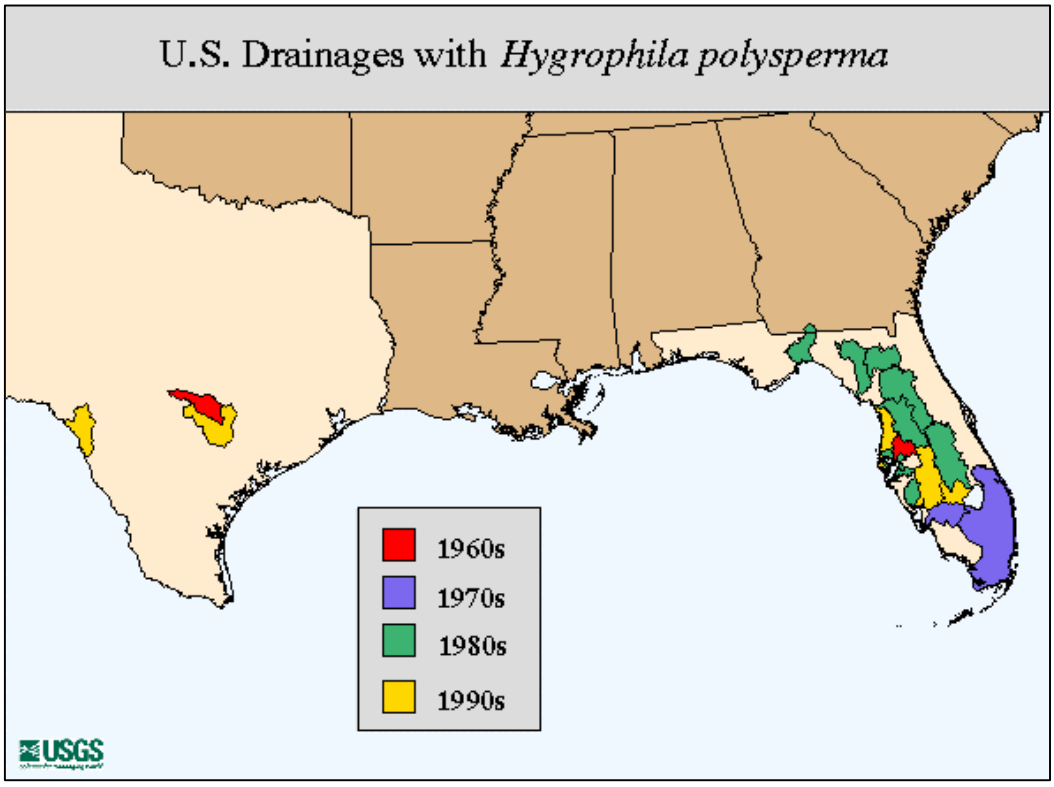
Acanthaceae

***Hygrophila polysperma* - Indian hygrophila** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1965							

Comments:

Highly invasive. Ranging through peninsular to northern Florida at more than 40 locales, including 22 flowing rivers and streams. Most southern parts of Region 4, mainly Gulf and Atlantic Coastal Plains, potentially vulnerable. Recognize by opposite, elliptical leaves, sessile to the stem. Submersed stems round, terrestrial becoming more square.



Alismataceae

***Sagittaria guyanensis* - Guyana arrow-head** South & Central America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1993*				

Comments:

Collected from rice fields of south central Louisiana; likely not of concern.

***Sagittaria montevidensis* - long-lobed arrow-head** South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1968*		1977	1939				1968*	1968*	

Comments:

Older, sporadic collections near seaports may not represent persisting populations. However, presence in the water-garden industry could serve as an introduction source for more recent and future populations. Plants to 1m high.

Amaranthaceae

***Alternanthera philoxeroides* - alligatorweed** South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1897	1988*	**1894**	1965	**1986**	1946	**1949**	**1967**	1957	**1975**

Comments:

Long established yet still expanding in range; new to western Kentucky in 1986 and Oklahoma in 1996. Invasive in aquatic and wetland habitats. Forming floating tangles of hollow stems in streams, marshes, and lakes. Perenniates vegetatively; rarely reproduces by seed. Northern distribution mainly limited by cold tolerance of herbaceous above ground parts.

Araceae

***Colocasia esculenta* - wild taro** Asia Tropics

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1981		**1958**	1985		1986	1994		?	

Comments:

Emergent aquatic and semi-aquatic with wide ecological amplitude in respects to habitat. Increasing in Gulf Coast regions to northern Louisiana, lower halves of Mississippi, Alabama and Georgia. Rapid colonization throughout Florida since the late 1950s and early 1960s. Three varieties newly described in the southeast; characterized by tubers, rhizomes and habitat. *Colocasia is* often confused with other non-natives aroids, namely *Alocasia* and *Xanthosoma* (Serviss *et al.* 2000). Reproduction vegetative, rarely by seed. Poisonous calcium oxylate crystals deposited throughout the plant, especially in tubers.

***Cryptocoryne wendtii* - water-trumpet** Asia Tropics - Sri Lanka

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1989							

Comments:

Rooted rosettes, submersed and locally abundant on limestone and organic substrate at high flow spring in Florida. Dense colony expanding by rhizomes at that site; habitat similar to that of the closely related and similarly introduced *Cryptocoryne beckettii,* in ripples and pools of spring fed San Marcos River, Texas (Rosen 2000). Popular aquarium plant; likely expanding from cultivation.

Cryptocoryne wendtii submersed in Florida.

***Pistia stratiotes* - water-lettuce** Pan tropical

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1765			1969	**1999**		**1991**	

Comments:

Free floating, velvety rosettes; prolific grower. Absence of indigenous, host specific insects indicates *Pisita* as introduced to the U.S. (Dray et al. 1993); introduction by birds has not been discounted. Range recently expanding to include Mississippi, persisting there along a creek in Madison Co., (Middle Pearl-Strong River drainage); also persisting in eastern South Carolina along the Waccama River. Frost intolerant; sexual reproduction important for the dynamics of some populations in the Netherlands, Australia, and Florida (Harley 1990, Dray and Center 1989); seeds survived prolonged experimental periods in water at 4C and a few weeks in ice at –5^{o}C; germination occurred between 20^{o}C and 25^{o}C (Pieterse 1981). With appropriate substrate and

hydrologic conditions, overwintering by seed could account for population reoccurrence in temperate regions of the U.S.; seedlings are light green and pubescent.

Pistia stratiotes: mature plant (left); flowering spathe (center), seedlings with *Wolffia* and *Lemna* (right, seedling photo courtesy T. Center, USDA, ARS).

Brassicaceae

***Nasturtium officinale* - water-cress** Europe
= Rorippa nasturtium-aquaticum

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1944*	1978*	1929	1951	1944*	1972	1969	1944*	1944*	1959

Comments:

Established in the US by the mid 1800s as a submersed plant in cold water streams and springs. Dense, leafy stands may alter function and flow in shallow streams. Sometimes confused in Florida with the indigenous *Nasturtium microphyllum* (*Rorippa floridana*). *Nasturtium officinale* is distinguish by pods bearing a double row of seeds, while *N. microphyllum* bears a single row of seeds in narrow pods.

Butomaceae

***Hydrocleys nymphoides* - water-poppy** South America - Brazil

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1989							

Comments:

Scattered collections from central Florida are likely water-garden escapes. Plants appear similar to the native *Limnobium spongia*, yet have large yellow flowers. In 1989 found forming 0.25-acre mat in an Orange Co. wetland; status there unknown.

Callitrichaceae

***Callitriche stagnalis* - pond water-starwort** Europe

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1980									1997*

Comments:

Introduced since late 1800s in dry ballast. Expanding to a 500 mile range in northeastern US; ranging south to Maryland with disjunct southern locals recent in Tennessee and Alabama (namely the Middle Tennesee-Elk River drainages). Submersed and mat forming in streams, ditches, and ponds. Seeds prolific in plant dispersal. Distinguish from native *Callitriche* by round fruits with a marginal wing. Potential exists for the species to become a nuisance in cooler zones of Region 4 (Philbrick et al. 1998).

Commelinaceae

***Murdannia keisak* - marsh dewflower** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1980s	**1960s**	**1960s**	**1950s**	1986*	**1981**	**1980s**	**1950s**	**1930s**	**1976**

Comments:

Competitive emergent; forming locally dominant colonies in marshes and along stream and reservoir margins. Found rooted in water up to 1.5 m deep, with trailing stems to 1 m long. Expanding from eastern Carolinas through the southeast, north to Maryland and Virginia. Introduced with early rice farming. Reproduction both vegetative and by small, abundant seeds. Most parts of Region 4 likely vulnerable.

