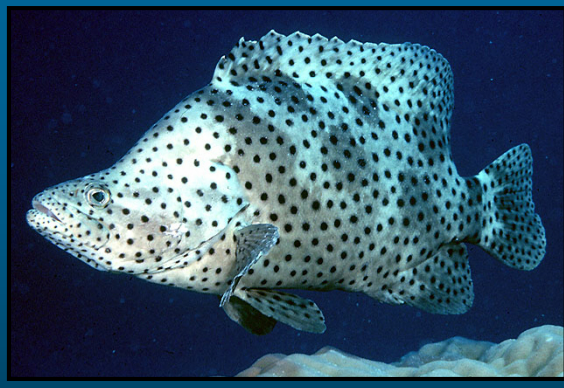
Field Guide to the Nonindigenous Marine Fishes of Florida






Schofield, P. J., J. A. Morris, Jr. and L. Akins

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Field Guide to

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NOAA, National Ocean Service
National Centers for Coastal Ocean Science
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Introduction

The purpose of this field guide is to provide information on nonindigenous (i.e., non-native) fishes that have been observed in Florida's marine waters. Introductions of non-native marine fishes into Florida's waters could be intentional or unintentional, and are likely from a variety of sources, including aquarium releases, escape from aquaculture, loss due to extreme weather events (e.g., flooding from hurricanes), and possibly transfer with ballast water or hull-fouling. Presently the lionfishes (*Pterois volitans* and *P. miles*) are the only non-native marine fish species known to be established along the coast of Florida. All other marine fishes in this guide (except the euryhaline species, see below) have infrequent occurrences, occur singly or in small groups, and have not yet become self-sustaining populations.

Aquarium releases are one of the major pathways whereby nonindigenous fishes gain access to new environments (Ruiz et al. 1997; Fuller et al. 1999). Most of the nonindigenous marine fishes found in Florida's waters are thought to be aquarium fishes that either were illegally released into the ocean or escaped captivity (e.g., during severe storm/flooding events). Indeed, south Florida is a hotspot for nonindigenous marine aquarium fishes (Semmens et al. 2004). Increased public awareness of the problems caused by released or escaped aquarium fishes may aid in stemming the frequency of releases. For example, Habitattitude™ (www.habitattitude.net) is a national public awareness and partnership campaign that encourages aquarists and water gardeners to prevent the release of unwanted aquarium plants, fish and other animals. It prompts hobbyists to adopt alternative actions when dealing with these aquatic plants and animals.

The invasion of Florida's marine waters by non-native fishes is in its early stages, especially compared to freshwaters of the state where dozens of fish species have become established. It is expected that new introductions will continue to occur, and it is possible that additional species could become established if no action is taken. To address this issue, NOAA's National Centers for Coastal Ocean Science (NCCOS), the Reef Environmental and Education Foundation (REEF), and the U.S. Geological Survey (USGS) have formed a partnership to focus on early detection and rapid response (i.e., removal) of non-native marine fishes. At this time, our efforts are focused on the southeastern coast of Florida, where many non-native fishes occur; however, it is our hope to expand this effort in time. Our goal in preparing this field guide was to synthesize identification information for the non-native marine fishes of Florida and to provide this information to the many collaborating state, federal, and local government agencies, universities, and non-profit organizations assisting in these

efforts. We hope this field guide will also be useful to a wider audience, including recreational divers and snorkelers, law enforcement and the interested public. Species in this guide could be considered to comprise a "watch list" of future potential invaders that might become established.

Herein, we provide information on 31 marine species and seven euryhaline species that are primarily freshwater, but can occasionally occur in brackish or marine waters. Of the euryhaline species that are included, five of the six cichlids (*Cichlasoma urophthalmus*, *Hemichromis letourneuxi*, *Oreochromis mossambicus, Sarotherodon melanotheron* and *Tilapia mariae*) and the poeciliid (*Belonesox belizanus*) are widely established in freshwaters of the state. The Nile tilapia (*O. niloticus*) is currently only known to be locally established (in Orange Lake, Alachua County), but could be more widespread in the State. We included these seven euryhaline species because they exhibit high tolerance to saline waters and are occasionally found in low-salinity habitats (e.g., seagrass beds, mangrove forests).

