PROHIBITED EXOTIC FISHES, SHELLFISHES, AND AQUATIC PLANTS FOUND BY TEXAS PARKS AND WILDLIFE PERSONNEL IN HARRIS COUNTY, TEXAS: 1995-1996 AND 2001 THROUGH MID-2003

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ABSTRACT

In five years of activity during the time periods 1995-1996 and 2001 through mid-2003, Texas Parks and Wildlife Department personnel seized 557 fish, 45 snails, 276 kg of oysters, and 1,014 kg of water spinach in the Houston area, all of which were legally prohibited as harmful and potentially harmful exotic species in Texas. A total of 38 individual violators were found including pet stores, food markets, and individual aquarists. Some stores were found to be in violation on more than one occasion. Some of the species seized represent major threats to the security of aquatic ecosystems and important fisheries in Texas. No similar data are available for other large cities in Texas.

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INTRODUCTION

In the 1960s, the American public became more aware of the problems and risks associated with the introduction of exotic species in U.S. waters. Walking catfish *Clarias batrachus* had been introduced into southern Florida with repercussions that echoed in news reports across the country (Courtenay et al. 1984). Grass carp *Ctenopharyngodon idella* was imported from eastern Asia by aquaculturists in Alabama and Arkansas (Courtenay et al. 1984) and, after experience with common carp *Cyprinus carpio* introductions in the last century, it too provoked concern. Not surprisingly then, in 1967, the Texas Legislature instructed Texas Parks and Wildlife Department (TPWD) to determine which tropical fish species were harmful or potentially harmful, and to list and regulate them (Howells 1999). In subsequent years, the term "tropical" was dropped and exotic shellfishes and aquatic plants were added to the list.

Experience has shown that the initial concerns expressed by the Texas Legislature in the 1960s were well justified. Estimated costs of nonindigenous species in the U.S. range into the billions of dollars annually (OTA 1993). About 42% of the species listed by the U.S. Fish and Wildlife Service under the Endangered Species Act are considered to be at risk primarily because of competition with or direct predation by exotic species (Nature Conservancy 1996). Howells (2001a) reported over 100 species of non-native fishes and shellfishes in Texas waters since the 1800s. With improvements in collection, transport, and holding techniques, vast numbers of exotic species continue to be imported, including prohibited species. Unfortunately, far too many of these are released or escape into public waters.

For over three decades since the first regulations on harmful and potentially harmful fishes, shellfishes, and aquatic plants were developed, TPWD biologists and law enforcement personnel have collaborated to address exotic species problems in Texas. Among the places where prohibited exotic species are most frequently encountered are pet and aquarium stores, water gardens, fish farms, and ethnic food markets, as well as occasionally in home aquaria and private waters.

Summarized here is a list of the prohibited exotic fishes, shellfishes, and aquatic plants documented in Houston, Harris County, Texas, by TPWD Inland Fisheries and Law Enforcement personnel in 1995 and 1996, from 2001 through mid-2003.

METHODS AND MATERIALS

Records of seizures and violations were documented by TPWD Law Enforcement personnel in Harris County. Similarly, notes and records relating to exotic species reports from TPWD, Inland Fisheries, Heart of the Hills Fisheries Science Center (HOH) staff were also reviewed. Terminology and general information follows Howells (1999) unless otherwise noted herein. Violators from whom prohibited species were seized (either individuals or companies) were given letter codes in this report to help identify offenders with repeated offenses or large numbers of infractions, without publicly identifying each by name.

SPECIES DISCUSSIONS

Freshwater stingrays (Family Potamotrygonidae)

Freshwater stingrays were included in some of the earliest TPWD regulations on exotic fishes (Howells 1999). Although large numbers do not appear to be available in Texas, a few continue to appear periodically in the aquarium trade. In recent years, an aquaculturist in Florida has been acclimating native, marine Atlantic stingray *Dasyatis sabina* (Family Dasyatidae) to fresh water. These, in turn, have appeared in some Texas pet stores under the name "freshwater stingray" (Howells 1999). However, TPWD regulations apply specifically to the South American potamotrygonids and not to any other types of stingrays.