Convolvulaceae

***Ipomoea aquatica* - water-spinach** Asia - Tropics

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1987							

Comments:

Scattered locales exist in Florida only. Aggressive vine-like species with floating stems that spread over the surface of canals, streams and lakes. Cultivated by Asian Americans for its edible green leaf with high protein content.

Cyperaceae

Cyperus alopecuroides - foxtail flatsedge

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1993							

Comments:

In Polk Co., Florida, a single local at a phosphate pit in the Peace River drainage, forming abundant floating mats and emerging in shallow water along wetland edges (Carter et al. 1996).

Cyperus prolifer - dwarf papyrus

Africa

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1993							

Comments:

Newly introduced and apparently spreading. Known from lakes in the Kissimmee, Peace, Hillsborough River and Tampa Bay drainages. Growing at shorelines and forming floating mats; water-garden escape (Carter et al. 1996).

Haloragaceae

Myriophyllum aquaticum - parrot-feather

South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1970	1970	**1918**	**1951**	1986*	1970	1944	**1958**	1968*	1959

Comments:

A favorite in the water-garden trade, this species readily escapes cultivation to form weedy masses in ponds, swamps and streams. Becomes terrestrial with water draw-down. Common throughout Florida, Louisiana and Alabama. Extending north to central Mississippi, much of Arkansas and Tennessee. Found in Georgia north through the Ridge and Valley Province, including the Upper Ocmulgee and Upper Coosa River drainages where plants occur at 950 ft. elevation. Known in the Carolinas west to the Piedmont. Occurrence in the Lower Susquehanna drainage of Pennsylvania and the Upper Ohio River drainage of West Virginia suggests vulnerability throughout Region 4. Absence of male plants in US implicates reproduction by vegetative propagules only.

Myriophyllum spicatum - Eurasian water-milfoil

Europe

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1963	**1997**	1964	1966	1977	1979	**1979**	1966	**1987**	**1955**

Comments:

The most problematic species in northern US, forming tangled, submersed stands. Well established in the Tennessee and Cumberland River systems of Kentucky and Tennessee. Common in reservoirs of Kentucky (including the Ohio and Green River drainages), Alabama (including Middle Alabama, and Middle Tombigbee drainages) and Mississippi (including Upper Tombigbee, Town and Tibbee drainages). New to Arkansas, at Lake Ouachita. In Florida, Louisiana and southern Alabama mainly occurring in estuaries of large rivers along the Gulf of Mexico. Many Region 4 waterbodies, especially in cooler zones, are prone to infestation. Lacking a current commercial market, new occurrences should be anticipated through spread from current infestations.

Hydrocharitaceae

***Blyxa aubertii* - blyxa** Asia & Australia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1968				

Comments:

Uncommon in a few lakes and ponds of southern Louisiana, apparently not of concern.

***Egeria densa* - Brazilian waterweed** South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1966	**1979**	**1937**	**1979**	1986*	1968*	1968*	1968*	**1966**	1959*

Comments:

Submersed perennial, forming aggressive, often dominant colonies. May be out competed only by hydrilla in southern regions. Similar in appearance and growth to hydrilla, recognize by whorled leaves exceeding 2cm and by fresh plants being smooth to the touch. Also established in Pennsylvania and southern Missouri. Seed production not known in US, however plants effectively spread by fragments. All parts of Region 4 are vulnerable.

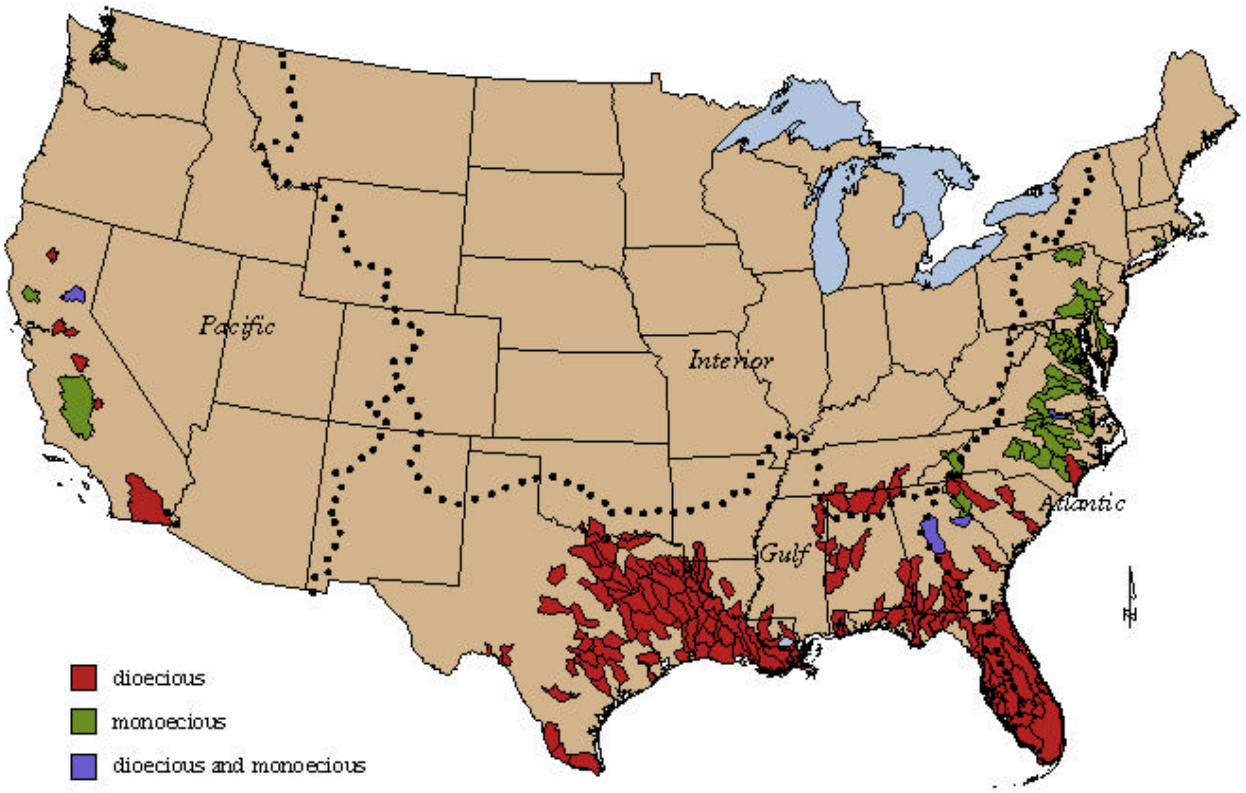
***Hydrilla verticillata* - hydrilla** Tropical and Temperate Asia, Northern Europe

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1978		**1953**	**1967**		1973	**1987**	**1980**	**1982**	1988

Comments:

Most critical invasive submersed species in Region 4. Range greatly expanding due to the separate introduction of two biotypes that independently populate warmer and cooler regions of the U.S. "Warm region" type spreading from Florida through southern states; "cooler "region" type extending from

North Carolina to northern Pennsylvania, and west across the Appalachian divide into the Tennessee and Ohio River drainages. Recognize by many toothed leaves, arranged in a whorl that do not exceed 1.5 cm in length; usually having midrib spines that give plants a rough touch.



Distribution of hydrilla biotypes in U.S. by drainage basin (USGS HUC 8) (Madeira, et al. 2000).

***Ottelia alismoides* - duck-lettuce** Asia, Australia & Africa

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1969				

Comments:

First discovered in rice field ditches of Cameron Parish in 1969. Recorded from four additional western Parishes in the Calcasieu-Mermentau drainage by 1993. Expanding east by 1986 to the Bayou Teche drainage and the East Central coastal drainages, the including the Barataria Basin. At lake, marsh ponds and canals, a completely submersed, rooted rosette with broad leaves on long petioles. Plants do not tolerate drying out. Lacking specialized organs for vegetative reproduction, plants reproduce solely by seed. Flowers submersed or emersed. Local populations probably not displaying the aggressiveness anticipated; population at Lake Chicot only ~18 sq. m.

Iridaceae

***Iris pseudacorus* - yellow iris** Europe & Africa

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1988*	1988*	**1943**	1997*	1986*	1972*****		1967		1993*

Comments:

Widespread in northeastern U.S. More southern collections are highly scattered and likely represent garden escapes. A cool climate invasive, potentially problematic in warm zones of Region 4 at cold spring fed, riparian habitat similar to that at the Frio River, Texas. Emergent in shallow streams, creek flats, marshes and lake shorelines. Identify yellow flower by 3 inner tepals being much shorter and more upright than the 3 large, outer tepals (called falls).

