

**INTRODUCED NON-NATIVE FISHES AND SHELLFISHES  
IN TEXAS WATERS: AN UPDATED LIST AND DISCUSSION**

by

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## ABSTRACT

Since 1874, at least 102 taxa of fishes and shellfishes have been introduced into Texas, including non-native (exotic) species, their genetic variants and hybrids, as well as releases of native Gulf of Mexico marine and estuarine species into inland waters (but not including interbasin transfers or non-native subspecies of native species). Among these, about 30% are known, or believed, to be established. Known or probable sources of first introductions include: federal agency (20%), state agency (30%), ornamental fish trade and public aquaria (28%), fish farms and bait dealers (7%), other sources (3%), and undetermined origins (12%). Aside from common carp (*Cyprinus carpio*) introduced by government agencies, generally, the most-ecologically problematic species have originated from the ornamental fish trades sources, fish farms, and live bait dealers. Some exotic species are now irreversibly elements of aquatic ecosystems in Texas. Preventing additional exotic fishes and shellfishes from further affecting aquatic resources in the state will remain a challenge into the future.

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## INTRODUCTION

The introduction of species from foreign lands has been part of man's history from prehistoric trade in non-native (exotic) birds (Courtenay and Stauffer 1990) to relocation of common carp (*Cyprinus carpio*) from the Danube River of eastern Europe into Greece and Italy during the Roman Empire, and ultimately throughout Europe (Welcomme 1984). However, Courtenay and Stauffer (1990) indicated that one could not inject a non-native species, plant or animal, into an ecosystem without altering that system. Indeed, Courtenay et al. (1974) further stated that any addition to an aquatic ecosystem, including biological factors, could be considered a pollutant.

An array of federal and state agencies, universities, commercial sector, and private individuals have been associated with the introduction of exotic fishes and shellfishes into Texas waters. The U.S. Commission on Fish and Fisheries (later the U.S. Bureau of Fisheries, USBF, and ultimately the U.S. Fish and Wildlife Service, USFWS) was created in 1871 (Nico and Fuller 1999). From the outset, one of its missions was to produce, distribute, and stock fishes throughout the country. Accordingly, Texas saw its first exotic fish introductions as early as 1874, when the USBF introduced American shad (*Alosa sapidissima*) and Chinook salmon (*Oncorhynchus tshawytscha*) in state waters (Baird 1876). Other introductions followed. Texas created a Fish Commission (TFC) in 1879 and constructed its first fish hatchery at Barton Springs in Austin in 1881 specifically to produce common carp (Thompson 1943). In subsequent years, both federal and state facilities produced and stocked numerous fishes and shellfishes in Texas waters.

Additional introductions came from university biologists, releases and escapes from private fish farms, the live bait industry, deliberate stockings by private individuals, and aquarium and water garden sources. Some exotic species probably reached Texas waters inadvertently when other fishes were being stocked, in ship ballast waters, or boats trailered here from outside the state.

This report presents a summary of exotic fishes and shellfishes introduced into Texas waters. This list includes fishes, crustaceans, and mollusks not native to Texas, as well as species native to marine or estuarine waters of the state but stocked at inland locations (where they would not naturally occur). Also included are hybrids of non-native species and genetic variants, with several marine examples as well. In several instances, exotic species that are known to be present at aquacultural facilities in the state, but have not yet escaped or been released, are also discussed. Not included are interbasin transfers of species otherwise native to Texas, introduced exotic strains or subspecies of native species, or records of coastal species that occasionally enter freshwater under natural conditions.

## MATERIALS AND METHODS

The following list was prepared from published literature, unpublished TPW stocking history records and departmental reports, unpublished records of the author and exotic species coordinator, as well as historical federal reports. In the following list, taxa are generally presented in taxonomic order and grouped as exotic fishes, native marine and estuarine fishes introduced inland, mollusks, and crustaceans, respectively. Reported sources of origin and "best guess estimates" of exotic introductions were tallied to produce the percent contribution from various sources of introductions. Several exotic taxa present, or once present, under culture conditions in Texas are discussed, but were not included in calculations because they were not released.

## ANNOTATED RESULTS

### Species Accounts

#### Exotic Fishes Introduced Inland

##### *Arapaima* (*Arapaima gigas*).

A single individual (508 mm in length) found dead on the shoreline of Lake Grapevine (Trinity River drainage), Tarrant County, 18 May 1995, is the only record for the state (TPW, unpublished data). Source of introduction is uncertain, but probably originated in the pet trade.

*Arowana (Osteoglossum sp.)*

A single individual 508 mm in length (probably silver arowana *O. bicirrhosum*, but identity not confirmed) found at Pebble Beach Park, Lake Lavon (Trinity River drainage), Collin County, summer 1990, is the only record for the state (TPW, unpublished data). Source of introduction is uncertain, but probably originated in the pet trade.

*Clown knifefish (Notopterus chitala)*

One specimen (ca. 430 mm in length) taken in Nasworthy Reservoir (Concho River-Colorado River drainage), Tom Green County, August or September 1992, and a second (ca 300 mm in length) from Lake Bryan (Brazos River drainage), Brazos County, 1993, are the only records for the state (TPW, unpublished data). Source of introduction is uncertain, but probably originated in the pet trade.

*Blueback herring (Alosa aestivalis)*

This species was brought to Texas from South Carolina by TPW and stocked in Lake Theo (Red River drainage), Caprock Canyons State Park, Briscoe County, and in a second lake (12-D; Trinity River drainage) in the Lyndon B. Johnson National Grasslands, Wise County, in 1982 to study its value as a forage fish in place of threadfin and gizzard shads (*Dorosoma* spp.) (Guest 1983, 1988; Howells 1992a). The species was still present in Lake Theo in 1998 (C.R. Munger, TPW; pers. comm.); continued survival is possible, and there has been no indication of escapes from either stocking site.

*American shad (Alosa sapidissima)*

The USBF imported and introduced over 3,000,000 at sites in the Brazos, Big Cypress, Colorado, Guadalupe, Sabine, San Antonio, San Marcos, and Trinity drainage basins in Texas from 1874 through at least 1905 (see summary in Baughman, undated). All stockings failed.

*Common carp (Cyprinus carpio)*

This species was brought to Texas in 1882 and 1883 by the USBF for production and distribution (Baughman undated, 1950; Hubbs 1982; Howells 1992a, b). It is now well established statewide. More-recently, TPW, pet trade, and water garden sources have produced and distributed domestic koi forms of this species. Some of these domestic strains have also been observed in the field.

*Goldfish (Carassius auratus)*

As early as 1883, the USBF began distributing goldfish in Texas. Subsequent production by TPW as a hatchery-forage species, and pet trade and water garden sources have resulted in periodic releases statewide (Baughman undated; Hubbs 1982; Howells 1992a). Goldfish is probably established at locations throughout the state, but is rarely very abundant, and probably maintained at some sites by periodic restocking.

*Grass carp (Ctenopharyngodon idella)*

There is little documentation of the first grass carp collections in Texas, but illegal importations occurred in the 1970s, and possibly earlier. The first legal stocking of fertile diploid fish was by Texas A&M University in Lake Conroe (San Jacinto River drainage), Montgomery County, and Lewis Creek Reservoir (San Jacinto River drainage), Montgomery County, in 1981 (Noble et al. 1986; Howells 1999). Illegal introductions in the area, escapees from Conroe stockings, or both (Trimm et al. 1989) led to a successfully reproducing population in the Trinity River downstream of Lake Livingston (Webb et al. 1994, 2000; Howells 1999). Texas A&M University stocked triploid grass carp under permit at Lilypons Water Gardens, Inc. (Brazos River drainage), Brookshire, Waller County, 1988-1989 (Strawn et al., undated). In 1989 under public pressure to allow use of triploid grass carp for vegetation control, TPW initiated experimental stockings in impoundments or canals at 10 locations in Guadalupe, Trinity, Lavaca-Navidad, lower Rio Grande, and Canadian river systems (TPW, unpublished data). In 1992, the TPW Commission authorized stocking of triploid grass carp in private waters for vegetation control under permits issued by the agency. Some stocked triploid grass carp in Texas have been documented moving a maximum 1-way distance of 325 km from the stocking site and crossing a maximum of 10 dams (Prentice et al. 1998). Legally- or illegally-stocked diploid fish, or their progeny, and escaped triploids may be encountered statewide. Reproduction is probably ongoing in the lower Trinity River, but has not been documented elsewhere in Texas to date.

**Bighead carp (*Hypophthalmichthys/Aristichthys nobilis*).**

Other than grass carp, TPW did not legally restrict Asian carps until 1990 when it became necessary to obtain a permit to possess several species. Prior to that time some fish farmers produced and sold bighead carp for use as live bait. Additionally, bighead carp have been found as contamination in imported shipments of grass carp (TPW, unpublished data). Bighead carp that were presumably bait-bucket releases or escapees from fish farms and grass carp stocking sites have been found at locations throughout Texas since approximately 1985 when the first specimen was netted in Lake Conroe. Additional collections have included: Victor Braunig Reservoir (San Antonio River drainage), Bexar County, one in 1992-13.9 kg, one in 1995-19.1 kg, and one in 2000-13.6 kg; private pond in Bexar County (San Antonio River drainage), three in 1993, 1.4 kg each; undefined water body in Bexar County near Van Ormy (San Antonio River drainage), 1998, one at 1.1 m and 21.8 kg; Fort Phantom Hill Reservoir, Jones County, one at 1.3 m and 29.5 kg (Brazos River drainage); three from Lake Kirby (Brazos River drainage), Taylor County, including one at 1.3 m and 40.8 kg (the current "all tackle" record, National Fishing Hall of Fame), another at 27.2 kg, and a third unmeasured; and Red River 14.5 km downstream of Dennison Dam at Lake Texoma (Red River drainage), Grayson County, one at 1.1 m and 15.0 kg. Photographs of a decomposing specimen found tangled in a gill net in Red River Oxbow pond (Red River drainage) northeast of Bonham, Fannin County, in 1994, were sent to Heart of the Hills Research Station (HOH), Ingram, Texas, by K. Winemiller (Texas A&M University, College Station); the carcass was not positively identified, but appeared to be this species. Most collections represent single-specimen or single-incident situations and there is no evidence of spawning in Texas to date. However, spawning requirements are nearly identical to those of grass carp that has successfully spawned in Texas.