For more information on these species please visit the U.S. Geological Survey's Nonindigenous Aquatic Species (USGS-NAS) database (http://nas.er.usgs.gov). This website has been established as the national repository for spatially-referenced biogeographic accounts of nonindigenous aquatic species. It contains information on various taxa of aquatic non-native species from freshwater, brackish and marine environments, including invertebrates (e.g., mollusks, crustaceans, sponges, jellyfishes), fishes, amphibians, reptiles and mammals.

Methods

In this field guide we provide species accounts for non-native fishes from estuarine and marine waters of Florida. Species accounts consist of one or two photographs of the species, identification criteria, a summary of similar species that occur in Florida, native geographic range, non-native occurrences in the U.S.A., and a synthesis of the ecology of the species. References to source material are provided to those interested in learning more about the species. A map of occurrences in Florida is provided for each species. The species are arranged in approximate phylogenetic sequence. General discussions of the families precede the species accounts. Scientific names and authorities follow "A Catalog of the Species of Fishes" (Eschmeyer et al. 1998). To assist the reader, we have provided a world map delineating major marine regions (Fig. 1).

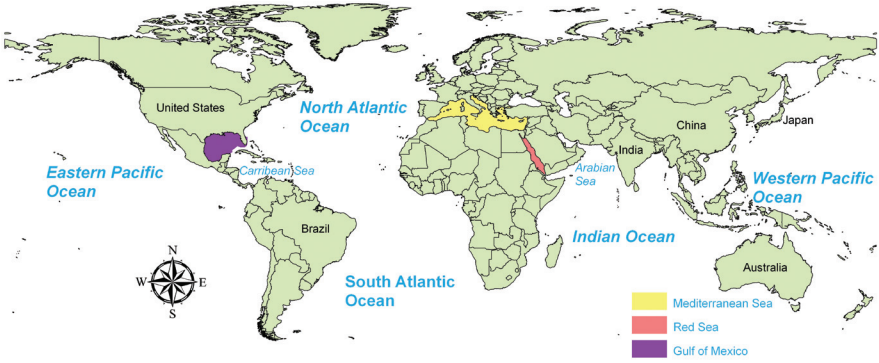

Figure 1. Major marine regions of the world

Meristics, Morphometrics and Species Identification

Meristics (the numbers of segments or body parts, such as scales or fin rays), morphometrics (the study of the shape or form of parts of the body), and body coloration are provided in each species account. One of the most commonly-used meristics is fin-ray counts, thus we have provided these when available. When fin-ray counts are reported, the first set of numbers in Roman numerals represents the number of spines, which are generally unbranched and stiffer than the rays. Soft rays occur on the dorsal and anal fins posterior to the spines, and are denoted in this text in parentheses with Arabic numerals directly after the spine count. Lengths are given as standard length (SL; distance from front of mouth to caudal peduncle) or total length (TL; distance from front of mouth to posterior end of caudal fin). To assist the reader with terminology used in the morphological descriptions of the species, we have provided line drawings (Fig. 2) denoting the major fins and body parts of fishes. For more information on meristics and morphometrics of a particular species, see the literature cited at the end of the “Identification” section of the species account.