Iris pseudacorus, Frio River, Texas. Photos courtesy C. Lee, USFWS

Lemnaceae

***Landoltia* (*Spirodela*) *punctata* - dotted duckweed** Asia & Australia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1976	1974	**1945**	1965	1985*	1961	1974*	1981*	1981*	1986*

Comments:

Well established in the southeast, expect throughout Region 4. Often overlooked due to resemblance to native duckweeds. Considered a "pioneer species" in that this species colonizes quickly, has a high rate of vegetative propagation and is distributed easily (Landolt 1986). Impact on natives not known; often found in pure stands.

Landoltia punctata has fronds appearing smaller and more elongated than the native *Spirodela polyrhiza*.

Lythraceae

***Lytrhum salicaria* – purple loosestrife** Eurasia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1978	1985*			**1896**		**1999**	1885		**1899**

Comments:

Cool zone marsh weed, not tolerating hot, humid climates of Region 4 coastal plains. Ten North Carolina populations, yet, only those in the mountains and piedmont established and aggressive. Northern Alabama, Huntsville, is the most southern Region 4 local. Plants also found recently in northeastern Mississippi, near Corinth, at roadside ditch and ponds.

***Rotala indica* – Indian toothcup** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1971				

Comments:

Rice field weed, sometimes escaping to ditches and wet prairies. Known in five southern Parishes of Louisiana, all draining the headwaters of the Mermentau River. Submersed or terrestrial, annual species with axillary reddish flowers. Perhaps more abundantly established in California rice regions than in Louisiana. In Italy, where also introduced, found to be nearly ubiquitous in rice fields, yet rarely straying from them (Cook 1973). Incorrectly advertised by the water-garden trade to be the same as *Rotala rotundifolia*. However *R. rotundifolia* is a perennial species with a racemose inflorescence and rose colored flowers (Cook 1976). It is being promoted for water-gardens in Florida and southern Louisiana, where it can be expected to perenniate.

Marsileaceae

***Marsilea ancylopoda, M. hirsuta, M. macropoda, M. vestita*.**

Comments:

Identification and distribution of introduced North American (western) and exotic *Marsilea* species under investigation at USGS/FCSC.

Marsilea minuta – small water-clover Africa and Tropical Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1992	**1993**						

Comments:

New to U.S. First recorded in the Pensacola Bay drainage, Florida (Burkhalter 1995), later collected in the Middle Chattahoochee-Lake Harding drainage in northern Georgia and most recently in the Briar drainage of eastern Georgia. Status under investigation at USGS/FCSC. Submersed to terrestrial fern, forming locally abundant colonies along water margins. Leaves appearing like a four-leaf clover. Larger floating leaves develop on long petioles; terrestrial leaves having crenate margins and are held erect. A widespread and important weed in tropical Asia; to be looked for in southern zones of Region 4.

Marsilea minuta, small water-clover, terrestial form, USGS.

Marsilea quadrifolia – European water-clover Eurasia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
				1920					

Comments:

Northern invasive, submersed to terrestrial fern. Known from the Upper Green and Northern Kentucky River drainages of Kentucky. Expected only in the colder zones of Region 4. Fruiting structures (sporocarps) required for identification of all *Marsilea* species.

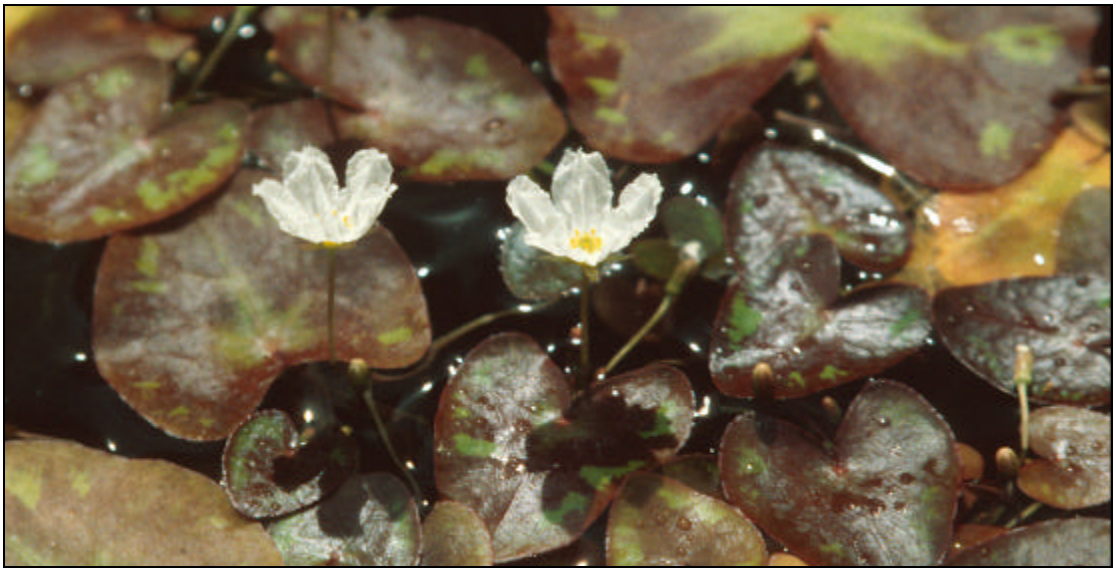
Menyanthaceae

***Nymphoides hydrophyllum* (*cristata*) – crested floating heart** Asian tropics

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1996							

Comments:

New, weedy, floating-leaved species in lakes and canals of central and southern Florida (Jagger pers. comm.; Burks 2000). Distinguish from the native *Nymphoides* by flower petals having a crested wing along the center of the inner surface. Populations expand vegetatively by rhizomes and by bulbils produced on leaves (Sivarajan and Joseph 1993). Water-garden escapes should be watch for in Region 4 coastal plains.



Nymphoides hydrophyllum, crested floating heart. Photo courtesy V. Ramey, U/FL Center for Aquatic and Invasive Plants.

***Nymphoides indica* – water snowflake** Tropics of America, Asia and Africa

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1998*							

Comments:

Collected from Manatee Co., Florida. Distinguish from native *Nymphoides* by flower petals with long, soft hairs covering the inside surface (petals of native Nymphoides are smooth on the inner surface) (Wunderlin 1998; Sivarajan and Joseph 1993).

***Nymphoides peltata* – yellow floating heart** Eurasia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
	1939			1986*		**1955**			

Comments:

Floating-leaved invasive, well established in the northeastern US, apparently not persisting in southern zones of Region 4. Early collections from Louisiana and Mississippi do not represent current populations. More adapted to northwestern Arkansas where a 1939 collection from a lake in the Illinois River

was still persisting in 1954. Rare occurrences recorded in lakes and ponds in the Lower Ohio-Salt River drainage of Kentucky. A water-garden favorite. Naturally dispersal by seed; seeds float when wet, are picked up and transported by waterfowl, detach and sink to germinate when the bird returns to water (Stuckey 1973-74; Cook 1990).

Najadaceae

***Najas minor* – brittle naiad** Europe

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1944*	1979*	**1958**	1951	1986*	**1980**	**1979**	1997	1969	1944*****

Comments:

Submersed; potentially invasive both widely or locally; many branching stems may fill the water column; earliest Region 4 occurrences in Tennessee River system, expanding since then in Alabama and Tennessee; abundant in impoundments of central North Carolina (Haw and Upper Neuse River drainages) and central South Carolina. (Saluda River and Lake Marion drainages); common in northern and western Georgia; more suited to cooler zones, becoming less common northern to central Florida, Mississippi and Louisiana; identify by seeds at leaf axils; reproducing prolifically as an annual by seed; seeds survive drought; plant tolerates pollution, turbidity and depths greater than 3.5 m; infestations develop in late summer.

Nelumbonaceae

***Nelumbo nucifera* – sacred lotus** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1901	1988*	1961	1951		1978	**1971**	1968*	1968*	1970*****

Comments:

Sporadically escaping and spreading locally from cultivation. Identify by flower petals pink compared to yellow for the native *Nelumbo lutea*.

Nymphaea ampla, N. blanda, N. capensis, N. jamesoniana, N. lotus, N. x daubeniana,

Comments:

Exotic water lily species and hybrids occasionally escaping ornamental cultivation to become locally established in Florida and Louisiana.

***Nymphaea mexicana* – banana water-lily** North America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
							1968*	1968*	

Comments:

Native south/western; yellow flower; escaping ornamental cultivation north of its natural range; primarily at impoundments in the outer coastal plain, Carolinas.

Onagraceae

***Ludwigia hexapetala* – Uruguay seedbox** North/South America ?

Comments:

Recorded for all states in Region 4; potentially native, status under investigation; problematic at reservoirs in the Lake Marion and Cooper River drainages of eastern South Carolina.

Parkeriaceae

***Ceratopteris thalictroides* – water sprite** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1878			1972*				

Comments:

Fern; rooted or floating; lakes and slow moving waters; peninsular Florida, north to the St. Johns River drainage in the east and to the Withlacoochee River drainage in the west; perhaps less common in coastal regions of southern Louisiana; also known from Hawaii, California and central Texas; plantlets form along leaf margin; similar native species, *Ceratopteris pteridoides* has inflated, slightly wider petioles.