**Hybrid grass carp (*C. idella x H. nobilis*).**

Until 1990 (with grandfathered fish to 1995), hybrid grass carp could be possessed and stocked in Texas without a permit. Hybrid grass carp were also stocked in Lewis Creek Reservoir (San Jacinto River drainage), Montgomery County, in 1983 by Texas A&M University (Noble et al. 1986). However, based on research on hybrid grass carp obtained by TPW for study at HOH and at four, widely separated sites throughout the state that found a wide variation in ploidy and variable viability (Prentice 1993), these hybrids were placed on the prohibited list. It is unlikely more than a few older survivors from original stockings could persist in the state and no recent collections have been reported to TPW.

**Other Asian carps.**

At least two other Asian carps have been imported into Texas and are currently under confinement here. Black carp (*Mylopharyngodon piceus*) was reportedly brought to Texas by A&M University in 1989 and stocked in an unidentified pond to control applesnails (*Pomacea* sp.) (Collins 1996); however, these specimens were apparently transferred to a commercial fish farmer (Nico and Williams 1996). In subsequent years, several fish farmers were granted permits by TPW to possess black carp as well. Additionally, silver carp (*Hypophthalmichthys molitrix*) has also been imported for use in sewage disposal ponds (TPW, unpublished data). Neither species has been found outside of fish-farm or sewage-lagoon situations to date, but escapes in the future are likely. Both have spawning requirements similar to grass carp and would probably be able to reproduce here.

**Ide (*Leuciscus idus*).**

This species was brought to Texas by the USBF from 1885 through 1896, usually under the name orfe or golden orfe. Some were sent to San Antonio, with further distribution to other locations (see summary in Baughman, undated). All stockings were unsuccessful.

**Rudd (*Scardinius erythrophthalmus*).**

Fish farmers and live bait dealers in Texas began importing this species in the mid- to late 1980s. Several specimens were taken in field collections in four reservoirs in 1989 including: one at Lake Texoma (Red River drainage), Grayson County; two in Victor Braunig and two in Calaveras reservoirs (San Antonio River drainage), Bexar County; and one from Lake Whitney (Brazos River drainage), Hill County (Howells et al. 1991b), with an additional specimen from Canyon Lake (Guadalupe River drainage), Comal County, June 1990 (Whiteside and Berkhouse 1992). TPW ultimately prohibited importation and sale of this species. None have been reported since 1990, except for a number of specimens purportedly collected in the Dallas area and shown to B.G. Whiteside in 1999 (Southwest Texas State University, San Marcos, Texas; pers. comm.). However, there has been no subsequent confirmation of the species in the Dallas area or elsewhere in Texas.

Tench (*Tinca tinca*).

From 1894 through 1898 the USBF released approximately 20,000 tench in Texas waters, with distribution to: Arlington and Fort Worth (Trinity River drainage), Tarrant County; Dallas (Trinity River drainage), Dallas County; Loraine (Colorado River drainage), Mitchell County; Austin (Colorado River drainage); San Marcos (San Marcos River-Guadalupe River drainage); several sites near Cisco (Brazos River drainage), Eastland County; Longview (Sabine River drainage), Gregg County; and Palestine (Neches River drainage), Anderson County (Baughman 1947). All introductions were unsuccessful.

Tiger barb (*Puntius tetrazona*).

Several specimens were taken in Cy Miller Pond (Brazos River drainage), Brazos County, June 1995 (TPW, unpublished data). Subsequent collections failed to find this species and none are known to remain in the state. These specimens were probably from aquarium releases.

Redbellied or red piranha (*Pygocentrus* spp.).

A specimen (119 mm TL, 119 g) was taken by an angler in Boerne City Reservoir (San Antonio River drainage), Kendall County, in the early 1980s; it appeared to be *P. nattereri* (Howells et al. 1991a). A second individual was found dead in Nasworthy Reservoir (Concho River-Colorado River drainage), Tom Green County, June 2000 (J.A. Dennis, TPW; pers. comm.). Both specimens were probably aquarium releases.

Black pacu (*Colossoma macropomum*).

Several specimens reported included: Forest Lake near Longview (Sabine River drainage), Gregg County, July 1988, 381 mm TL; Eagle Point near Houston (Trinity Bay drainage), Harris County, August 1988, 406 mm TL, 1.7 kg, collected at 10 ppt salinity; Branch Creek (Neches River drainage), Port Arthur, Jefferson County, May 1990, 279 mm TL; bar ditch (Neches River drainage), Port Arthur, Jefferson County, April 1995; Dietert Creek (Guadalupe River drainage), Kerrville, Kerr County, June 1995, ca. 305 mm TL; and Lake View Pond (Oso Creek drainage), Corpus Christi, Nueces County, March 1995, 76 mm in length (Howells et al. 1991a; TPW, unpublished data). All represent scattered individual specimens with no evidence of established populations. All were probably aquarium releases.

Redbellied pacu (*Piaractus brachypomus*).

Specimens reported included: Lake Bastrop (Colorado River drainage), Bastrop County, June or July 1987; Colorado River near Bastrop, Bastrop County, July 1987, 232 mm TL, Colorado River 1.6 km downstream of Bastrop (Colorado River drainage), Bastrop County, August 1991, 360 mm, 977.6 g; Lake on Texas A&M University campus near SH 6 (Brazos River drainage), Brazos County, May 1993; 432 mm, 1.6 kg; Cleveland Lake (Brazos River drainage), Sugar Land, Fort Bend County, December 1991, 432 mm TL, 1,950 g; lake at Missouri City (Brazos River drainage), Fort Bend County, March 1994, two specimens, each about 330 mm in length; Trinity Bay at Tri Cities Beach Road, Baytown, Harris County, July 1990, 340 mm TL, 1.0 kg, 9 ppt salinity; freshwater canal (Neches River drainage), Jefferson County, Nederland, June 1990, 298 mm TL; Main Canal B at US 69/96 (Sabine Lake drainage), Jefferson County, July 2000, 303 mm TL, 53.1 g; private pond near Cleburne (Brazos River drainage), Johnson County, June 1989, 2.3 kg; All American Rice Growers Canal (Trinity River drainage), Dayton, Liberty County, October 1990, one specimen 1,263 mm TL taken by an angler and three others reportedly seen; Lake Worth (Trinity River drainage), Tarrant County, September 1996; Town Lake (Colorado River drainage), Austin, Travis County, June 1985, large adult; Onion Creek (Colorado River drainage), Austin, Travis County, July 1992; and San Antonio River near Floresville, Wilson County, July 1992, 470 mm, 2.3 kg (Howells et al. 1991a; TPW unpublished data). Although there have been reports of exceptionally large specimens observed in Spring Lake (Hays County) and Buffalo Bayou (Harris County) that suggest overwintering may occur, there has been no confirmation to date. No established populations are known. All were probably aquarium releases.

Smallscale pacu (*Piaractus mesopotamicus*).

A single specimen from Dietert Creek (Guadalupe River drainage), Kerrville, Kerr County, July 1995, ca. 305 mm TL, is the only confirmed record from the state (RGH, unpublished data). This was probably an aquarium release.

Unidentified pacu (*Colossoma/Piaractus* spp.).

Many pacus taken to TPW offices or otherwise reported to the agency are not identified to genus or species. These records include: Sam Rayburn Reservoir (Neches River drainage), Angelina County, July 1991, 305 mm TL,

454 g; Lake Lavon (Trinity River drainage), Collin County, one in June 1987, 280 mm TL, 0.45 kg and a second during summer 1989; Lake Lewisville (Trinity River drainage), Denton County, October 1994, 0.9 kg; Guadalupe River, railroad trestle at Cuero, DeWitt County, July 1995, 406 mm; Rhodair Gully north of Taylor Bayou (Sabine Lake drainage), Jefferson County, September 1990, ca. 300-350 mm TL; San Marcos River at the mouth of the Blanco River (Guadalupe River drainage), Hays County, July 1990, 381 mm TL, 2.3 kg; Medina River (San Antonio River drainage), Medina County, July 1988, 406 mm, 1.4 kg; Eagle Mountain Reservoir (Trinity River drainage), Tarrant County, September 2000, 451 mm, 1.5 kg; Lake Arlington (Trinity River drainage), Tarrant County, October 1994, 1.07 kg; Lake Benbrook (Trinity River drainage), Tarrant County, October 1994, 267 mm TL; Lake Grapevine (Trinity River drainage), Tarrant-Denton counties, October 1994, two specimens, one at 356 mm and a second at 254 mm, 340 g; Lake Worth (Trinity River drainage), Tarrant County, October 1994, 206 mm, 153 g; Mullin's Crossing on the Concho River (Colorado River drainage), Tom Green County, June 1994, ca. 0.23 kg; and Nasworthy Reservoir (Concho River - Colorado River drainage), Tom Green County, one specimen on August 1992 at 311 mm and 0.51 kg and a second on July 1994, between 0.11 and 0.23 kg (Howells et al. 1991a; TPW, unpublished data). None of these locations are known to support established populations. All were probably private or public aquarium releases.

Suckermouth catfish (*Hypostomus* spp.).