Species	Date	*N*	Violator
Ocellated freshwater stingray *Potamotrygon motoro*	02 Aug 1995	2	tropical fish retailer (B)
Reticulated freshwater stingray	11 Aug 2001	1	tropical fish retailer (Q)
Potamotrygon reticulatus	11 Aug 2001	3	tropical fish wholesaler (R)

Bonytongues (Family Osteoglossidae)

At present, TPWD only prohibits arapaima *Arapaima gigas* among the osteoglossid species (Howells 1999). The U.S. Fish and Wildlife Service also lists it as an endangered species (Howells 1999). Individuals obtaining arapaima imported legally under federal permits sometimes fail to acquire additional state paperwork required to allow possession of this fish in Texas. Another osteoglossid, Asian arowana *Scleropages formosus*, that is also listed under federal regulations (but is not listed in state rules in Texas) has been regularly available in Houston-area aquarium shops. Such fish have generally been assumed to have been bred within the U.S. and therefore are not subject to federal import restrictions.

Species	Date	*N*	Violator
Arapaima *Arapaima gigas*	02 Aug 1995	4	tropical fish retailer (B)

Freshwater eels (Family Anguillidae)

Freshwater eels (either American eel *Anguilla rostrata* or European eel *A. anguilla*) were imported in 1994 or 1995 from the East Coast of the U.S. for culture at a Cameron County shrimp farm (Fries et al. 1996). However, these eels were found to be carrying the exotic eel swim bladder nematode *Anguillicola crassus* that is known to be harmful to native American eels (Fries et al. 1996; Howells 2002). In response to this finding, TPWD moved to prohibit all

Anguillidae except native American eel. However, a commercial fish farm built in Monaville, near Brookshire, in southeastern Texas, approached TPWD to request an exemption to this regulation for the production of Japanese eels. An exception was granted to this single facility for importation and grow-out of Japanese eels, but no provisions were included to allow possession or sale of live Japanese eels at any other location. In August 2001, the fish farmer was found to have illegally shipped large numbers of live Japanese eels to food markets and restaurants throughout the Houston area. Specimens found by TPWD personnel at this time were seized and removed by TPWD or killed and allowed to remain with the retailer.

Species	Date	*N*	Violator
Japanese eel	10 Aug 2001	10	retail food fish market (G)
Anguilla japonica	13 Aug 2001	55	retail food fish market (F)
	13 Aug 2001	22	retail food fish market (U)
	13 Aug 2001	17	retail food fish market (V)
	13 Aug 2001	25	retail food fish market (W)
	18 May 2002	2	retail food fish market (P)

South American pike characoids (Family Characidae; subfamily Ctenoluciinae)

Historically, species of South American pike characins have occasionally been included in shipments of aquarium fishes to U.S. dealers, although numbers and frequency were limited. Some can be rather fragile to capture, ship, and maintain; none are particularly attractive; and all require small, live fishes as food. However, with improvements in capture, holding, and transport techniques, several species have begun to appear much more frequently in the U.S. Indeed, some shipments have apparently originated from fish farms in Taiwan and Hong Kong where they are being produced commercially. Some were being sold as Asian gars.