Poaceae

***Urochloa* (*Brachiaria*) *mutica* – para grass** Africa

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		Early 1900s						After 1968	

Comments:

Introduced for pasture grass. Hollow stems form floating mats in aquatic systems; out competes native shoreline species. Distributed throughout peninsular Florida, especiallly problematic in drainage canals. Also found in lakes, marshes and rivers; tens of thousands of acres burned in Lake Okeechobee this season. Status of a single collection from Aiken Co., South

Carolina, unknown, perhaps not representing an aquatic site.

***Hymenachne amplexicaulus* – West Indian marsh grass** South & Central America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1968*							

Comments:

Robust, emergent grass. First documented as part of the Florida flora in the 1960's and 70's. Not becoming more frequent until the mid 1990s when recorded at marshes, rivers and drainage canals in six drainages of central and southern Florida. Extending north to the Myakka and the Crystal-Pithlachascotee River drainages. Found forming monocultures to the displacement of native species. Tolerates extensive periods of flooding and drought. Dispersal by seed; seeds float [Langeland and Burks (eds.) 1998].

Hymenachne amplexicaulis, photos courtesy V. Ramey, U/FL Center for Aquatic and Invasive Plants.

***Luziola peruviana* – Peruvian watergrass** South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1901			**1882**				

Comments:

Shallow ponds, ditches and miry places. Low growing grass, almost always in standing water with leaf blades floating. Occurrence local and infrequent; limited to the Lower Mississippi and coastal drainages of Louisiana and the Pensacola Bay drainage of Florida. Likely ballast introduction; not of concern.

***Oryza sativa* – rice** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1993*****		1968*	1968*	

Comments:

Escaping locally from rice cultivation; not of concern.

***Panicum repens* – torpedo grass** Australia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1876		Cultivated in 1920s			1971	1971	1969	1987	1987

Comments:

Invasive grass displacing native species in marshes and along shorelines mainly throughout Florida. Not spreading much beyond the coast in Alabama, where it was first recorded in the Mobile Basin. Otherwise scattered northward along the Atlantic Coast to North Carolina. Initially planted for forage in wet pasture.

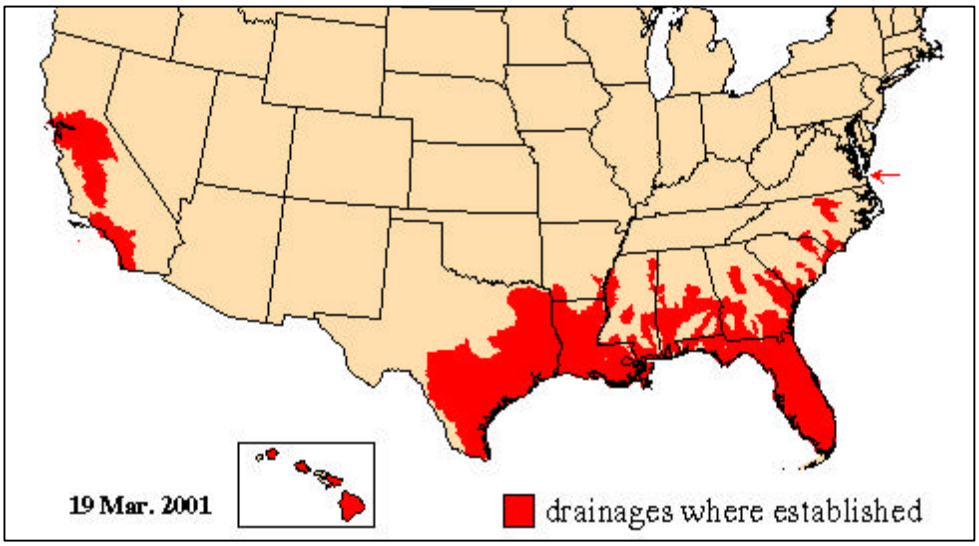
Pontederiaceae

***Eichhornia crassipes* – water-hyacinth** South America - Upper Amazon Basin

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1947*	+	**1890s**	1947*	+	**1933**	**1916**	1947*	1947*	+

Comments:

Floating invasive with thick, glossy leaves. Distributed throughout Gulf Coastal plain, including entire states of Louisiana and Florida. In Mississippi extending north to the Big Sunflower drainage in the west and to Columbus Lake in the east. Ranging through central Alabama to the Coosa River drainage. In Georgia extending north in to the Upper Ocmulgee River drainage; perenniating in coastal tidewater regions of Georgia and South Carolina where marshes were diked. Persisting in southeastern North Carolina after harsh winters, extending there into the Piedmont during warm years. More recently persisting in coastal Virginia. Several populations in southern Arkansas, southwestern Tennessee and Kentucky were temporary, not surviving the winter. In cooler regions, including northern Mississippi and Alabama, this species may have the potential to reappear annually by seed.



U.S. Distribution of water-hyacinth, *Eichhornia crassipes*.

Potamogetonaceae

***Potamogeton crispus* – curly pondweed** Europe

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1943	1988*	**1937**	**1947**	**1973**	**1949**	1979	**1950**	**1990**	**1946**

Comments:

Aggressive, cool climate, totally submersed perennial. Established in northeastern US ~160 yrs (Stuckey 1979). Florida populations infrequent and short lived. In cooler regions, life cycle described by turion production and plant die-back by mid-summer, followed by turion germination in the fall for seedlings to over winter and serve as colonizing species in the spring. Tolerates pollution, turbidity, and deep water. Distinguish from native pondweeds by serrated leaf margins. Expect in cooler zones of Region 4

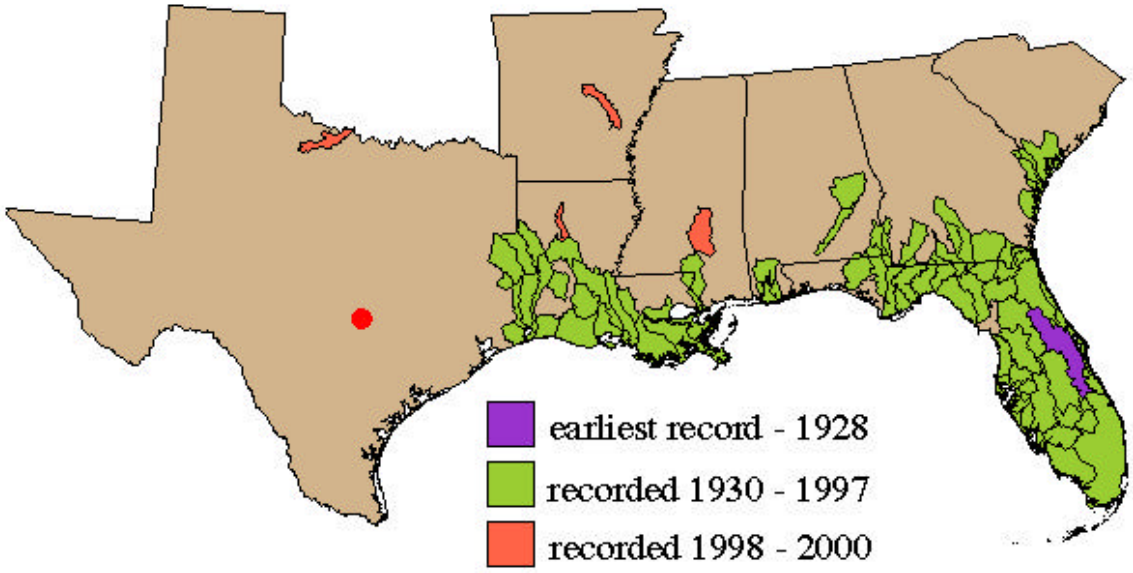
Salviniaceae

***Salvinia minima* – water spangles/common salvinia** Central & South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1982	**1998**	**1930**	**1936**		**1980**	**1999**		**1998**	

Comments:

Free floating fern with oval leaves and velvety hairs. Introduced 1928 to Florida (St. John's River drainage), currently expanding to 73 drainages in eight southern states. Extremely problematic in Louisiana and Texas. Florida populations less problematic, probably due to feeding damage by the *Salvinia* weevil, which is not fond in other states (Jacono et al. 2001). Distinguish from *S. molesta* by hairs on the upper leaf that are spreading - not attached at the tips



Salvinia minima, U.S. Distribution by USGS HUC 8 Drainages.