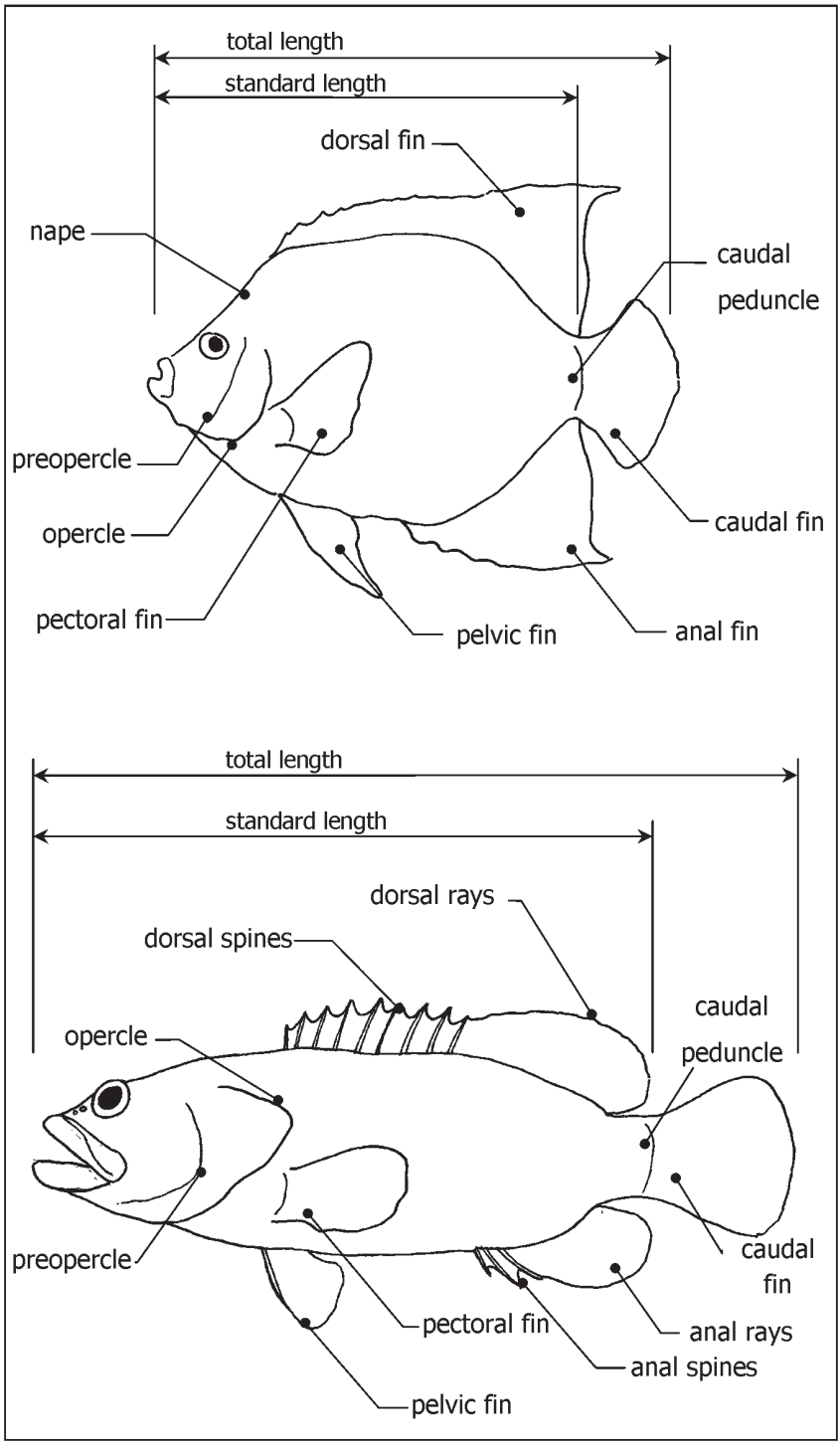

Figure 2. Line drawing showing fish fins and body parts.

Maps

The geographical occurrence of each species in Florida is given on a map within each species account. These maps are derived from records taken from the USGS-NAS database (http://nas.er.usgs.gov). Most of the occurrence data from the database have been mapped in point form; however, sometimes records with unspecific locations exist that cannot be mapped. When this is the case, we discuss the records in the "Nonindigenous Occurrences" section of the species account. For the euryhaline species that occur primarily in freshwater, but can also occur in brackish or marine waters, we use U.S. Geological Survey Hydrologic Unit Codes (HUCs) as a base to build the maps. This is a nationwide system that delineates watersheds based on surface hydrology (for more information, see: http://nas.er.usgs.gov/hucs.asp). Maps in this guide use 8-digit HUCs that are shaded in orange where the species is present.