Species	Date	*N*	Violator
Gar characin	17 Oct 2001	1	tropical fish retailer (J)
Ctenolucius hujeta	17 Oct 2001	1	tropical fish retailer (K)
	19 Oct 2001	12	tropical fish wholesaler (L)
	27 Dec 2001	5	tropical fish retailer (B)
	08 Jan 2002	4	tropical fish retailer (M)
	09 Jan 2002	18	tropical fish retailer (N)
	25 Jan 2002	21	tropical fish retailer (O)
Golden pike-characin	27 Dec 2001	5	tropical fish retailer (B)
Boulengerella lucius	09 Jan 2002	8	tropical fish retailer (N)
(*Luciocharax lucia*)	05 Jun 2002	14	tropical fish retailer (P)

Spotted pike-characin *Boulengerella maculata* (*Luciocharax maculata*)	27 Dec 2001	3	tropical fish retailer (B)

South American pike characoids (Family Characidae; subfamily Characinae)

See comments under other pike characoid species above.

Species	Date	*N*	Violator
Falcate pike characin	22 Aug 1995	7	tropical fish retailer (B)
Acestrorhynchus falcatus	14 Aug 2001	15	tropical fish retailer (H)

Piranhas (Family Characidae, Subfamily Serrasalminae)

South American red piranha *Pygocentrus nattereri* (or a similar redbellied species), and others in the subfamily, have appeared from time to time in American pet stores, including shops in Texas where piranhas have been prohibited since the 1960s (Howells 1999). A May 2002 seizure in Houston was particularly interesting because the shipment originated in Hong Kong where piranhas are apparently being reared commercially. Additionally, they were sent to the Texas dealer as tetras and not properly identified as piranhas.

Species	Date	*N*	Violator
Red piranha	05 May 1995	1	private aquarist (A)
Pygocentrus nattereri	02 Aug 1995	6	tropical fish retailer (B)
(*Serrasalmus nattereri*)	28 Jun 1996	9	tropical fish retailer (C)
	01 Oct 1996	15	private aquarist (D)
	14 May 2002	60	tropical fish retailer (E)

Electric catfishes (Family Malapteruridae)

Despite being rather unattractive and lethargic, limited numbers of electric catfish have occasionally been imported for sale in U.S. pet stores.

Species	Date	*N*	Violator
Electric catfish *Malapterurus electricus*	16 Sep 2001	1	tropical fish retailer (S)

Whale catfishes (Family Cetopsidae)

South American whale catfishes are related to parasitic catfishes (Family Trichomycteridae), but often function more like piranhas, attacking other fishes in large schools and rasping off pieces of flesh. They have not historically been imported for sale in the pet trade because of their unattractive appearance and peculiar feeding habits. Nonetheless, TPWD moved to prohibit them over 10 years ago (Howells 1999). It was somewhat surprising to find one species had actually been imported for sale in two Houston aquarium stores. Another much larger shipment that was reported to TPWD Law Enforcement personnel during this time period did not arrive.

Species	Date	*N*	Violator
Whale catfish	18 May 2002	2	tropical fish retailer (P)
Cetopsis coecutiens	07 Feb 2003	1	tropical fish retailer (B)

Cichlids (Family Cichlidae)

This family contains some of the most popular aquarium fishes as well as species that are among the most frequently released into U.S. waters. Some members of this family are especially ecologically problematic when established in local waters.

About a decade ago and in response to dramatically increased numbers appearing in the pet trade, all pike cichlids were added to the list of prohibited species in Texas. However, intense pressure from cichlid enthusiasts in the pet trade prompted TPWD to remove them from the prohibited list (effective February 1997) (Howells 1999).

Although several tilapia taxa have been available in pet shops historically, blue tilapia *Oreochromis aureus* was rarely included among the aquarium species due to unattractive juvenile and adult coloration and its ultimate large size. It has been widely introduced in Texas waters through use as live bait (now illegal) (Howells 2001a). However, aquacultural production of color variants of this and other tilapia species (and hybrids), reminiscent of those seen in goldfish *Carassius auratus*, have sparked an increased interest among aquarists (Howells 1999).

Interest in nearly all tilapiine cichlid species in the pet trade dropped dramatically in the 1960s and 1970s when numerous taxa of brightly-colored rift lake cichlids became available. Among all the tilapias, hornet tilapia *Tilapia buttikoferi* has, however, remained in demand in aquarium culture because it maintains bold black and white bar patterns both in juveniles and adults (Howells 1999). Texas regulations prohibit all tilapia species, but due to continued interest in hornet tilapia, it continues to be imported for sale.