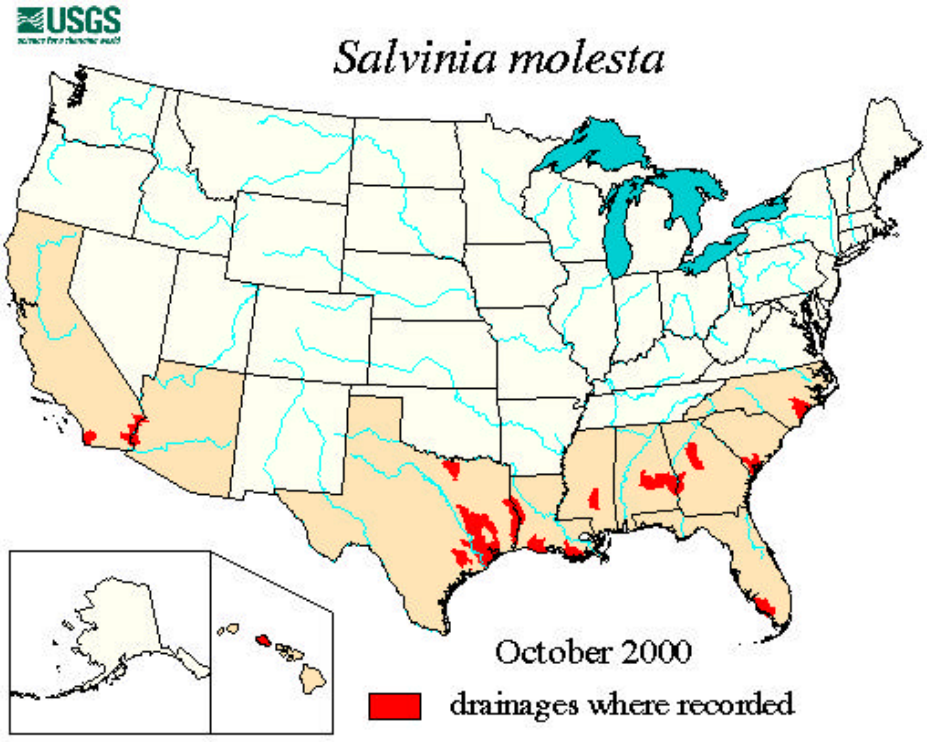
***Salvinia molesta* – giant salvinia** South America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
1999		**1999**	**1999**		**1998**	**1999**	**2000**		

Comments:

Free floating fern, about two times larger than *Salvinia minima*. Distinguished by leaf hairs that are joined at the tips to form an eggbeater-like cage. Highly adapted invasive weed of tropics and warm-temperate zones; forms impenetrable monoculture covering water surface. Since 1998 found at >60 locations in 29 drainages of ten states (including Texas, Arizona, California and Hi). Originating from water-garden trade, quickly dispersed in nature through flooding and by man (Jacono 1999; Haynes and Jacono 2000).

Mature specimens of *Salvinia minima* (left) and *Salvinia molesta* (right), USGS.



Locality records of *Salvinia molesta* within Region 4

ST	HUC 8 Drainage Name	Location	Status
AL	Lower Tallapoosa	Auburn, Indian Pines Country Club, 7 acre golf course pond	potentially eradicated
	Lower Tallapoosa	Pond, north of Auburn, resulting from impounded tributary of Sougahatchee Creek	potentially eradicated
	Mid. Chattahoochee-Walter F. George Res.	Seale, private pond, 3.8 acre, aprox. 200 meters from Uchee Creek	potentially eradicated
	Mid. Chattahoochee-Walter F. George Res.	Seale, private pond, 0.25 acre, upslope from larger pond	potentially eradicated
	Upper Alabama	Private pond, 0.25 acre, east of Montgomery	present
	Lower Tallapoosa	Auburn University Forestry School, pond 1 acre, across from Auburn Fisheries Unit #1, along hwy 147, north of Auburn	present
FL	Big Cypress Swamp	Naples, Kings Lake Subdivision, Lake #3 (5 acre retention pond)	potentially eradicated
	Big Cypress Swamp	Naples, off Airport-Pulling Road, private retention pond behind the nursery	present
	Big Cypress Swamp	North Naples, canal along east side Airport Rd., north of Pine Ridge Rd.	present
GA	Upper Ocmulgee	Edie Creek, at a .33 acre farm impoundment, and downstream in a 10 acre impoundment, where the spillway has been removed	not persisting
	Upper Ocmulgee	Neighborhood pond at Evergreen Lakes, Lilburn	not persisting
	Upper Ocmulgee	Unnamed tributary below the subdivision ponds, just N of Hwy 78, on west side of Yellow River	not persisting
LA	Mermentau	Duson, just north of 1-10, neighboring private ponds	present
	Mermantau	Toledo Bend Reservoir	present
	Mermentau	Slough at golf course, uplake from Salter Creek, leading to Toledo Bend Reservoir	present
	West Central Louisiana	Houma, small diked swamp at residence where plants escaped from an earthen pond	present
MS	Upper Leaf	Moselle, one-quarter acre private pond and ditch below the pond	potentially eradicated
NC	New River	Jacksonville, private pond and adjacent wet, bottomland woods	present
	North East Cape Fear	Riverbend subdivision, off hwy 53, additional sites	present
	North East Cape Fear	Riverbend subdivision, off hwy 53, slough through swamp, approx. 100 ft E of North East Cape Fear River	present
	North East Cape Fear	Wilmington, golf course, two ponds, 1 and 0.5 acre	present
SC	Broad-St. Helena	Pineland Plantation, pond located off secondary road 87 about 10 miles south of Walterboro (1995)	eradicated

Scrophulariaceae

***Bacopa egensis* – Brazilian water-hyssop** Central & South America, Africa

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1930				

Comments:

Distributed in shallow, quiet waters of Bayou Tech and in the Lower Ouachita, Lower Red and Little River drainages of central Louisiana. Frequently intermingled with the native and somewhat similar *Bacopa rotundifolia*; *B. egensis* differs in having tapering leaves with crenate margins (Depoe 1969).

***Dopatrium junceum* – dopatrium** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1969				

Comments:

Restricted to rice fields of southern Louisiana. Inconspicuous, small, slender annual species; emersed in water up to 30 cm deep.

***Limnophila indica* – Indian marshweed** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1983	**1967**						

Comments:

Recorded from Lake Seminole, Georgia and from a marsh, Pinellas Co., Florida, as well as from Texas. Similar *to Limnophila sessiliflora*, differs by emersed stems having glands. Distributed in the aquarium trade with *L. sessiliflora*.

***Limnophila x ludoviciana* – marshweed** hybrid from cultivation

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
					1963				

Comments:

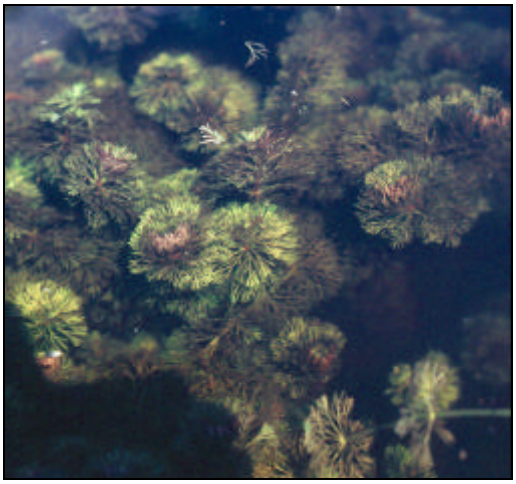
Common where found at several rice fields, lakes and a cypress swamp in Louisiana. Known from the Bayou Tech drainage, the Mermentau headwaters and central coastal Louisiana. Suspected to be a horticultural hybrid between *Limnophila sessiliflora* and *L. indica* that was developed for aquaria.

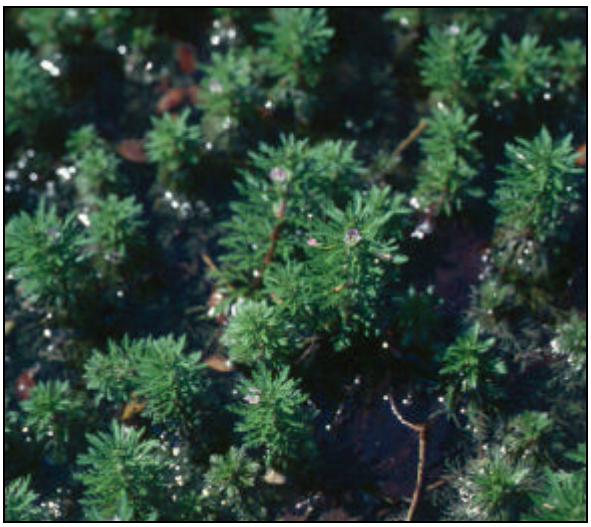
***Limnophila sessiliflora* - Asian marshweed** Asia

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1961	**1967**						

Comments:

Submersed, weedy species with the potential to develop large stands near the surface of relatively shallow, quiet waters. Known from over 30 water bodies in central, south and the panhandle regions of Florida, including lakes, rivers and canals. In Georgia known only at Lake Seminole and a nearby pond. Dispersed mainly through seed. Flowering tips emersed; identify by emersed stems powdery and hairy. Expect in warmer zones of Region 4.