Data used to create the maps were derived from the USGS-NAS database, which is comprised of multiple data sources including published literature, reports, other databases and personal communications. The Reef Environmental Education Foundation database (REEF 2008) and NOAA are major contributors of data to the USGS-NAS database. We have attempted to make the maps as current as possible; however, it is possible that we might not be informed of all occurrences of a species in Florida. Additionally, species distributions change over time; some more rapidly than others. Consequently, readers attempting to identify a specimen should not rule out a particular species because it has not been previously reported from the area. For the most current information on species distributions, visit the USGS-NAS database at http://nas.er.usgs.gov. The database is frequently updated as new records are added and earlier records are reviewed and corrected. Individuals who have relevant information concerning non-native fishes are encouraged to report their findings to state fish and game agencies and the USGS-NAS database.

Reporting discovery of non-native species

The collection or sighting of aquatic non-native species should be reported to the USGS-NAS database (http://nas.er.usgs.gov/sightingreport.asp). To report a new record, please provide photographs and the location where the species was sighted or collected as accurately as possible (including GPS coordinates, if possible).

Laws pertaining to non-native fishes in Florida marine waters

The Florida Fish and Wildlife Conservation Commission (FWC) regulates and manages Florida's fish and wildlife resources as authorized by Article IV, Section 9, of the Constitution of the State of Florida. ***The FWC prohibits the release of non-native fish and other aquatic organisms***

without a permit. Certain saltwater species are listed in Chapter 68-5, Non-Native Species, Florida Administrative Code (F.A.C.), as prohibited and may not be imported into the state, sold, possessed, or transported live. These species include mitten crab (*Eriocheir* spp.), sea snakes (Hydrophiidae), weeverfishes (Trachinidae) and stonefishes (*Synanceia* spp.). Prohibited species are considered to be dangerous to the ecology of the State and/or human health and welfare. These species cannot be personally possessed alive.

Non-native marine species that are not prohibited may be caught alive and personally possessed in private aquaria without a permit. However, once caught, they may not be released. The FWC allows the unrestricted take of these marine non-native species by legal methods. In order to catch non-native marine fish, a recreational fisher would need a recreational saltwater fishing license (unless marine life fishing is done by a Florida resident using cast nets or bait seines less than 100 feet in length and that have mesh that is 3/8 inch or less). Non-native marine fish may be taken by the following: rod and reel; hook and line; while free diving; by spearfishing except where prohibited; with landing or dip nets; with cast nets; with a bait, beach, or haul seine; or with blue crab or stone crab traps. There are certain methods of harvesting non-native marine fish that are strictly prohibited. These include gill or entangling nets, bangsticks and powerheads, diving by means of a rebreather, poisons, drugs or other chemicals unless permitted to do so.

These harvest/take regulations pertain only to marine waters within the jurisdiction of State of Florida (up to three geographic miles [3.45 statute miles] from the Florida coast into the Atlantic Ocean and nine leagues [10.376 statute miles] into the Gulf of Mexico). There are many other jurisdictions within the state that have separate rules that might differ from State rules. Some of these alternate jurisdictions include national parks, refuges, wildlife management areas, marine protected areas, and state parks. It is the responsibility of the fisher/diver to determine the jurisdiction and regulations before removing any marine life. For more information on Florida's regulations, visit http://myfwc.com/nonnatives/.

Acknowledgments

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Family Hemiscylliidae (bamboosharks)

Bamboosharks are distributed in the tropical western Pacific. They typically have two dorsal fins without spines and an anal fin. Bamboosharks inhabit near-shore marine waters where they feed on benthic fishes and invertebrates. They are generally docile, harmless, and are common foodfishes. From Compagno (1984).