Specimens of "plecostomus" have been reported from: the headwaters and adjacent springs of the San Antonio River, Bexar County, since 1964 (Barron 1964) with subsequent reports through the present (Hubbs et al. 1978, Hubbs 1982, Howells 1992a; and Edwards 2001); Victor Braunig and Calaveras reservoirs (San Antonio River drainage) in 2000, Bexar County, (TPW, unpublished data); Landa Lake in 1991 (Whiteside and Berkhouse 1992) and the adjacent headwaters of the Comal River (Guadalupe River drainage) in 1991 (Hubbs et al. 1991; Howells 1992a), Comal County; San Marcos River (Guadalupe River drainage), several locations in San Marcos, Hays County, 1994 through 1997, specimens from 21 to about 200 mm; Buffalo Bayou, Houston, Harris County, June 2000 (TPW, unpublished data); Lakeview Pond (Oso Creek drainage), Nueces County, April 1995, 42 specimens 104 to 260 mm in length (TPW, unpublished data); and San Felipe Creek (Rio Grande drainage), Del Rio, Val Verde County, August 2000 (Edwards 2001). The population in the upper San Antonio River has been established for several decades. Other populations in the San Marcos and Comal rivers, Buffalo Bayou, and Victor Braunig and Calaveras reservoirs may be established as well. The status of the San Felipe Creek introduction is uncertain. All were probably aquarium releases, except for the San Antonio River population that was released by San Antonio Zoo personnel.

Snow pleco or southern sailfin catfish (*Pterygoplichthys anisitsi*).

Texas records include: Calaveras Reservoir (San Antonio River drainage), Bexar County, March 1997, 387 mm, 604 g; and Lake Dunlap (Guadalupe River), Guadalupe County, October 1997, one at 471 mm and 0.98 kg and a second that was deformed and not measured (TPW, unpublished data). These specimens were originally identified as sailfin catfish (*P. multiradiatus*), but subsequent analysis found them to be *P. anisitsi* (Fuller et al. 1999). Nico and Martin (2001) reported confirmed collections of this species at three sites in the Buffalo Bayou system (Sims and Brays bayous), with two additional unconfirmed locations in the same system between 1996 and 1999, including collections of juveniles and gravid females. The Buffalo Bayou population appears to have been present since at least 1996 (Nico and Martin 2001). All were probably aquarium releases.

Vermiculated sailfin catfish (*Pterygoplichthys disjunctivus*).

Texas records include: upper San Antonio River, San Antonio, Bexar County, 42-265 mm TL, numerous, August 2000; Sims Bayou (Buffalo Bayou drainage), Harris County, 230 mm SL, July 230; and San Marcos River (Guadalupe River drainage), San Marcos, Hays County, 15 mm SL, September 1996 (Edwards 2001). This species may be established in the upper San Antonio River drainage, but its status in other waters is uncertain. All were probably aquarium releases. Nico and Martin (2001) discussed variation in specimens from U.S. waters and discussed the possibility of hybridization within this group, where classification is already confused. Indeed, R.J. Edwards (University of Texas-Pan American, Edinburg; pers. comm.) suggested that *Pterygoplichthys*, like *Hypostomus*, may be too confused to allow confident species designations.

Raphael catfish (*Platydoras costatus*).

A specimen was obtained from San Felipe Creek (Rio Grande drainage), Del Rio, Val Verde County, in September 1999, 162 mm TL, 64 g (TPW, unpublished data). This was probably an aquarium release.

Leopard catfish (*Perrunichthys perruno*).

A single specimen was taken by an angler in Cedar Bayou (Trinity Bay drainage), Harris-Chambers counties, March 1992, 533 mm TL, 1.29 kg (Fuller et al. 1999; TPW, unpublished data). No subsequent collections have been documented. This was probably an aquarium release.

Northern pike (*Esox lucius*).

Between 1967 and 1981, approximately 1.5 million northern pike were stocked by TPW as a game fish in 21 reservoirs in drainages from the Red River to the Rio Grande (TPW, unpublished data). Because this is a long-lived species, some individuals may still remain in state waters, but generally, no large, well-established populations are known to persist.

Muskellunge (*Esox masquinongy*).

In 1975 and 1976, approximately 2,700 muskellunge were stocked by TPW as a game fish into Inks Lake (Colorado River drainage), Burnet-Llano counties; Copper Breaks State Park Lake (Pease River – Red River drainage), Hardeman County; and Amistad Reservoir (Rio Grande drainage), Val Verde County (TPW, unpublished data). Although this is a long-lived species and individuals may have survived, none have been reported in many years.

Hybrid northern pike x muskellunge.

In 1974 and 1975, approximately 3,300 of these hybrids were stocked by TPW as a game fish in Bouton Reservoir (Neches River drainage), Angelina National Forest, Jasper County (TPW, unpublished data). None are known to persist.

Hybrid northern pike x chain pickerel (*Esox niger*).

In 1976 and 1977, approximately 38,000 of these hybrids were stocked by TPW as a game fish in Texas waters including: Meridian State Park Lake (Brazos River drainage), Bosque County; Lake Leon (Brazos River drainage), Eastland County; Copper Breaks State Park Lake (Pease River – Red River drainage), Hardeman County; Alcoa Reservoir (Brazos River drainage), Milam County; Lake Nacona (Red River drainage), Montague County; Mill Creek Reservoir (Sabine River drainage), Van Zandt County; Lake Raven (San Jacinto River drainage), Walker County. None are known to persist.

Rainbow trout (*Oncorhynchus mykiss*).

This species was brought to Texas by the USBF in 1882 (Burr 1945), with numerous subsequent stockings by TPW, private individuals, and other organizations through the present. In McKittrick Creek, Guadalupe Mountains State Park, Culberson County, introduced rainbow trout replaced native Rio Grande cutthroat trout (*O. clarki virginialis*) and is now established (Garrett and Matlock 1991). Over-summer survival may occur in the Guadalupe River downstream of Canyon Reservoir Dam (Comal County), the Brazos River downstream of Possum Kingdom Reservoir Dam (Palo Pinto County), and some private spring headwaters. Otherwise, stockings are on a put-and-take basis, with no summer survival.

Redband trout (*Oncorhynchus mykiss* ssp.).

This fish was imported and stocked by TPW because of possible greater heat tolerance over other rainbow trout strains (Sonski 1982, 1984). Approximately 8,400 specimens were released in 1983 and 1986 in the Guadalupe River downstream of Canyon Reservoir Dam, Comal County (TPW, unpublished data). Current status is uncertain.

Coho salmon (*Oncorhynchus kisutch*).

TPW stocked 1,245 specimens in Inks Lake (Colorado River drainage), Llano-Burnet counties, in 1974 (TPW, unpublished data). None are known to remain.

Chinook salmon (*Oncorhynchus tshawytscha*).

The USBF imported and stocked this species in 1874, with approximately 20,000 released at sites including the Brazos River at Hempstead, Austin-Waller counties, and Colorado River at Austin, Travis County (Baird 1876; Smiley 1884; Hedgpeth 1945). None survived.

Atlantic salmon (*Salmo salar*).

An 1881 attempt by the USBF to introduce this species failed when eggs from a sea-run strain died (MacCrimmon and Gots 1979).

Brown trout (*Salmo trutta*).

The USBF distributed Von Behr strain brown trout in Texas in 1895 and Loch Leven strain specimens in 1938 (see summary in Baughman, undated). From 1973 through 1993, TPW stocked approximately 124,700 brown trout in the Guadalupe River downstream of Canyon Reservoir Dam, Comal County; Rita Blanca Reservoir (Canadian River drainage), Hartley County; Lake Meredith (Canadian River drainage), Hutchinson-Moore-Potter counties; and Lake Mackenzie (Red River drainage), Swisher-Briscoe counties (TPW, unpublished data). Trout clubs and private individuals have likely introduced this species as well. None are known to persist.

Brook trout (*Salvelinus fontinalis*).

TPW released nearly 7,000 brook trout into the Guadalupe River downstream of Canyon Reservoir Dam, Comal County, in 1981 (TPW, unpublished data). None are known to have survived.

Pike killifish (*Belonesox belizanus*).

A population reported by Barron (1964) in the spring headwaters of the San Antonio River, Bexar County, was not found subsequently by Hubbs et al. (1978), Howells (1992a), or Edwards (2001). The original introduction likely came from release of aquarium fish.

Mexican molly (*Poecilia mexicana*).

This species was reported in Texas by Courtney et al. (1984). It was not listed by Hubbs (1982) or Hubbs et al. (1991), nor found by or reported to the author. No populations are currently known to exist in Texas. The aquarium trade could have been the source of this species.

Guppy (*Poecilia reticulata*).

This aquarium species has been introduced at two sites including: Barton Springs (Colorado River drainage), Austin, Travis County (Edwards 1976) and the headwater springs of the San Antonio Zoo and just downstream in adjacent upper San Antonio River headwaters in Brackenridge Park, San Antonio, Bexar County (Hubbs et al. 1978). The Austin population disappeared shortly after being discovered (Edwards 1976). The San Antonio population was abundant when first reported (Edwards 2001), was not found by Howells in the mid- and late 1980s (Howells 1992a), but was confirmed present by Edwards (2001) in 2000, though at reduced numbers. These introductions were probably from aquarium releases.

Green swordtail (*Xiphophorus helleri*).

Howells (1992a) reported this species as present in the spring head waters of the San Antonio River within the San Antonio Zoo, Bexar County, in 1985-88 and 1990. Edwards (2001) collected a single specimen downstream of the zoo in 2000, confirming its continued presence. The present population likely originated from pet-trade or public aquarium releases or escapes. It appears to be established.

Bluefin killifish (*Lucania goodei*).