Limnophila sessiliflora submersed (left) and emersed with flowers (right). Photos courtesy V. Ramey, University of Florida, Center for Aquatic and Invasive Plants.

Solanaceae

***Solanum tapicense* – wetland nightshade** Central America

AL	AR	FL	GA	KY	LA	MS	NC	SC	TN
		1983							

Comments:

Recorded from six counties in southwestern Florida. Sprawling stems up to 5m with harsh, recurved prickles create impenetrable thickets along wetland streams and in moist cypress domes. Does not tolerating continuous flooding. Believed to have the potential to spread and persist much farther north than southern Florida (Fox and Bryson 1998).

Solanum tapicense, photo courtesy V. Ramey, Univ. FL, Center for Aquatic and Invasive Plants.

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APPENDIX A

Table 1. Native fishes introduced outside their native range in the Southeast.

Family	Scientific Name	Common Name	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	PR	Pathway
Acipenseridae	*Acipenser transmontanus*	white sturgeon				I								AE
Amiidae	*Amia calva*	bowfin	N	N	N	N	N/I	N	N	N/I	N	N		S
Atherinidae	*Menidia beryllina*	inland silverside	N	N/I	N	N	N	N	N	N	N	N		S
Belonidae	*Strongylura marina*	Atlantic needlefish	N/I		N	N		N	N	N	N	I		Canal
Catostomidae	*Carpiodes cyprinus*	quillback	N	N	N	N	N	N	N	N/I	N	N		?
Catostomidae	*Carpiodes velifer*	highfin carpsucker	N	N	N		N	N	N	N/I	I	N		?
Catostomidae	*Catostomus commersoni*	white sucker	N	N		N/I	N		N	N/I	N	N		?
Catostomidae	*Hypentelium etowanum*	Alabama hog sucker	N			N			N			N/I		?
Catostomidae	*Ictiobus bubalus*	smallmouth buffalo	N	N		N	N	N	N	I	I	N		S?
Catostomidae	*Ictiobus cyprinellus*	bigmouth buffalo	N/I	N			N	N	N	I		N		S?
Catostomidae	*Scartomyzon lachneri*	greater jumprock	N			N/I								?
Catostomidae	*Scartomyzon rupiscartes*	striped jumprock				N				N/I?	N			?
Centrarchidae	*Ambloplites cavifrons*	Roanoke bass								N/I				S
Centrarchidae	*Ambloplites constellatus*	Ozark bass		N/I										S
Centrarchidae	*Ambloplites rupestris*	rock bass	N	I		N	N		N	N/I	N/I	N		S
Centrarchidae	*Chaenobryttus gulosus*	warmouth	N	N	N	N	N/I	N	N	N/I	N	N	I	S
Centrarchidae	*Enneacanthus gloriosus*	bluespotted sunfish	N		N	N			N/I	N	N			S
Centrarchidae	*Lepomis auritus*	redbreast sunfish	N/I	I	N	N/I	I	I		N/I	N	I	I	S
Centrarchidae	*Lepomis cyanellus*	green sunfish	N/I	N	I	I	N	N	N	N/I	I	N		S
Centrarchidae	*Lepomis gibbosus*	pumpkinseed					N/I			N/I	N	I		S
Centrarchidae	*Lepomis humilis*	orangespotted sunfish	N/I	N	I	I	N	N	N			N		S
Centrarchidae	*Lepomis macrochirus*	bluegill	N	N/I	N	N	N	N	N	N/I	N/I	N	I	S
Centrarchidae	*Lepomis megalotis*	longear sunfish	N	N	N	N	N	N	N	N/I	N	N		S
Centrarchidae	*Lepomis microlophus*	redear sunfish	N	N	N	N	N/I	N	N	N/I	N/I	N/I	I	S
Centrarchidae	*Lepomis miniatus*	redspotted sunfish	N	N			N/I?	N	N			N		S
Centrarchidae	*Micropterus coosae*	redeye bass	N	I		N/I	I			I	N	N/I	I	S
Centrarchidae	*Micropterus dolomieu*	smallmouth bass	N/I	N/I		N/I	N/I		N/I	N/I	I	N		S
Centrarchidae	*Micropterus punctulatus*	spotted bass	N/I	N	N/I	N/I	N/I	N	N	N/I	I	N/I		S
Centrarchidae	*Micropterus salmoides*	largemouth bass	N/I	N/I	N	N/I	N/I	N	N/I	N/I	N	N	I	S
Centrarchidae	*Micropterus undescribed sp.*	shoal bass	N		N	N/I								S
Centrarchidae	*Pomoxis annularis*	white crappie	N/I	N	I	N/I	N/I	N	N	N/I	I	N		S
Centrarchidae	*Pomoxis nigromaculatus*	black crappie	N	N/I	N	N	N/I	N	N	N	N	N		S
Characidae	*Astyanax mexicanus*	Mexican tetra						I						B
Cichlidae	*Cichlasoma cyanoguttatum*	Rio Grande cichlid			I			I						A
Clupeidae	*Alosa aestivalis*	blueback herring			N	N				N/I	N			S
Clupeidae	*Alosa pseudoharengus*	alewife				I	I			N	N	I		S

Clupeidae	*Alosa sapidissima*	American shad	I	I	N	N/I	I	I	I	N/I	N			S
Clupeidae	*Dorosoma cepedianum*	gizzard shad	N	N	N	N	N/I	N	N	N	N	N		S
Clupeidae	*Dorosoma petenense*	threadfin shad	N/I	N/I	N	N/I	N/I	N	N	I	I	N/I	I	S
Cottidae	*Cottus bairdi*	mottled sculpin	N			N	N			N/I	N	N		?
Cyprinidae	*Campostoma anomalum*	central stoneroller		N		N	N	N	N	N/I	N	N		B
Cyprinidae	*Campostoma oligolepis*	largescale stoneroller	N/I	N		N	N		N	N?		N?		B
Cyprinidae	*Cyprinella galactura*	whitetail shiner	N	N		N	N/I		N	N/I	N	N		B
Cyprinidae	*Cyprinella lutrensis*	red shiner	I	N		I	N	N	N	I		N		B
Cyprinidae	*Cyprinella pyrrhomelas*	fieryblack shiner								N	N/I			B
Cyprinidae	*Cyprinella venusta*	blacktail shiner	N	N	N	N/I	N	N	N			N/I		B
Cyprinidae	*Hybognathus hankinsoni*	brassy minnow										I		B
Cyprinidae	*Hybopsis winchelli*	clear chub	N		N/I	N								B
Cyprinidae	*Luxilus albeolus*	white shiner								N/I				B
Cyprinidae	*Luxilus cerasinus*	crescent shiner								N/I				B
Cyprinidae	*Luxilus chrysocephalus*	striped shiner	N/I	N		N	N	N	N	N		N		B
Cyprinidae	*Luxilus coccogenis*	warpaint shiner	N			N				N/I	N/I	N		B
Cyprinidae	*Luxilus zonistius*	bandfin shiner	N/I		N	N/I								B
Cyprinidae	*Lythrurus ardens*	rosefin shiner	N/I			N	N		N	N/I		N		B
Cyprinidae	*Lythrurus atrapiculus*	blacktip shiner	N/I		N	N/I								B
Cyprinidae	*Nocomis biguttatus*	hornyhead chub		N			N/I							B
Cyprinidae	*Nocomis leptocephalus*	bluehead chub	N/I			N		N	N	N/I	N			B
Cyprinidae	*Nocomis micropogon*	river chub	N			N/I	N		N	N/I	N/I	N		B
Cyprinidae	*Nocomis raneyi*	bull chub								N/I				B
Cyprinidae	*Notemigonus crysoleucas*	golden shiner	N	N/I	N/I	N	N/I	N	N	N/I	N	N/I		B
Cyprinidae	*Notropis amoenus*	comely shiner								N/I				B
Cyprinidae	*Notropis baileyi*	rough shiner	N/I		I	I			N					B
Cyprinidae	*Notropis bifrenatus*	bridle shiner								I				B
Cyprinidae	*Notropis buccatus*	silverjaw minnow	N			N/I	N	N	N			N		B
Cyprinidae	*Notropis chiliticus*	redlip shiner								N/I				B
Cyprinidae	*Notropis chrosomus*	rainbow shiner	N/I			N/I						N		B
Cyprinidae	*Notropis harperi*	redeye chub	N		N/I	N								B
Cyprinidae	*Notropis hudsonius*	spottail shiner				N/I				N	N			B
Cyprinidae	*Notropis hypsilepis*	highscale shiner	N			N/I								B
Cyprinidae	*Notropis leuciodus*	Tennessee shiner	N			N/I	N			N/I	I	N		B
Cyprinidae	*Notropis longirostris*	longnose minnow	N		N	N/I		N	N					B
Cyprinidae	*Notropis lutipinnis*	yellowfin shiner				N/I				N/I	N			B
Cyprinidae	*Notropis ozarcanus*	Ozark shiner		N/I										B
Cyprinidae	*Notropis potteri*	chub shiner		I				I						B
Cyprinidae	*Notropis procne*	swallowtail shiner								N/I	N			B
Cyprinidae	*Notropis rubricroceus*	saffron shiner								N/I		N		B
Cyprinidae	*Notropis shumardi*	silverband shiner		N			N	N/I	N			N		B
Cyprinidae	*Notropis spectrunculus*	mirror shiner				N				N/I	I	N		B