Chiloscyllium punctatum Müller & Henle 1838
Brownbanded Bambooshark

Photo of specimen with unusual throat swelling by D. Leazenby

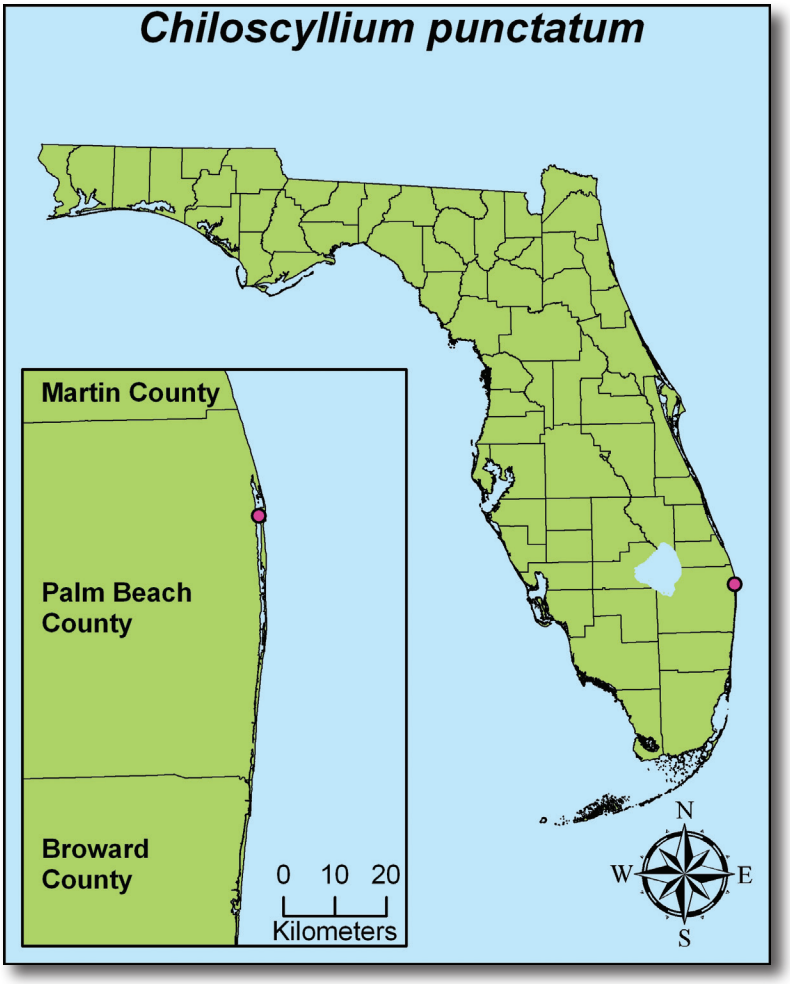
Identification: Juveniles exhibit alternating brown/white or black/white banding. White bands become brown with maturity. Body shape is long and slender. Adults are light brown to greyish brown with no prominent color patterns. Dorsal fins larger than pelvic fins. Pectoral and pelvic fins forward of dorsal fin. Grows to about 120 cm TL. From Compagno and Niem (1998) and Allen et al. (2003).

Similar Species: Nurse Shark (*Ginglymostoma cirratum*) exhibits a wider head, heavier body, and uniform grey to brown coloration. Juvenile nurse sharks do not have color banding on the body.

Native Range: The Brownbanded Bambooshark is distributed in the Indo-Asian Pacific from Madagascar and India to Indonesia and Philippines, north to southern Japan. From Allen et al. (2003).

Ecology: The Brownbanded Bambooshark inhabits near-shore coral reefs and tide pools. In Australia, the species prefers seagrass habitat, which could be a function of habitat partitioning with other near-shore sharks (White and Potter 2004). The diet likely consists of invertebrates and small fish (Last and Stevens 1994). The species is small and adapts well to captivity. It can also withstand a wide range of environmental conditions. Breeding programs in Australia and Germany have been successful (Harahush et al. 2007). Bamboosharks are on the IUCN Red List of Threatened Species and are classified as 'Near Threatened' globally. In Australia, the bambooshark is classified as 'Least Concern' (Cavanagh et al. 2003). The species lays brown rectangular eggs attached to coral and rocky substrates by small and delicate tendrils (Harahush et al. 2007).

Nonindigenous Occurrences: The species was observed in 2007 in Riviera Beach.



Family Poeciliidae (livebearers)

The family Poeciliidae is comprised of mostly small-bodied fishes (of which *Belonesox* is the largest) that have internal fertilization by means of the male gonopodium (modified anal rays 3-5) and bear live young. Poeciliids are generally the most dominant fishes in lowland fresh and brackish waters of Middle America and the West Indies, ranging from the eastern U.S.A. to northeastern Argentina. Many popular aquarium fishes (e.g., Swordtails, Guppies, Mollies) are poeciliids, as well as the ubiquitous Mosquitofish (*Gambusia* spp.). From Miller (2005).