This species was collected in 1998 by B.J. Gallaway (LGL Ecological Research Associates, Bryan, Texas) from a man-made wetland constructed on duPont de Nemours Company property (Guadalupe River drainage), Victoria County. The species was likely introduced with aquatic plants brought from Florida when the wetland was built. Based on different size classes present in 1999 and 2000, it appears to be established, but has not been taken in collections from other adjacent sites to date (B.J. Gallaway; pers. comm.).

Mesa or Mexican silverside (*Chirostoma jordani*).

Records of this species in Texas reflect releases of fertilized eggs by Mexican authorities into the Rio Grande impoundments Amistad Reservoir, Val Verde County, and Falcon Reservoir, Zapata County, prior to June 1975, apparently as a food source for local human residents (see discussion in Fuller et al. 1999). A suggestion by Howells (1992a) that records of this species reflect collections by C. Hubbs is incorrect (Fuller et al. 1999). No members of this genus are known to be present in Texas waters at this time.

**Tanganyika Nile perch (*Lates angustifrons*).**

Nile perches were examined by TPW as a potential game fish and for control of rough fish populations in heated, power-plant reservoirs in Texas (Thompson et al. 1977). When research studies indicated this genus posed too great an environmental risk, work with this group was halted and the remaining two specimens of this species were placed in Smithers Reservoir (Brazos River Drainage), Fort Bend County, in 1985 (Howells and Garrett 1992). Efforts to collect specimens by TPW and Boston Aquarium personnel in Smithers Reservoir in 1999 failed to find any members of this genus (W.S. Johnson, TPW, Bryan; pers. comm.) and none are known to have survived to the present (TPW, unpublished data).

**Bigeye Nile perch (*Lates mariae*).**

See discussion under Tanganyika Nile perch above. Six specimens were placed in Smithers Reservoir (Brazos River drainage), Fort Bend County, in 1985 (Howells and Garrett 1992). None are known to remain.

**Nile perch (*Lates niloticus*).**

See discussion under Tanganyika Nile perch above. Six specimens were placed in Smithers Reservoir (Brazos River drainage), Fort Bend County, in 1985 (Howells and Garrett 1992). Among these, a dead specimen was found in January 1990 following very cold weather (1,400 mm SL, 27 kg, but decomposing). Efforts to collect others in 1999 failed and none are known to remain.

**Nile perches (*Lates* spp.).**

See discussion under Tanganyika Nile perch above. Nile perches of mixed species composition (*L. angustifrons* and *L. mariae*) were stocked by TPW. From 1978 through 1984, 200 were released into Victor Braunig Reservoir (San Antonio River drainage), Bexar County; over 1,300 in 1983 in Fairfield Reservoir (Trinity River drainage), Freestone County; and approximately 68,000 in 1981 in Coletto Creek Reservoir, Goliad County (Howells and Garrett 1992). None have been documented from these waters in recent years.

**Striped bass (*Morone saxatilis*).**

Since 1965, TPW has stocked this game fish in nearly 50 reservoirs from the Red River to the Rio Grande, with approximately 117 million released (TPW, unpublished data). The species is established in Lake Texoma on the Red River where natural reproduction supports a fishery (Mauck 1991). Eggs and larvae have been documented in the Trinity River downstream of Lake Livingston, San Jacinto-Polk counties, but the extent of this reproduction is unclear (Kurzawski and Maddux 1991). The Trinity River and other Texas populations are maintained through stocking.

**Hybrid striped bass x white bass (*Morone chrysops*).**

TPW has produced and released approximately 164 million specimens of this hybrid since 1972 in over 90 reservoirs from the Red River to the Rio Grande. Existing populations are maintained by stocking (TPW, unpublished data).

**Hybrid striped bass x yellow bass (*Morone mississippiensis*).**

This hybrid was produced in 1977 when it was stocked into three reservoirs as a game fish: McClellan Reservoir (Canadian River drainage), Gray County; Lake Weatherford (Trinity River drainage), Parker County; and Gladewater City Reservoir (Sabine River drainage), Upshur County. In 1981, five individuals were also stocked into Old Ingram Reservoir (Guadalupe River drainage), Kerr County. None have been reported in recent years.

**Rock bass (*Ambloplites rupestris*).**

The USBF introduced this species from 1883 through 1898 at sites in the Brazos, Trinity, Colorado, and Guadalupe River Basins (see summary by Baughman, undated). TPW stocked 25,000 in 1945 and 1947 in Lake Texoma (Red River drainage)(TPW, unpublished data). The species is currently established in the San Marcos and central Guadalupe rivers, and possibly elsewhere (Hubbs 1982).

**Sacramento perch (*Archoplites interruptus*).**

McCarragher and Gregory (1970) indicated this species was introduced into Hamlin Lake (Brazos River drainage), Jones County, in 1966 and that subsequent netting surveys failed to find survival or reproduction from the original release.

Redbreast sunfish (*Lepomis auritus*).

It is unclear when or how this species was introduced into Texas waters, but Bollman (1892) listed it as present in the Rio Blanco (Blanco River – San Marcos River – Guadalupe River drainage). It is now established at numerous locations.

Shoal bass (*Micropterus cataractae*) or redeye bass (*Micropterus coosae*).

In 1976, TPW stocked 26 specimens in a private pond in Kerr County (Guadalupe River drainage) and in October 1977, five specimens from this pond were removed and stocked into Johnson Creek, Kerr County (TPW, unpublished data). Current TPW stocking list this species as shoal bass, but hand written notes from 1977 list it as redeyebass. Current status is unknown, but unpublished notes from the 1977 transfer indicate fish were in poor condition (though largemouth bass taken from the same pond were in good condition).

Smallmouth bass (*Micropterus dolomieu*).

TPW first introduced smallmouth bass in 1974 (Guest 1985). Approximately 11.2 million have been released at nearly 130 sites statewide from the Canadian River to the Rio Grande (TPW, unpublished data). It is currently established at numerous locations.

Hybrid smallmouth bass x largemouth bass (*Micropterus salmoides*).

Although this hybrid was produced and evaluated in Texas, it was not released into public waters (Prentice 1983).

Sauger (*Stizostedion canadense*).

TPW stocked 54,113 sauger into Belton Reservoir (Brazos River drainage) in 1984 (TPW, unpublished data). Surveys in 1993, 1996, and 1999 in this reservoir failed to find the species and there is no indication it persists there (M. Baird, TPW, Waco; pers. comm.).

Walleye (*Stizostedion vitreum*).

Walleye was first brought to Texas by the USBF in 1896 and released into Lake McDonald (Colorado River drainage), Austin, Travis County (Baughman, undated). TPW initiated stocking in 1954 and expanded efforts in 1964. Nearly 391 million have been released at over 65 locations from the Canadian River to the Rio Grande drainages (TPW, unpublished data). It is currently established in several reservoirs.

Hybrid walleye x sauger.

Approximately 353,000 of these hybrids, called saugeye, were produced by TPW in 1993, 1995, and 1996, and stocked into Live Oak City Reservoir (San Antonio River drainage), Bexar County; Sulphur Springs Reservoir (Sulphur River drainage), Hopkins County; Langsford Creek Reservoir (Sulphur River drainage), Red River County; Lake Kirby (Brazos River drainage), Taylor County; and Lake Gordon (Wichita River-Red River drainage), Wichita County (TPW, unpublished data). These introductions are still being evaluated by fishery managers.

Yellow perch (*Perca flavescens*).

This species was first brought to Texas by the USBF before the turn of the century (McDonald 1893). Federal stocking sites included: Salado Creek, San Antonio (San Antonio River drainage), Bexar County; Frost (Trinity River drainage), Navarro County; Athens (Trinity-Neches River drainage), Henderson County; Picnic Lake (Sulphur River drainage), Sulphur Springs; and McDonald Lake (Colorado River drainage), Austin, Travis County. Additionally, from 1980 through 1996 TPW released approximately 860,000 at 30 sites, primarily in the Canadian and Red River drainages in northwestern Texas and the Texas Panhandle, but with other releases in Pittsburg City Lake (Big Cypress Bayou drainage), Camp County, and Teague Park (Sabine River drainage), Gregg County (TPW, unpublished data). Some populations appear to be established.

Orangemouth corvina (*Cynoscion xanthulus*).

TPW brought this species from the Salton Sea, California, and stocked 315 into Victor Braunig Reservoir in 1985, and in 1985 and 1986 released approximately 766,000 in Calaveras Reservoir (both San Antonio River drainage), Bexar County (Howells 1991b; Howells and Garrett 1992). Stockings were discontinued because of reduced cold tolerance in this species and potential of hybridization with native spotted seatrout (*C. nebulosus*). No reproduction is expected in freshwater (Howells 1990). A few probably remain, but will likely be eliminated by old age or anglers in the near future.

Hybrid orangemouth corvina x spotted seatrout (*Cynoscion nebulosus*).

During studies on orangemouth corvina, TPW produced these hybrids. Approximately 75,000 were stocked 1984 through 1986 in Calaveras Reservoir (San Antonio River drainage) Bexar County, Texas (Howells 1991b; Howells and Garrett 1992). Releases were discontinued and the few remaining will likely be eliminated by old age or anglers in the near future.

Oscar (*Astronotus ocellatus*).

Several specimens have been collected at various locations including: Victor Braunig Reservoir (San Antonio River drainage) and the San Antonio River, Bexar County, date not recorded (Fuller et al. 1999); Lakeview Pond (Oso Creek drainage), Corpus Christi, April 1996, 226 mm; and Lake Raven (San Jacinto River drainage), Walker County, fall 1991, ca 254 mm (TPW, unpublished data). All represent single-specimen collections that likely originated from aquarium releases. No established populations are known.

Peacock cichlid (*Cichla ocellaris*) and speckled pavon (*Cichla temensis*).