Species	Date	*N*	Violator
Spot-face pike cichlid *Crenicichla lenticulata*	22 Aug 1995	20	tropical fish retailer (B)

Blue tilapia	27 Dec 2001	1	tropical fish retailer (B)
Oreochromis aureus	18 May 2002	4	tropical fish retailer (P)
	19 Jun 2002	1	sporting goods store (X)
Hornet tilapia	29 Jan 2002	3	tropical fish retailer (T)
Tilapia buttikoferi	31 Jan 2002	1	aquarium maintenance company (Y)
	16 Feb 2002	24	tropical fish retailer (Z)
	16 Mar 2002	65	tropical fish retailer (H)

Stonefishes (Family Synanceiidae)

Marine aquarium culture capabilities have improved extensively in recent decades. Consequently, the availability of marine fishes from around the world has also increased in recent years. Marine stonefishes were prohibited in Texas because of their extremely lethal venom and lack of antivenin availability locally (Howells 1999). Other related species of venomous fishes are regularly offered for sale in the pet trade, but stonefishes appear not to have been imported in large numbers. However, a single specimen was found in a Houston pet store in 2002.

Species	Date	*N*	Violator
Stonefish *Synanceia verrucosa*	13 Jun 2002	1	tropical fish retailer (AA)

Snakeheads (Family Channidae)

Limited numbers of snakehead specimens have been imported for sale in the pet trade for many years as a curiosity item. As a result, species like giant or red snakehead *Channa micropeltes* and splendid snakehead *C. lucia* have occasionally been encountered in pet stores. However, because they can be ecologically harmful, TPWD moved to prohibit them several decades ago.

Unfortunately, in 2001, a new avenue of snakehead importation developed. Snakeheads are regarded not only as a desirable food fish in some Asian countries, but are believed to have medicinal properties as well. The increasing number of Asian immigrants in the U.S. prompted an increased demand for these fishes. Although snakeheads that are frozen or on ice are legally imported for sale, some individuals sought living specimens, perhaps as an indication of their freshness or because filleted or frozen snakeheads are thought by some to loose their curative value.

In early 2001, HOH was advised by U.S. Geological Survey personnel (J.D. Williams, U.S.G.S., Gainesville, Florida; pers. comm.) that snakeheads were being imported for distribution. In August 2001, living northern snakeheads *C. argus* were found in tanks in two Houston markets. When other stores were examined by TPWD personnel, some had empty aquaria and packaged snakeheads in their frozen fish cases that were not yet frozen, suggesting word of TPWD actions reached these stores before game wardens and biologists could examine them. These snakeheads had been imported from New York by a fish farmer in Monaville, Texas, then distributed to retail outlets in the Houston area.

Following August 2001 seizures in Houston, HOH and U.S.G.S. personnel produced a paper summarizing snakehead records in the U.S. and cautioning about this potential problem (Howells et al. 2002). Within four months, a reproducing population of northern snakeheads was discovered in Maryland that drew national attention and eradication efforts (by 4 September 2002, over 3,500 Internet sites addressed northern snakehead, a large proportion of which were specific to the Maryland introduction). Northern snakehead can survive in ice-covered ponds, burrow into mud to survive dewatering, and even cross land to reach new waters (Courtenay and Williams 2002; Howells et al. 2002; U.S. Department of the Interior 2002). These behaviors, in conjunction with its extremely predatory nature, indicate northern snakehead poses a major ecological threat to the U.S. Unlike in Maryland, it appears this species may have been discovered in Texas stores before any escaped or were released.