Cyprinidae	*Notropis telescopus*	telescope shiner	N	N		N	N			N/I		N		B
Cyprinidae	*Notropis texanus*	weed shiner	N/I	N	N	N/I	N	N	N			N/I		B
Cyprinidae	*Notropis xaenocephalus*	Coosa shiner	N			N/I						N		B
Cyprinidae	*Phoxinus oreas*	mountain redbelly dace								N/I				B
Cyprinidae	*Pimephales notatus*	bluntnose minnow	N	N		I	N	N	N			N		B
Cyprinidae	*Pimephales promelas*	fathead minnow	N/I	N/I	I	N/I	N/I	N/I	N/I	N/I		N/I	I	B
Cyprinidae	*Rhinichthys atratulus*	blacknose dace	N			N	N			N/I	N	N		B
Cyprinidae	*Rhinichthys cataractae*	longnose dace				N	N/I			N	N	N		B
Cyprinodontidae	*Jordanella floridae*	flagfish			N/I						I			?
Esocidae	*Esox lucius*	northern pike		I		I	I			I		I		S
Esocidae	*Esox masquinongy*	muskellunge	I	I		N/I	N/I			N/I	I	N/I		S
Esocidae	*Esox niger*	chain pickerel	N	N/I	N/I	N	N/I	N	N	N	N	N		S
Fundulidae	*Fundulus catenatus*	northern studfish	N	N			N/I	N	N			N		B
Fundulidae	*Fundulus lineolatus*	lined topminnow			N/I	N				N	N			B
Fundulidae	*Fundulus seminolis*	Seminole killifish			N/I									B
Fundulidae	*Fundulus stellifer*	southern studfish	N			N/I						N		B
Fundulidae	*Lucania goodei*	bluefin killifish	N		N	N				I	I			?
Gasterosteidae	*Culaea inconstans*	brook stickleback	I				I					I		B
Ictaluridae	*Ameiurus brunneus*	snail bullhead	N		N	N/I				N/I	N			S
Ictaluridae	*Ameiurus catus*	white catfish	N/I	I	N/I	N	I		N/I	N/I	N	I	I	S
Ictaluridae	*Ameiurus melas*	black bullhead	N	N	N	N/I	N	N	N	N/I		N		S
Ictaluridae	*Ameiurus nebulosus*	brown bullhead	N/I	N/I	N	N	N/I	N/I	N	N	N	N	I	S
Ictaluridae	*Ameiurus platycephalus*	flat bullhead				N/I				N/I	N			S
Ictaluridae	*Ictalurus furcatus*	blue catfish	N/I	N/I	I	I	N	N	N	N/I	I	N		S
Ictaluridae	*Ictalurus punctatus*	channel catfish	N	N/I	N	N/I	N	N	N	N/I	N/I	N	I	S
Ictaluridae	*Noturus exilis*	slender madtom	N	N/I			N		N			N		B
Ictaluridae	*Noturus insignis*	margined madtom				N				N/I	N	I		S
Ictaluridae	*Pylodictis olivaris*	flathead catfish	N	N	I	N/I	N	N	N	N/I	I	N		S
Moronidae	*Morone chrysops*	white bass	N/I	N/I	I	I	N/I	N/I	N/I	I	I	N/I	I	S
Moronidae	*Morone mississippiensis*	yellow bass	N/I	N			N/I	N	N			N/I		S
Moronidae	*Morone saxatilis*	striped bass	N/I	I	N/I	N/I	I	N/I	N/I	N/I	N/I	I		S
Osmeridae	*Osmerus mordax*	rainbow smelt		I		I	I	I		I		I		S
Percidae	*Ammocrypta bifascia*	Florida sand darter	N		N/I									B
Percidae	*Etheostoma edwini*	brown darter	N		N/I	N								B
Percidae	*Etheostoma fusiforme*	swamp darter	N	N	N	N	N	N	N	N/I	N	N		?
Percidae	*Etheostoma nuchale*	watercress darter	N/I											S
Percidae	*Etheostoma olmstedi*	tessellated darter			N	N				N/I	N			B
Percidae	*Etheostoma zonale*	banded darter	N	N		N/I	N			N	I	N		B
Percidae	*Perca flavescens*	yellow perch	I	I	I	I	I		I	N/I	N/I	I		S
Percidae	*Percina tanasi*	snail darter	N			N						N/I		S
Percidae	*Stizostedion canadense*	sauger	N/I	N/I	I	N/I	N	N/I	N/I	N/I	I	N		S
Percidae	*Stizostedion vitreum*	walleye	N/I	N/I		N/I	N/I	I	N/I	N/I	I	N/I		S

Poeciliidae	*Gambusia affinis*	western mosquitofish	N/I	N	N/I	N	N/I	N	N/I	N/I	N	N/I	I	S
Poeciliidae	*Gambusia holbrooki*	eastern mosquitofish	N/I		N	N			N/I	N	N	N/I		S
Poeciliidae	*Heterandria formosa*	least killifish	N		N	N		N	N	N/I	N			?
Polydontidae	*Polydon spathula*	paddlefish	N	N	I	I	N	N	N			N		AE
Salmonidae	*Coregonus artedi*	cisco										I		S
Salmonidae	*Oncorhynchus clarki*	cutthroat trout		I								I		S
Salmonidae	*Oncorhynchus kisutch*	coho salmon					I					I		S
Salmonidae	*Oncorhynchus mykiss*	rainbow trout	I	I	I	I	I	I	I	I	I	I	I	S
Salmonidae	*Oncorhynchus nerka*	kokanee								I		I		S
Salmonidae	*Oncorhynchus tshawytscha*	chinook salmon						I						S
Salmonidae	*Salmo salar*	Atlantic salmon					I		I	I	I	I		S
Salmonidae	*Salvelinus fontinalis*	brook trout	I	I		N/I	I			N/I	N/I	N/I		S
Salmonidae	*Salvelinus namaycush*	lake trout		I			I					I		S
		Exotics (from table 2)	13	11	92	14	12	13	7	10	8	10	15	
		I	6	13	13	14	15	7	4	14	20	19	14	
		N/I	27	18	13	34	25	6	11	59	10	17	0	
		Total	46	42	118	62	52	26	22	83	38	46	29	

* Explanation of designations:
N - native to the state (or to a portion of the state)
I - introduced to the state (or to a portion of the state)
N/I - native to part of the state and introduced to a non-native area of the state
N?/I? - not clear if native or introduced to the state
N/I? - native and possibly introduced

Pathway designations
S - Stocked (legally, illegally, or stock contamination)
A - Aquarium release or escape from tropical fish farm
B - Bait release
AE - Aquaculture escape
? - Unknown

Table 2. Exotic fishes introduced into the Southeast.