Approximately 20,600 were produced by TPW and stocked (without identification to species) in four power-plant reservoirs from 1978 through 1984 including: Lake Bastrop (Colorado River drainage), Bastrop County; Coletto Creek Reservoir (Guadalupe River drainage), Goliad County; Tradinghouse Creek Reservoir (Brazos River drainage), McClennan County; and Alcoa Reservoir (Brazos River drainage), Milam County (Garrett 1982; Howells and Garrett 1992). All were eliminated by extremely cold or hot temperatures (Howells and Garrett 1992).

Blue tilapia (*Oreochromis aureus*).

This species first appeared in Texas waters in the 1960s from bait bucket and fish farm releases (Howells 1992a). The first report of a self-sustaining population (Noble et al. 1975) was followed by numerous other reports, often from power-plant reservoirs or thermally-stable spring waters. Muoneke (1988) summarized records from Texas waters and Howells (1991a) reported electrophoretic analyses for identification of Texas populations. Nearly all feral tilapia populations examined throughout the state were found to be blue tilapia (except as noted below) and the species is well established at multiple locations.

Mozambique tilapia (*Oreochromis mossambicus*).

The first record of this species in Texas was from the San Marcos River (Guadalupe River drainage) in 1959 (Brown 1961), with subsequent reports from the San Antonio River headwaters, San Antonio, Bexar County (Hubbs 1961) and Canyon Reservoir (Guadalupe River drainage), Comal County (Whiteside 1975). However, specimens examined genetically by Howells (1991a) from the San Marcos River and Canyon Reservoir were found to be blue x Mozambique hybrids. Further, domestic color morphs of blue tilapia were introduced into the San Antonio population in the 1980s (TPW, unpublished data) and that population too appears to have been genetically contaminated (G. Stettner, San Antonio Zoo Aquarium; pers. comm.). The only genetically pure Mozambique tilapia remaining in Texas are likely restricted to fish farm stocks. The original introductions were apparently from a public aquarium, but more-recent records reflect fish farm releases or escapes.

Blue tilapia x Mozambique tilapia hybrids.

Howells (1991a) found these hybrids in the San Marcos River, Bexar County, and Canyon Reservoir, Comal County, both in the Guadalupe River drainage. He also reported blue x Mozambique tilapia hybrids were also found in Gibbons Creek Reservoir (Brazos River drainage), Grimes County. However, the Gibbons Creek Reservoir population appears to have been dominated by blue tilapia in recent years based on morphological appearance of that population.

Nile tilapia (*Oreochromis niloticus*).

This species was reportedly stocked into Buffalo Bayou, Harris County (Nico and Martin 2001) where it may be reproducing. However, the identity of these fish remains questionable. Due to the wide distribution of very similar blue tilapia in Texas, extensive hybridization among and variation within domestic stocks, and failure to confirm Nile tilapia in Texas waters with electrophoretic techniques (Howells 1991a), this species has tentatively not been counted as a confirmed introduction herein.

Redbelly tilapia (*Tilapia zilli*).

This species was first reported in the spring waters of the San Antonio River within the San Antonio Zoo, Bexar County, in 1978 (Hubbs 1982). It was also reported there by Howells (1991a, 1992a) and more-recently in 2000 by Edwards (2001). It appears established only at this location. The initial introduction was probably from aquarium sources.

Convict cichlid (*Cichlasoma nigrofasciatum*).

A single specimen was reported from the San Marcos River (Guadalupe River drainage), Hays County, September 1989 (Whiteside and Berkhouse 1992). It likely originated from an aquarium release.

Rift lake cichlid (*Pseudotropheus* sp.).

A single specimen was reported from the San Marcos River (Guadalupe River drainage), San Marcos, Hays County, September 1991 (Whiteside and Berkhouse 1992). It likely originated from an aquarium release.

Unidentified cichlid.

A single specimen was collected in a city park lake (Trinity River drainage), Tarrant County, October 2000, but despite being 254 mm in length, was not identified (TPW, unpublished data). It likely originated from an aquarium release.

#### Native Marine and Estuarine Fishes Introduced Inland

Tarpon (*Megalops atlanticus*).

Juvenile tarpon were obtained in Calhoun County in 1983 for use in cold-tolerance research. Controls and survivors ( $N = 34$ ) were released in Victor Braunig Reservoir (San Antonio River drainage), Bexar County, in December 1984 and March 1985 (Howells and Garrett 1992). Because these fish had been fresh-water acclimated and coastal water temperatures were too cold for release at that time, these tarpon were placed in this heated power-plant reservoir as sport fish, with no expectation of their reproducing or becoming established. A 4.9-kg specimen was taken by an angler in 1986 and another (12.2 kg) was found dead in 1989. Survivors could still remain in this reservoir, but have not been reported in many years.

Sheepshead minnow (*Cyprinodon variegatus*).

This species has been found established at sites in the Trans-Pecos (Rio Grande drainage), several counties, and San Antonio (San Antonio River drainage), Bexar County (Hubbs et al. 1991), with other collections elsewhere around the state (TPW, unpublished data). It has been especially problematic when introduced into areas containing other *Cyprinodon* species. Rectification efforts at these sites have been costly (Hubbs 1982). Multiple methods of introduction are likely including bait-bucket releases and contamination when other marine species have been stocked.

Gulf killifish (*Fundulus grandis*).

This species has been introduced and established at locations in Central and West Texas (Hubbs 1982), and elsewhere in the state (TPW, unpublished data). Anglers at Lake Buchanan (Colorado River drainage), Llano-Burnet counties, reported stocking this fish deliberately as a forage species for local game fishes. Many introductions likely reflect bait-bucket releases, but accidental stocking with other marine species is also possible.

Rough silverside (*Membras martinica*).

This species was found established in the 1990s in Canyon Reservoir (Guadalupe River drainage), Comal County (B.G. Whiteside, Southwest Texas State University, San Marcos; pers. comm.). Hubbs et al. (1991) also report it established in Amistad Reservoir, Val Verde County, and Falcon Reservoir, Zapata County, both on the Rio Grande. The sources of these introductions are uncertain.

Mullet (*Mugil* spp.).

Bowers (1906) reported 57 "sea mullet" transplanted into a natural salt lake at Palestine (Neches River drainage), Anderson County. None survived.

*Pinfish (Lagodon rhomboides).*

Pinfish was stocked by TPW in limited numbers in 1964 and 1965 in Red Bluff Reservoir (Pecos River-Rio Grande drainage), Reeves and Loving counties, and seepage pits near Imperial (Pecos River-Rio Grande drainage), Pecos County (Henderson 1966). None survived.

*Silver perch (Bairdiella chrysoura).*

Bowers (1906) reported 38 transplanted into a natural salt lake at Palestine (Neches River or Trinity River drainages), Anderson County. None survived.

*Spotted seatrout (Cynoscion nebulosus).*

Bowers (1906) reported 20 transplanted into a natural salt lake at Palestine (Neches River or Trinity River drainages), Anderson County. None survived. TPW initially released this species into Red Bluff Reservoir (Pecos River-Rio Grande drainage), Reeves and Loving counties, in 1960, 1961, and 1963; and in Imperial Reservoir (Pecos River-Rio Grande drainage), Pecos County, in 1960. More recently, TPW also stocked approximately 72,600 into Walter E. Long Reservoir (Colorado River drainage), Travis County, in 1974, 1975, and 1984 (TPW, unpublished data). Some were taken by anglers shortly after release, but none are known to persist.

*Spot (Leiostomus xanthurus).*

This species was stocked by TPW in 1960 in Imperial Reservoir (Pecos River-Rio Grande drainage), Reeves and Loving counties (Campbell 1964). None survived.

*Black drum (Pogonias cromis).*

This species was initially stocked by TPW into Red Bluff Reservoir (Pecos River – Rio Grande drainage), Reeves and Loving counties, in 1963 and 1964 (Henderson 1966). Nearly 200,000 black drum were produced and stocked by TPW into several reservoirs in 1976 and 1977 including: Victor Braunig Reservoir (San Antonio River drainage), Bexar County; Red Bluff Reservoir (Rio Grande drainage), Reeves and Loving counties; Lake Creek Reservoir (Brazos River drainage), McLennan County; and Walter E. Long Reservoir (Colorado River drainage), Travis County (Howells and Garrett 1992). None are known to have survived to the present.

*Red drum (Sciaenops ocellatus).*

Bowers (1906) reported 12 transplanted into a natural salt lake at Palestine (Neches River or Trinity River drainages), Anderson County. None survived. This species was also released in 1953 and 1954 in lakes Kemp (Wichita River-Red River drainage), Baylor County, and O.R. Mitchell (San Antonio River drainage), Bexar County (Lasswell et al. 1977). Further stockings in the Pecos River (Rio Grande drainage), Pecos County, in 1959 and in Imperial Reservoir, Pecos County and Red Bluff Reservoir, Reeves and Loving counties, as well as in seepage pits near Imperial, Pecos County, in 1960-1961 and 1963-1965 (Campbell 1964; Henderson 1966) saw survival, favorable growth, and angler catches. TPW began major stockings of hatchery-produced red drum in 1975 and introduced it into over 25 reservoirs and rivers in drainages from the Red River to the Rio Grande. Currently most inland stockings are restricted to: Victor Braunig and Calaveras reservoirs (San Antonio River drainage), Bexar County; Fairfield Reservoir (Trinity River drainage); Tradinghouse Creek Reservoir (Brazos River drainage), McLennan County; Colorado City Reservoir (Colorado River drainage), Mitchell County; and Nasworthy Reservoir (Concho River-Colorado River drainage), Tom Green County. Fisheries are maintained at these sites through periodic restocking. No reproduction is known or expected.

*Hybrid red drum x black drum.*

Approximately 143,000 of this hybrid, called brown drum, were produced and stocked by TPW as game fish in 1983 and 1984 into Victor Braunig Reservoir (San Antonio River drainage), Bexar County, and Lake Creek Reservoir (Brazos River drainage), McLennan County (Howells and Garrett 1992). None are known to have survived to the present.