Species	Date	*N*	Violator
Splendid snakehead	22 Aug 1995	1	tropical fish retailer (B)
Channa lucia	28 Jun 1996	1	tropical fish retailer (C)
(previously *Ophicephalus polylepis*)			
Northern snakehead	13 Aug 2002	45	retail food fish market (F)
Channa argus	10 Aug 2002	3	retail food fish market (G)

Swamp eels (Family Synbranchidae)

A large (ca. 750 mm TL), albino adult swamp eel was seized in one Houston-area pet store in January 2003 followed by a group of normal colored juveniles (ca.150 mm TL) in March 2003. All appeared to be *Monopterus albus*. However, the *albus*-group is apparently a species complex only now being subjected to genetic analysis in an attempt to better define taxa involved (Collins et al. 2002). Tissue samples have been sent to authorities in Florida currently conducting biochemical genetic work with this group. Shipping invoices associated with the smaller specimens indicated they had been shipped from a dealer in Hialeah, Florida, under the name "yellow eels". Populations of swamp eels have recently been found at locations in Florida and Georgia and could represent significant threats to aquatic ecosystems in Texas.

Species	Date	*N*	Violator
Asian swamp eel	19 Dec 2002	1	tropical fish retailer (B)
"*Monopterus albus*"	07 Mar 2003	36	tropical fish retailer (E)

Oysters (Family Ostreidae)

Oyster culture and harvest is a major industry in Texas. Pacific giant oyster *Crassostrea gigas* can displace native oyster populations. Consequently it was prohibited as a potentially harmful species in Texas (Howells 1999). In 2001 and again in 2002, shipments of live Pacific giant oysters were sent from producers in British Columbia to Houston markets where they were found by TPWD personnel and seized. Boxes of oysters examined in 2001 contained several native eastern oysters (*C. virginica*) mixed with the Pacific giant oysters. Both species have been introduced into culture operations in the Pacific Northwest.

Species	Date	kg	Violator
Pacific giant oyster	13 Aug 2001	70.3	retail food fish market (V)
Crassostrea gigas	12 Jan 2002	65.8	retail food fish market (BB)
	17 Jul 2002	45.4	retail food fish market (V)
	16 Oct 2002	94.3	seafood wholesaler (CC)

Applesnails (Family Ampullariidae)

Channeled applesnail *Pomacea canaliculata* was introduced into Taiwan, the Philippines, and elsewhere in the Indo-Pacific about 20 years ago and has since become a major threat to production of rice and other crops (Cowie 2002). A reproducing population was found in a rice irrigation canal near Alvin, Texas, in July 2000 and other populations were found in the area in subsequent months (Howells 2001a, b, c). Because this area was centrally located in the Texas rice belt, TPWD moved to prohibit channeled applesnails in April 2001. Despite this restriction, some pet stores have continued to sell it and a number of large specimens were seized in Houston in 2002. Currently, channeled applesnail is still readily available in Texas aquarium stores either because dealers cannot differentiate it from related species or are not motivated to do so. Logically, this may continue due to limited enforcement efforts.

Species	Date	*N*	Violator
Channeled applesnail *Pomacea canaliculata*	14 Aug 2002	45	tropical fish retailer (H)

Water spinach (Family Convolvulaceae)

Water spinach *Ipomoea aquatica*, an aquatic morning-glory, was prohibited by TPWD as a harmful exotic species in 1990 (Howells 1999) in response to its introduction in Florida and noxious growths that threatened aquatic ecosystems in that state. The species is also listed as a noxious weed under U.S. Department of Agriculture (USDA) regulations. In June 2003, TPWD Law Enforcement personnel became aware water spinach was being illegally imported, produced, and sold in the Houston area. On 3 July 2003, personnel from TPWD's Law Enforcement, Inland Fisheries, Coastal Fisheries, and Resource Protection divisions joined with USDA personnel to examine retail stores in Harris County that might be selling this plant. In all, 17 of 18 stores examined were selling water spinach. In each case, the plants were seized; however, no violations or warnings were issued. Rather, each outlet was informed the plants were illegal in Texas, provided a description of the plant and list of Asian common names, and informed that wardens would check their stores in the weeks ahead to confirm sales in water spinach had ceased. Game wardens found that water spinach had been produced locally as well as imported from California.