Belonesox belizanus Kner 1860
Pike Killifish

Photo by H. Jelks, USGS

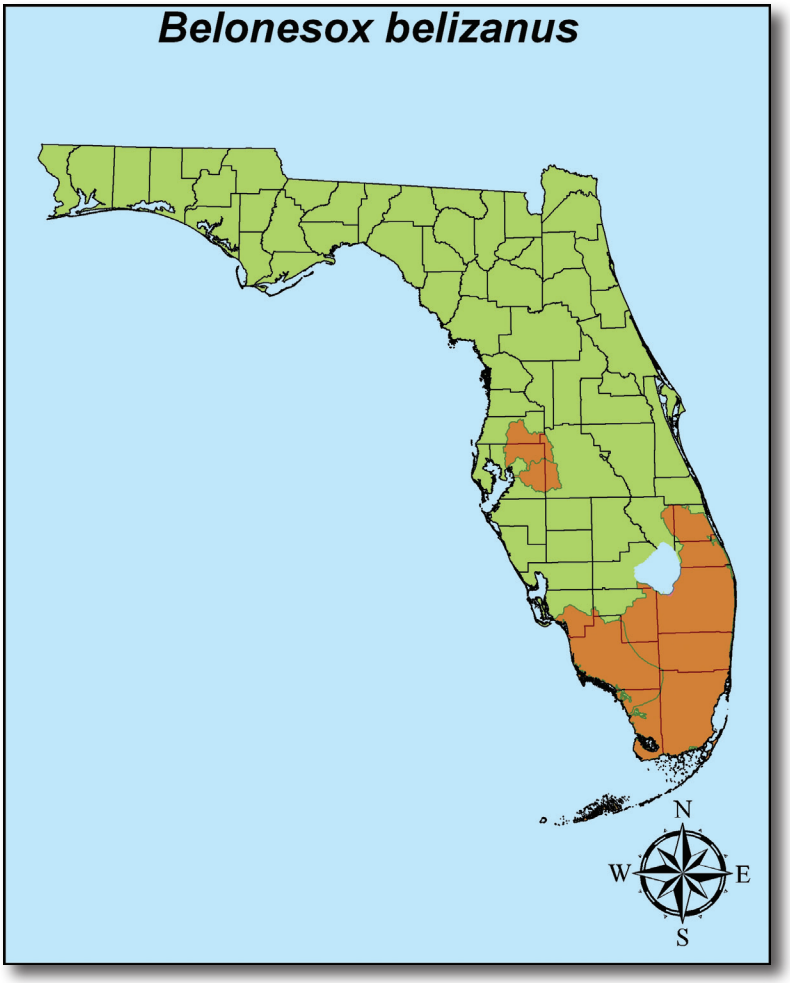
Identification: The body is dark grey dorsally and fades lighter ventrally. Several rows of black spots occur along the side, and a larger black spot is visible along the caudal peduncle (but is sometimes faded). The Pike Killifish has long jaws that form a pointed beak (similar to *Esox*) and contain large teeth. The dorsal-fin origin is well behind the anal-fin origin. As the largest species within the family Poeciliidae, the Pike Killifish reaches 20 cm SL. Sometimes called Picudito or Top Minnow. From Page and Burr (1991) and Miller (2005).

Similar Species: Juvenile Great Barracuda (*Sphyraena barracuda*) has two dorsal fins and mottled body markings. Guaganche (*S. guagancho*) has two dorsal fins and a yellowish mid-body stripe. Southern Sennet (*S. picudilla*) has two dorsal fins and a silvery body.

Native Range: The species is native to the Atlantic slope from Veracruz, Mexico south to the Yucatan, Guatemala and Belize, the Atlantic drainages of Honduras and Guatemala, and to Costa Rica (Rosen and Bailey 1963; Reis et al. 2003; Miller 2005).

Ecology: Most females larger than 75 mm SL and males larger than 55 mm SL are sexually mature. Average brood size is approximately 99, and larger females tend to have larger broods (up to about 320). In south Florida, reproduction continues year-round, and females are able to store viable sperm for several months. Male courtship displays are described by Horth (2004). The young are remarkably precocial; within one day of their birth, they pursue, capture, and eat prey. Adults are primarily piscivorous, and in south Florida eat Mosquitofish, Mollies, and other Pike Killifishes as their primary diet. From Turner and Snelson (1984) except where noted otherwise.