*Atlantic croaker (Micropogonias undulatus).*

Bowers (1906) reported 30 transplanted into a natural salt lake at Palestine (Neches River or Trinity River drainages), Anderson County. Additionally, TPW released this species into Imperial Reservoir (Pecos River-Rio Grande drainage), Pecos County, in 1960 and in Red Bluff Reservoir (Pecos River-Rio Grande drainage), Reeves

and Loving counties, in 1961; it also stocked 250 into Town Lake (Colorado River drainage), Travis County, in 1975 (TPW, unpublished data). None are known to persist.

Southern flounder (*Paralichthys lethostigma*).

TPW released this species in 1960 in Imperial Reservoir (Pecos River – Rio Grande drainage), Pecos County, and in 1960-1961 and 1963-1965 in Red Bluff Reservoir (Pecos River- Rio Grande drainage), Reeves and Loving counties. During further experimental stockings from 1974-1978, TPW stocked nearly 7,500 into Boerne City Park Lake (San Antonio River drainage), Kendall County; Alcoa Reservoir (Brazos River drainage), Milam County; Town Lake (Colorado River drainage), Travis County; and Walter E. Long Reservoir (Colorado River drainage), Travis County (Howells and Garrett 1992). None are known to have survived to the present.

Naked goby (*Gobiosoma bosc*).

This species has become established in Victor Braunig and Calaveras reservoirs (San Antonio River drainage), Bexar County (Fuller et al. 1999). It was likely introduced accidentally when marine game fishes were released in these reservoirs.

### Exotic Mollusks

Giant rams-horn snail (*Marisa cornuarietis*).

This species was first reported in the San Marcos River (Guadalupe River drainage), Hays County, in 1983 (Neck 1984b), but had been observed earlier in 1981 (Horne et al. 1992). It was subsequently found in Landa Lake at the head of the Comal River (Guadalupe River drainage) in 1984 (Horne et al. 1992). More recently (August 2000) another population was reported by R.J. Edwards (Pan American University, Edinburg, Texas; pers. comm.) in the San Antonio River headwaters, Bexar County. The San Marcos and Comal River populations appear well established, though with cyclic levels of abundance, and have caused defoliation problems in local waters. Introductions likely originated from aquarium trade sources.

Channeled applesnail (*Pomacea canaliculata*).

Florida applesnail (*P. paludosa*) was reported from Texas waters in Matagorda, Harris, and Cameron (at Harlingen) counties (Fullington 1978). Neck (1984a, 1986) subsequently indicated the Cameron County report was actually channeled applesnail; he further reported a second specimen from Arroyo Colorado State Park, also in Cameron County, but considered the Matagorda and Harris County specimens to be Florida applesnails. Neck and Schultz (1992) reported another channeled applesnail shell found in a dry creek bed in Austin (Colorado River drainage), Travis County. However, these reports were of shells with no evidence of living specimens or established populations. An established population was documented by Neck and Schultz (1992) at Hedwig Village (Houston) in an unnamed tributary of Buffalo Bayou, Harris County, in 1989 and 1990; living specimens were confirmed present in March 2001 (C. Harris, Angleton; pers. comm.). Collins (1996) reported that during this same time period, Texas A&M University had applesnails of an unnamed species in a "demonstration" pond where black carp were studied as possible control agents). In 2000, TPW found established populations in the American Canal south of Houston (Brazos River-Galveston Bay drainage), Brazoria and Galveston counties, and Mustang Bayou (Galveston Bay drainage), Brazoria County (Howells 2001). In March 2001, living specimens and shells were found in the Briscoe Canal and Halls Bayou near Alvin, Brazoria County; shells were found in Chocolate Bayou, Brazoria County; and snails that had survived the winter were actively laying eggs in the American Canal and Mustang Bayou (C. Harris, Angleton; pers. comm.). Also, in March 2001, additional living specimens were reported from a small pond in Bedford (Fort Worth), Tarrant County, where snails and eggs had been observed one or two years earlier (M. Berg, Galveston; pers. comm.). In April 2001, yet another population was reported from a borrow pit in Barker Reservoir (upper Buffalo Bayou drainage), Houston (K. Brown, U.S. Army Corps of Engineers, Houston; pers. comm.). Channeled applesnail appears established in American Canal, Mustang Bayou, Hedwig Village, the pond in Bedford, and probably the other Alvin-area waters. Introductions probably originated from pet trade sources, with the possible exception of the Texas A&M University study group. Two additional established populations in private waters in southeastern Texas are known to TPW, but cannot legally be reported without landowner permission (Howells 2001).

Florida applesnail (*Pomacea paludosa*).

Fullington (1978) reported this species from Harris and Matagorda counties; Neck (1984a, 1986) examined the specimens and agreed with the identification. These were likely isolated aquarium releases and there have been no subsequent reports of this species in Texas (Howells 2001).

Mexican applesnail (*Pomacea flagellata*),

Andrews (1971) reported shells of this species from South Texas beaches. She indicated that gasses sealed within the shells of dead specimens washed from Mexican rivers often kept the shell afloat long enough to drift to Texas waters. Because there is no evidence to date of introduction of living specimens and records are based on seashore collections, this species has not been counted as an introduction herein.

Chinese mysterysnail (*Cipangopaludina chinensis malleata*).

Clench and Fuller (1965) reported this species from Waco (Brazos River drainage), McLennan County and Dundee (1974) listed museum records from Dallas and Tarrant counties (Trinity River drainage). A recently-dead shell was found by a diver in Lake Sweetwater (Brazos River drainage), Nolan County, in August 1995 (author, unpublished data). A large number of dead shells was found along the shoreline of Backman Lake (Trinity River drainage), Dallas County, in February 2001, but no living animals were located (M.D. Eisthen, Dallas; pers. comm.). Drought conditions and high temperatures in summer 2000 may have eliminated the Backman Lake population and deeper waters may have harbored survivors during the February 2001 examination. Nonetheless, there are no confirmations of established populations in Texas at present. However, this species and Japanese mysterysnail (*C. japonica*) are reared and sold in large numbers in the ornamental fish-pond trade in Texas. Releases of both should be expected statewide.

Red-rim melania (*Melanoides tuberculatus*).

This species was reported in Texas waters by Murray (1964) and Dundee (1974). TPW collections between 1992 and 2000 have documented it at locations including: Calaveras Reservoir (San Antonio River drainage), Bexar County; San Antonio River, San Antonio, Bexar County; Comal River headwaters, Comal County; San Marcos River headwaters, Hays County; Oxbow Pond, La Coma Tract of the Lower Rio Grande Valley National Wildlife Refuge (Rio Grande drainage), Hidalgo County; Lake Edinburg (Rio Grande drainage), Hidalgo County; Delta Lake (Rio Grande drainage), Hidalgo County; Las Moras Creek and Fort Clark Springs (Rio Grande drainage), Brackettville, Kinney County; Lake Balmorhea and adjacent springs and runs (Pecos River - Rio Grande drainage), Reeves County; and San Felipe Creek (Rio Grande drainage), Val Verde County. Recent unconfirmed sightings have also been reported for Diamond-Y Springs (Pecos River - Rio Grande drainage), Pecos County, and Barton Springs (Colorado River drainage), Travis County. Although not initially recognized as ecologically threatening as some other exotic gastropods, this species is now known to host a parasitic trematode that infects gills of Central Texas fishes including endangered species (U.S. Fish and Wildlife Service 1998) as well as other human parasites (Murray 1971).

Quilted melania (*Tarebia granifera*).

Murray (1971) reported this species from Bexar and Comal counties and Lindholm and Huffman (1979) listed it in the San Marcos River, Hays County. TPW collections between 1992 and 2000 have confirmed it in the upper San Antonio River springs, Bexar County; Comal River headwaters (Guadalupe River drainage), Comal County; and upper San Marcos River (Guadalupe River drainage), Hays County. It is particularly abundant in the upper San Marcos River. Introductions likely originated from pet trade releases.

Marbled apoxa (*Stenophysa marmorata*) and tawny apoxa (*Stenophysa maugeriae*).

Both pond or tadpole snail species were listed by Te (1978) as introduced into Texas and this record was subsequently repeated by Howells (1992a) and others. However, Te did not give location, date, or other collection specifics and their current status remains unclear. The method of introduction is also uncertain, but aquarium trade origin is a reasonable possibility.

Asian clam (*Corbicula fluminea*).

This species was first reported in Texas by Metcalf (1966) from the El Paso area. It has subsequently spread statewide from the Canadian River to the Rio Grande (Howells et al. 1996). Though often accused of displacing native unionids and causing ecological problems, evidence to support such claims is weak, though competition at some level must occur (Strayer 1999). It may have been deliberately introduced into North America's West Coast

as a food item (Strayer 1999), but has exceptional dispersal abilities through a variety of methods (McMahon 1982) as well as others not clearly understood.

#### Asian clam (*Corbicula* sp.).

Most sources recognize only a single species of Asian clam in North America (*C. fluminea*) (Howells et al. 1996; Strayer 1999). However, Hillis and Patton (1982) and McLeod (1986) provided electrophoretic evidence that a second species may be present from Texas to Arizona, with additional supportive evidence yet to be published (D.M. Hillis, University of Texas, Austin; pers. comm.). This species is often smaller than *C. fluminea*, has deep purple nacre, and is apparently more often found in spring habitats. TPW collections have produced specimens of this form at many locations throughout the state.

#### Zebra mussel (*Dreissena polymorpha*).

In the 1990s, this species escaped the Great Lakes and spread down the Mississippi River and its tributaries into Oklahoma, Arkansas, and Louisiana (Howells et al. 1996). Zebra mussel was not documented in Texas until November 1999 when found on a large boat trailered from Lake Michigan to Lake Grapevine (Trinity River drainage), Tarrant County (TPW, unpublished data). A marina operator noticed mussels on the boat hull and prevented launch until TPW personnel were contacted and sterilization was arranged.