Some dealers reported obtaining water spinach from growers in Harris County. These sites were not examined on 3 July 2003. Other suspected producers in Brazoria County were also not examined during the 3 July 2003 activity because they were located in another county. The following week, a representative of the Brazoria County producers contacted TPWD to request a meeting to discuss water spinach issues. It was reported that Houston-area retailers would no longer purchase their plants and production and distribution had been 22,680 kg/day. As this report was being drafted, further discussions and actions were pending.

Species	Date	kg	Violator
Water spinach	03 Jul 2003	140.6	retail food fish market (F)
Ipomoea aquatica	03 Jul 2003	42.6	retail food fish market (V)
	03 Jul 2003	301.6	retail food fish market (W[1])
	03 Jul 2003	186.0	retail food fish market (BB)
	03 Jul 2003	48.5	retail food fish market (DD)
	03 Jul 2003	5.0	retail food fish market (EE)
	03 Jul 2003	14.5	retail food fish market (FF)
	03 Jul 2003	75.3	retail food fish market (GG)
	03 Jul 2003	17.7	retail food fish market (HH)
	03 Jul 2003	11.3	produce wholesaler (II)
	03 Jul 2003	12.7	retail food fish market (JJ)
	03 Jul 2003	9.1	retail food fish market (KK)
	03 Jul 2003	3.2	retail food fish market (LL)
	03 Jul 2003	145.2	retail food fish market (MM)

[1] Four locations combined

SUMMARY

In five years during the time period 1995-1996 and 2001 through mid-2003, TPWD personnel documented seizure of 557 fish, 45 snails, 276 kg of oysters, and 1,014 kg of water spinach that were legally prohibited in Texas as harmful or potentially harmful species. A total of 38 violators were identified, including pet stores, food markets, and individual aquarists. In some cases, individual stores were found in violation of TPWD regulations on more than one occasion.

In 2002, a number of Asian cyprinid specimens were discovered in stores in the Houston area that appeared to be prohibited giant barbs *Tor*. However, upon closer examination, they were identified as the unrestricted but closely related genus *Leptobarbus* that is sometimes called mud barb or red-fingered cigar shark. Both are similar, but *Tor* has the lateral line placed centrally in the peduncle and *Leptobarbus* has the lateral line positioned below the center line. Although these fish provoked initial concern because of their similarity to a group of prohibited barbs, their importation and sale was not a violation of TPWD regulations.

The gap in years between 1996 and 2001 does not indicate compliance with regulations during that time period or failure of TPWD Law Enforcement personnel to find illegal species. Rather, other important Law Enforcement duties elsewhere precluded or limited time that could be spent examining locations where prohibited species might have been offered for sale.

No comparative data are available covering these time periods for other large cities in Texas. It is probably reasonable to assume that other individuals and stores throughout Texas also occasionally import and sell prohibited exotic fishes, shellfishes, and aquatic plants.

Finally, it should be noted that quick action by TPWD Law Enforcement and Inland Fisheries personnel is very necessary to inform the public about exotic species concerns and enforce regulations designed to protect aquatic resources of Texas. For example, when northern snakeheads were first found in August 2001, a rapid response by TPWD staff may have saved local waters from an ecologically disastrous release of this species. State and federal officials in Maryland struggled to eliminate a population of northern snakeheads found to be reproducing in that state. A substantial amount of time and money were required to eliminate a population of northern snakeheads resulting from a single person releasing perhaps only two or three fish there. Limited amount of time invested by the TPWD staff in addressing harmful exotic species problems here stands in sharp contrast to the extensive efforts required on the East Coast.

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