Family	*Scientific Name*	Common Name	AL	AR	FL	GA	KY	LA	MS	NC	SC	TN	PR	Pathway
Anabantidae	*Anabas testudineus*	climbing perch			X									A
Anabantidae	*Ctenopoma nigropanosum*	twospot climbing perch			X									A
Anostomidae	*Leporinus fasciatus*	banded leporinus			R									A
Belontiidae	*Betta splendens*	Siamese fighting fish			X*									A
Belontiidae	*Colisa labiosa*	thicklipped gourami			R									A
Belontiidae	*Colisa lalia*	dwarf gourami			R*									A
Belontiidae	*Macropodus opercularis*	paradisefish			R*			R*						A
Belontiidae	*Trichogaster leerii*	pearl gourami			R									A
Belontiidae	*Trichogaster trichopterus*	blue gourami			R*									A
Belontiidae	*Trichopsis vittata*	croaking gourami			E*									A
Callichthyidae	*Callichthys callichthys*	cascarudo			R									A
Callichthyidae	*Corydoras* sp.	corydoras			R									A
Callichthyidae	*Hoplosternum littorale*	brown hoplo			E*									A
Characidae	*Aphyocharax anisitsi*	bloodfin tetra			R*									A
Characidae	*Colossoma macropomum* (?)	tambaquí			R*									A
Characidae	*Colossoma/Piaractus* sp. (?)	unidentified pacu		R	R	R		R		R	R			A
Characidae	*Gymnocorymbus ternetzi*	black tetra			R*									A
Characidae	*Hyphessobrycon serpae*	serpae tetra			R									A
Characidae	*Metynnis* sp. (?)	metynnis			R		R?							A
Characidae	*Moenkhausia sanctaefilomenae*	redeye tetra			R*									A
Characidae	*Piaractus brachypomus*	pirapatinga	R*	R	R*	R*	R*		R*	R				A
Characidae	*Piaractus mesopotamicus* (?)	small-scaled pacu			R?									A
Characidae	*Pygocentrus nattereri*	red piranha			R*									A
Characidae	*Pygocentrus/Serrasalmus* sp. (?)	unidentified piranha			R		R							A
Characidae	*Serrasalmus rhombeus*	redeye piranha			X*									A
Cichlidae	*Aequidens pulcher* (?)	blue acara			X?									A
Cichlidae	*Astronotus ocellatus*	oscar			E*	R		R	R*				E	A
Cichlidae	*Cichla ocellaris* (?)	peacock cichlid			E*								E	S
Cichlidae	*Cichla temensis*	speckled pavon			R									S
Cichlidae	*Cichlasoma bimaculatum*	black acara			E*									A
Cichlidae	*Cichlasoma citrinellum*	Midas cichlid			E*									A
Cichlidae	*Cichlasoma managuense*	jaguar guapote			E*									A
Cichlidae	*Cichlasoma meeki*	firemouth cichlid			E*									A
Cichlidae	*Cichlasoma nigrofasciatum*	convict cichlid			X?									A
Cichlidae	*Cichlasoma octofasciatum*	Jack Dempsey			E*									A
Cichlidae	*Cichlasoma salvini*	yellowbelly cichlid			E*									A
Cichlidae	*Cichlasoma trimaculatum*	threespot cichlid			X*									A
Cichlidae	*Cichlasoma urophthalmus*	Mayan cichlid			E*									A
Cichlidae	*Geophagus brasiliensis* (?)	pearl eartheater			R?									A

Cichlidae	*Geophagus surinamensis* (?)	redstriped eartheater			E*									A
Cichlidae	*Hemichromis letourneauxi*	jewelfish			E*									A
Cichlidae	*Heros severus*	banded cichlid			E*									A
Cichlidae	*Labeotropheus* sp. (?)	scrapermouth cichlid			R?									A
Cichlidae	*Oreochromis aureus*	blue tilapia	R		E*	R				E*			E	S
Cichlidae	*Oreochromis mossambicus*	Mozambique tilapia	R*		E*	X				X			E	S
Cichlidae	*Oreochromis niloticus*	Nile tilapia	R		E?*	E?*							E	S
Cichlidae	*Oreochromis urolepis*	Wami tilapia											E	S
Cichlidae	*Pterophyllum scalare*	freshwater angelfish			R		R							A
Cichlidae	*Pterophyllum* sp.	freshwater angelfish			R									A
Cichlidae	*Sarotherodon melanotheron*	blackchin tilapia			E*									A
Cichlidae	*Telmatochromis bifrenatus* (?)	Lake Tanganyika dwarf cichlid			R*									A
Cichlidae	*Tilapia mariae*	spotted tilapia			E*									A
Cichlidae	*Tilapia rendalli*	redbreast tilapia											E	A
Cichlidae	*Tilapia sparrmannii*	banded tilapia			R*									A
Cichlidae	*Tilapia zillii*	redbelly tilapia	R	R	X*					E*	E			S
Cichlidae	*tilapine cichlids*	unidentified tilapias			R	R	R	R	R					S
Clariidae	*Clarias batrachus*	walking catfish			E*	R								A
Cobitidae	*Misgurnus anguillicaudatus*	Oriental weatherfish			E*							R*		A
Cobitidae	*Pangio kuhlii*	coolie loach			R*									A
Cyprinidae	*Brachydanio rerio*	zebra danio			R*									A
Cyprinidae	*Carassius auratus*	goldfish	E?*	E?*	R*	E*	E	E?	E?*	E?*	E*	E*	E	A
Cyprinidae	*Ctenopharyngodon idella*	grass carp	R	E	R*	R	E	E*	E?	E	R	E	I	S
Cyprinidae	*Cyprinus carpio*	common carp	E*	E*	E*	E*	E*	E*	E*	E*	E*	E*		S
Cyprinidae	*Danio malabaricus*	Malabar danio			R*									A
Cyprinidae	*Hypophthalmichthys molitrix*	silver carp	R	R	R*		R	E?*				R	I	S
Cyprinidae	*Hypophthalmichthys nobilis*	bighead carp	R	R	R		R	E?*	E?			R		S
Cyprinidae	*Leuciscus idus*	ide										R		A
Cyprinidae	*Morulius chrysophekadion*	black sharkminnow			R									A
Cyprinidae	*Puntius conchonius*	rosy barb			R								E	A
Cyprinidae	*Puntius gelius*	dwarf barb			R									A
Cyprinidae	*Puntius schwanenfeldii*	tinfoil barb			R									A
Cyprinidae	*Puntius tetrazona*	tiger barb			R									A
Cyprinidae	*Scardinius erythrophthalmus*	rudd	R	R										B
Cyprinidae	*Tinca tinca*	tench	R?	R?	R?	R	R?	R		R	R	R		S
Doradidae	*Oxydoras niger*	ripsaw catfish			R									A
Doradidae	*Platydoras costatus*	Raphael catfish			R									A
Doradidae	*Pterodoras granulosus*	granulated catfish			R*									A
Doradidae	*Pterodoras* sp. (?)	thorny catfish			R?									A
Erythrinidae	*Hoplias malabaricus*	trahira			X*									A
Helostomatidae	*Helostoma temminckii*	kissing gourami			R*									A
Loricariidae	*Hypostomus* spp.	suckermouth catfish			X?*			R?						A

Loricariidae	*Pterygoplichthys disjunctivus*	vermiculated sailfin catfish			E*										A
Loricariidae	*Pterygoplichthys multiradiatus*	Orinoco sailfin catfish			E*										A
Loricariidae	*Pterygoplichthys pardalis*	Amazon sailfin catfish									R*				A
Notopteridae	*Chitala ornata*	clown knife			E?										A
Pimelodidae	*Phractocephalus hemioliopterus*	redtail catfish			R										A
Pimelodidae	*Rhamdia quelan*	bagre			R*										A
Poeciliidae	*Belonesox belizanus*	pike killifish			E*										A
Poeciliidae	*Poecilia latipunctata*	broadspotted molly			R										A
Poeciliidae	*Poecilia petenensis*	swordtail molly			R										A
Poeciliidae	*Poecilia reticulata*	guppy			E?									E	A
Poeciliidae	*Poecilia sphenops* (?)	liberty molly			E?										A
Poeciliidae	*Xiphophorus hellerii*	green swordtail			E*									E	A
Poeciliidae	*Xiphophorus maculatus*	southern platyfish			E*									E	A
Poeciliidae	*Xiphophorus variatus*	variable platyfish			E*										A
Salmonidae	*Salmo letnica*	Ohrid trout											R		S
Salmonidae	*Salmo trutta*	brown trout	R*	E	R*	E*	E?			E*	E	E?*	R		S
Synbranchidae	*Monopterus albus* (?)	swamp eel			E*	E*									?

Appendix B. Numbers of introduced and established species in each southeastern state of both native and foreign origins.

	Total number introduced	Number established	Percentage established	Number of established natives	Number of natives introduced	Percentage of natives established	Number of established exotics	Total number exotics introduced	Percentage of exotics established	Main Vector
AL	53	33	62%	31	40	78%	2	13	15%	stocking
AR	48	30	63%	26	37	70%	4	11	36%	stocking
FL	122	53	43%	20	30	67%	33	92	36%	Aquarium trade
GA	65	45	69%	40	51	78%	5	14	36%	stocking
KY	55	35	64%	31	43	72%	4	12	33%	stocking
LA	28	13	46%	8	17	47%	5	11	45%	stocking
MS	23	16	70%	12	16	75%	4	7	57%	stocking
NC	83	65	78%	59	73	81%	6	10	60%	stocking
PR	29	26	90%	14	14	100%	12	15	80%	stocking
SC	38	28	74%	24	30	80%	4	8	50%	stocking
TN	49	31	63%	27	39	69%	4	10	40%	stocking
AVG	**59**	**38**	**72%**	**29**	**39**	**82%**	**8**	**20**	**49%**	