#### Brown edible mussel (*Perna perna*).

This biofouling species was first collected along the Texas coast in 1990, but was likely introduced in ballast water in 1989 (Hicks and Tunnell 1994; Howells 1999). Although some biofouling problems have been reported in Texas, it has not been as environmentally problematic as first feared. Nonetheless, it still presents a high risk potential if populations suddenly expand.

### Native Mollusks Introduced Inland

#### Eastern oyster (*Crassostrea virginica*).

Bowers (1906) reported one barrel of oysters was transplanted into a natural salt lake at Palestine (Neches River or Trinity River drainages), Anderson County. None survived.

### Exotic Crustaceans

#### Pacific or Mexican white shrimp (*Litopenaeus vannamei*).

This species was taken by commercial shrimpers in the Brownsville Ship Channel, Cameron County, in 1988 and 1989 (Balboa et al. 1991). It was not collected again following cold winter temperatures in December 1989 and January 1990 (Howells 1992a). However, in 1998, specimens from several minor escapes were taken near Palacios, Matagorda County; but to date, there is no evidence the species is established in state waters (Ya-Sheng Juan, TPW, Brownsville; pers. comm.). This species can be cultured under a special permit and all captured specimens are believed to represent shrimp farm releases or escapes. An additional species, Pacific blue shrimp (*L. stylirostris*) is also being cultivated in Texas, but at sites on the Pecos River drainage (TPW, unpublished data) where risk of escape or disease introduction to native penaeid shrimp populations is significantly less than for Mexican white shrimp being reared in coastal shrimp farms.

#### American lobster (*Homarus americanus*).

McDonald (1893) reported lobsters (presumably this species) were released into Galveston Bay along the Texas coast by the USBF. None are known to have survived.

#### Spiny Daphnia (*Daphnia lumholtzi*).

This waterflea is native to Africa, southern Asia, and Australia, but has been found in the southern and mid-western U.S., including Texas (Havel et al. 1995). The earliest Texas record was in 1990, with subsequent collections at several sites in central and eastern Texas (see Internet site discussion at <http://nas.er.usgs.gov/dlumholtzi.html>). TPW found it to be abundant in Lake Alice, Jim Wells County, in 1998 (Howells 1999). It has the potential for disrupting aquatic community structure (Havel et al. 1995). Although the method of introduction is unknown, Havel and Hebert (1993) postulated it may have been transported to Texas

among shipments of Nile perch as early as 1983. However, it has never been documented from HOH waters where imported Nile perch were held and reared. Additionally, shipments of aquarium fishes, especially cichlids, and aquatic plants from Africa have dramatically increased in recent decades, suggesting other possible sources of introduction.

#### Native Marine Crustaceans Introduced Inland

##### Brown Shrimp (*Penaeus aztecus*).

Henderson (1966) reported eight specimens were stocked into the Pecos River (Rio Grande drainage) near Imperial, Pecos County, and three were released into Imperial Reservoir (Pecos River – Rio Grande drainage), Reeves and Loving counties in 1964. None survived.

##### Harris mud crab (*Rithropanopeus harrisi*).

Harris or white-fingered mud crab has been found in four Texas reservoirs including: E.V. Spence Reservoir (Colorado River drainage), Coke County; Colorado City Reservoir (Colorado River drainage), Mitchell County; Tradinghouse Creek Reservoir (Brazos River drainage), McLennan County; and Possum Kingdom Reservoir (Brazos River drainage), Palo Pinto County (Howells 1998; TPW, unpublished data). The source of these introductions is unknown, but may reflect bait bucket or accidental angler and boater releases. However, all reservoirs involved receive either red drum stockings from a coastal hatchery (where this crab occurs naturally) or striped bass reared at the Possum Kingdom hatchery (that receives water from Possum Kingdom Reservoir).

##### Blue crab (*Callinectes sapidus*).

Bowers (1906) reported 24 blue crabs were transplanted into a natural salt lake at Palestine (Neches River or Trinity River drainages), Anderson County. None survived. This species has been encountered at other inland sites in recent years, probably reflecting introductions with marine fish stockings or other deliberate or accidental releases. These reports are rarely formally documented, but no populations are known to be established in inland waters.

## DISCUSSION

At least 102 taxa of exotic fishes and shellfishes and marine species stocked at inland locations have been introduced into Texas since at least 1874 (Table 1). Among these, about 30% are believed to be established. The known or probable sources of first introductions of these animals include federal agency (20%), state agency (30%), ornamental fish trade and public aquaria (28%), fish farms and bait dealers (7%), others sources (3%), and undetermined sources (12%). In general, aside from common carp, the most ecologically problematic species originated from aquarium trade, fish farm, and bait bucket releases.

Details presented herein covering species, dates, and locations should not be considered complete and all inclusive. Unfortunately, many collections and releases of exotic fishes and shellfishes are poorly documented. Past efforts often relied on voluntary reports and observations from agency field staff and even other organizations. Throughout most of its history, TPW made no specific effort to record collections and reports of exotics. Even in the 1990s when the exotic species coordinator circulated forms to be completed and submitted when exotic fishes were collected, these forms were primarily available only within TPW's Inland Fisheries Division, but rarely, if ever, to other departmental branches or to others outside the agency. At this writing, no formal departmental database for exotic fish or shellfish records exists. It is almost certain that additional records exist that have not been included herein.

#### Predicted Exotic Species Concerns

In all probability, some of the most significant potential threats in the future will likely include temperate species not historically associated with the tropical fish trade. Although the original legislation relating to regulation of exotic species in Texas specifically stressed "tropical" fishes, the first major problematic introduction in the state involved a temperate fish, common carp. Subsequent temperate species like grass carp and rudd became threats in more recent times. The aquaculture, ornamental aquarium, and pond fish trades are importing an increasing number

of cold-tolerant fishes. Species that have appeared in pet store tanks or aquarium literature in recent years include: Chinese sucker (*Myxocyprinus asiaticus*) and Chinese perch (*Siniperca chuatsi* and its relatives). Bitterlings (Cyprinidae, several genera and species) have also become more readily available through aquarium fish dealers in recent years (but likely pose minimal ecological risks). Species, including round goby (*Neogobius melanostomus*) and ruffe (*Gymnocephalus cernuus*) (Howells 1999) that have established in the Great Lakes, are also potential future invaders of Texas waters. Curiously, although TPW prohibits all members of the genus *Gymnocephalus*, it has not moved to prohibit round goby (Howells 1999). Black and silver carps, in confinement in Texas already, can be expected in open waters in the future along with grass and bighead carps that already occur in Texas waters.

Some tropical fishes have also been imported with increasing frequency. For example, redbtail catfish (*Phractocephalus hemiliopterus*) is attractively colored as a juvenile, but grows 1.3 m in length (Burgess 1989). Because of origins in the Amazon, exceptional cold tolerance would not particularly be anticipated, but has apparently never been studied. Much like pacus that are attractive when small, but grow large rapidly and become unattractive and aggressive, species like redbtail catfish may have an increased probability of being released by aquarists. Continued periodic release of miscellaneous aquarium fishes by uninformed individuals can be expected to continue.

Zebra mussel already has been carried into Texas once. There is a high probability this will happen again. The current absence of TPW public information and education programs, lack of detection sampling, and inspection protocols increases the chances for an introduction to not only occur, but to go unnoticed until the species is established. Other bivalves like Asian lake or mud mussel (*Limnoperna fortunei*) that has invaded Argentina (Ricciardi 1996; Howells 1999); Asian green mussel or New Zealand greenlip mussel (*Perna viridis*) that has established in Tampa Bay, Florida (see Internet site <http://www.fmri.usf.edu/invert/pviridis.htm>); and Asian estuarine clam or Amur River corbula (*Potamocorbula amurensis*) that now dominates much of San Francisco Bay (Carlton et al. 1990; Nichols et al. 1990) should be on the list of potentially invasive species that could be expected in Texas in the future.

Among the gastropods, New Zealand mud snail (*Potamopygus antipodarum*) has established at several sites in the U.S. (Zaranko et al. 1997) and could well include Texas in its range in the future. Redrim melania and channeled applesnail, that are already established in Texas, will likely extend their ranges in the years ahead as well.

Chinese mitten crab (*Eriocheir sinensis*) has been found at several sites in the U.S., including Louisiana (see Internet site [http://lionfish.ims.usm.edu/~musweb/nis/Eriocheir\\_sinensis.html](http://lionfish.ims.usm.edu/~musweb/nis/Eriocheir_sinensis.html)) and could be a threat to Texas too. Spiny waterflea (*Bythotrephes cederstroemi*) and fish hook waterflea (*Cercopagis pengoi*) that are established in the Great Lakes (MacIsaac et al. 1999) are also potential invaders.

Non-native crayfishes, especially some larger Australian species including members of the genus *Cherax*, should be considered among potential invaders. Bait dealers and even pet trade outlets sell crayfishes, and others are reared in aquaculture. Current TPW regulations prohibit only two species of Tasmanian crayfishes that live in cool mountain streams and are of questionable threat to Texas, but do not restrict other Australian species like *C. destructor*, known to be environmentally tolerant and ecologically disruptive (Howells 1999).

Historically, states have developed lists of prohibited exotic fishes that often focused on predatory species at the top of the food chain, as well as a phytophagous grass carp and environmentally disruptive tilapias. Certainly examples of ecological destruction perpetrated by Nile perch and zander (*S. zander*) demonstrate these predators need to be regarded with caution, as do threats to habitat like grass carp and tilapias. However, herbivores and planktivores further down the food chain have the potential of causing massive alteration of entire ecosystems. Exotics impacting all levels of the food chain cannot be ignored when assessing risk.

Even when exotic species themselves appear relatively benign in an ecological sense, diseases and parasites associated with them can be problematic. A classic example in Texas occurred with redbottom melania snails and a gill fluke they subsequently passed along to fountain darters (*Etheostoma fonticola*) and other native fishes (T.M. Brandt, USFWS, San Marcos; pers. comm.). Risk of introduction of disease and parasites with importations of exotic fishes and shellfishes is very real, not only to native fauna, but with aquacultural and aquarium stocks as well. Unfortunately, while scientific experts on exotic species are somewhat limited in number, authorities on exotic

diseases and parasites are even fewer still. Problems not only with exotic diseases and parasites can be expected in the future, but also with the paucity of experts in the field and the difficulties in addressing these issues.

For better or worse, some exotic species like common carp are irreversibly part of aquatic ecosystems in Texas. Future efforts to maintain and protect natural areas in the state will include the challenge of protecting their ecological stability and integrity from additional "species pollution" without unduly restricting private interests like aquaculture and the ornamental fish trade.

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Table 1. Fish and shellfishes believed established in the inland waters of Texas including freshwater and marine species not native to Texas, native marine and estuarine species introduced at fresh water locations, and hybrids and genetic variants of these species. Also noted is the known or probable source of first introduction.

Species	Source
<b>Exotic Fishes Introduced</b>	
Blueback herring <i>Alosa aestivalis</i>	State agency
Common carp <i>Cyprinus carpio</i>	Federal agency
Goldfish <i>Carassius auratus</i>	Federal agency
Grass carp <i>Ctenopharyngodon idella</i> –diploid	University (concurrent illegal releases)
Suckermouth catfish <i>Hypostomus</i> spp.	Pet trade/public aquarium
Snow pleco <i>Pterygoplichthys anisitsi</i>	Pet trade
Vermiculated sailfin catfish <i>Pterygoplichthys disjunctivus</i>	Pet trade
Rainbow trout <i>Oncorhynchus mykiss</i>	Federal agency
Guppy <i>Poecilia reticulata</i>	Pet trade
Green swordtail <i>Xiphophorus helleri</i>	Pet trade
Bluefin killifish <i>Lucania goodei</i>	Eggs on transplanted marsh plants
Striped bass <i>Morone saxatilis</i>	State agency
Rock bass <i>Ambloplites rupestris</i>	Federal agency
Redbreast sunfish <i>Lepomis auratus</i>	Undetermined
Smallmouth bass <i>Micropterus dolomieu</i>	State agency
Walleye <i>Stizostedion vitreum</i>	Federal agency
Yellow perch <i>Perca flavescens</i>	Federal agency
Blue tilapia <i>Oreochromis aureus</i>	Fish farms – live bait dealers
Mozambique tilapia <i>Oreochromis mossambicus</i>	Public aquarium – pet trade
Blue tilapia x Mozambique tilapia hybrids	Fish farms – live bait dealers
Redbellied tilapia <i>Tilapia zilli</i>	Pet trade
<b>Native Marine and Estuarine Fishes Introduced Inland</b>	
Sheepshead minnow <i>Cyprinodon variegatus</i>	Bait bucket
Gulf killifish <i>Fundulus grandis</i>	Bait bucket – angler releases
Rough silverside <i>Membras martinica</i>	Undetermined
Naked goby <i>Gobiosoma bosc</i>	State agency –with stocked marine fish
<b>Exotic Shellfishes Introduced</b>	
Giant rams-horn snail <i>Marisa cornuarietis</i>	Pet trade
Channeled applesnail <i>Pomacea canaliculata</i>	Pet trade
Red-rim melania <i>Melanoides tuberculatus</i>	Pet trade
Quilted melania <i>Tarebia granifera</i>	Pet trade
Asian clam <i>Corbicula fluminea</i>	Undetermined – multiple sources
Asian clam <i>Corbicula</i> sp.	Undetermined – multiple sources
Brown edible mussel <i>Perna perna</i>	Commercial ship bilge water
Spiny daphnia <i>Daphnia lumholtzi</i>	Undetermined
<b>Native Estuarine Shellfishes Introduced Inland</b>	
Harris' mud crab <i>Rithropanopeus harrisi</i>	Undetermined

Table 2. Fishes and shellfishes recorded from inland waters of Texas, but not known to be established, including freshwater and marine species not native to Texas, native marine and estuarine species introduced at fresh water locations, and hybrids and genetic variants of these species. Also noted is the known or probable source of first introduction.

Species	Source
<b>Exotic Fish Introductions</b>	
Arapaima <i>Arapaima gigas</i>	Pet trade
Arowana <i>Osteoglossum</i> sp.	Pet trade
Clown knifefish <i>Notopterus chitala</i>	Pet trade
American shad <i>Alosa sapidissima</i>	Federal agency
Grass carp <i>Ctenopharyngodon idella</i> – triploid	University, state agency
Bighead carp <i>Hypophthalmichthys nobilis</i>	Undetermined, probably University stocking
Grass carp x bighead carp hybrids	University, fish farms – live bait dealers
Ide <i>Leuciscus idus</i>	Federal agency
Rudd <i>Scardinius erythrophthalmus</i>	Fish farms – live bait dealers
Tench <i>Tinca tinca</i>	Federal agency
Tiger barb <i>Puntius tetrazona</i>	Pet trade
Redbellied piranha <i>Pygocentrus</i> sp(p).	Pet trade
Black pacu <i>Colossoma macropomum</i>	Pet trade
Redbellied pacu <i>Piaractus brachypomus</i>	Pet trade
Smallscale pacu <i>Piaractus mesopotamicus</i>	Pet trade
Unidentified pacus <i>ColossomalPiaractus</i> sp(p).	Pet trade
Raphael catfish <i>Platydoras costatus</i>	Pet trade
Leopard catfish <i>Perrunichthys perruno</i>	Pet trade
Northern pike <i>Esox lucius</i>	State agency
Muskellunge <i>Esox masquinongy</i>	State agency
Northern pike x muskellunge hybrids	State agency
Northern pike x chain pickerel <i>Esox niger</i> hybrids	State agency
Redband trout <i>Oncorhynchus mykiss</i> spp.	State agency
Coho salmon <i>Oncorhynchus kisutch</i>	State agency
Chinook salmon <i>Oncorhynchus tshawytscha</i>	Federal agency
Atlantic salmon <i>Salmo salar</i>	Federal agency
Brown trout <i>Salmo trutta</i>	State agency
Brook trout <i>Salvelinus fontinalis</i>	State agency
Pike killifish <i>Belonesox belizanus</i>	Pet trade
Mexican molly <i>Poecilia mexicana</i>	Pet trade
Mesa silverside <i>Chirostoma jordani</i>	Mexican government
Tanganyika Nile perch <i>Lates angustifrons</i>	State agency
Bigeye Nile perch <i>Lates mariae</i>	State agency
Nile perch <i>Lates niloticus</i>	State agency
Nile perches <i>Lates</i> spp.	State agency
Striped bass <i>Morone saxatilis</i> x white bass <i>M. chrysops</i> hybrids	State agency
Striped bass x yellow bass <i>M. mississippiensis</i> hybrids	State agency
Sacramento perch <i>Archoplites interruptus</i>	Undetermined
Shoal bass <i>Micropterus cataractae</i> or redeye bass <i>M. coosae</i>	State agency
Sauger <i>Stizostedion canadense</i>	State agency
Walleye <i>S. vitreum</i> x sauger hybrids	State agency
Orangemouth corvina <i>Cynoscion xanthulus</i>	State agency
Orangemouth corvina x spotted seatrout <i>C. nebulosus</i> hybrids	State agency

Table 2. Continued.

Species	Source
Exotic Fish Introductions - continued	
Oscar <i>Astronotus ocellatus</i>	Pet trade
Peacock cichlid <i>Cichla ocellaris</i>	State agency
Speckled pavon <i>Cichla temensis</i>	State agency
Convict cichlid <i>Cichlasoma nigrofasciatum</i>	Pet trade
Rift lake cichlid <i>Pseudotropheus</i> sp.	Pet trade
Unidentified cichlid	Pet trade
Native Marine and Estuarine Fishes Introduced Inland	
Tarpon <i>Megalops atlanticus</i>	State agency
Mullet <i>Mugil</i> sp(p).	Federal agency
Pinfish <i>Lagodon rhomboids</i>	State agency
Silver perch <i>Bairdiella chrysoura</i>	Federal agency
Spotted seatrout	Federal agency
Spot <i>Leiostomus xanthurus</i>	State agency
Black drum <i>Pogonias cromis</i>	State agency
Red drum <i>Sciaenops ocellatus</i>	Federal agency
Red drum x black drum hybrids	State agency
Atlantic croaker <i>Micropogonias undulatus</i>	Federal agency
Southern flounder <i>Paralichthys lethostigma</i>	Federal agency
Exotic Shellfishes Introductions	
Florida applesnail <i>Pomacea paludosa</i>	Pet trade
Chinese mysterysnail <i>Cipangopaludina chinensis malleata</i>	Pet trade
Marbled aplesa <i>Stenophysa marmorata</i>	Undetermined
Tawny aplesa <i>Stenophysa maugeriae</i>	Undetermined
Zebra mussel <i>Dreissena polymorpha</i>	Pleasure boat transport
Mexican white shrimp <i>Litopenaeus vannamei</i>	Shrimp farms
American lobster <i>Homarus americanus?</i>	Federal agency
Native Marine and Estuarine Shellfishes Introduced Inland	
Eastern oyster <i>Crassostrea virginica</i>	Federal agency
Brown shrimp <i>Penaeus aztecus</i>	State agency
Blue crab <i>Callinectes sapidus</i>	Federal agency