Nonindigenous Occurrences: The species was first observed in the canals of Homestead, Dade County, in 1957 (Belshe 1961). The Pike Killifish is now common in inland waterbodies (especially vegetation-choked canals) of south Florida (Shafland et al. 2008). In the native range as well as in south Florida, the species inhabits freshwater and estuarine habitats and is occasionally found in marine environments.



Family Scorpaenidae (scorpionfishes)

Scorpionfishes are found in the Indian, Pacific, and Atlantic oceans. The majority of scorpionfishes reside in marine waters although some can be found in fresh and brackish waters. Scorpionfishes typically exhibit a compressed body with a single notched dorsal fin and well developed pectoral fins. The head usually contains numerous spines and ridges. A large number of the scorpionfishes are venomous, having venom glands located in the dorsal, anal, and pelvic spines. Some scorpionfishes have internal fertilization and are live-bearers. Scorpaenidae is one of the largest families of fishes, comprising well over 150 species.

Pterois volitans (Linnaeus 1758)
Red Lionfish
and
Pterois miles (Bennett 1828)
Devil Firefish

Photo by J. Randall, Bishop Museum

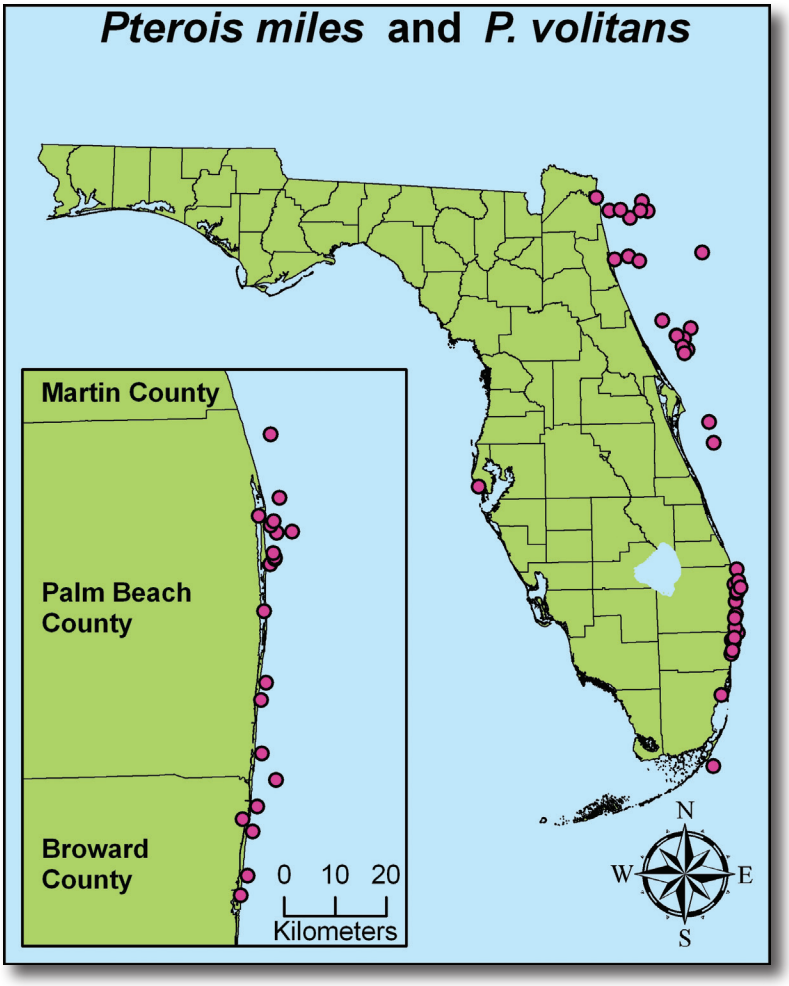
Identification: The Red Lionfish and the Devil Firefish are sister species identifiable to the species level by meristics only at extreme ranges of their native habitats (Hamner et al. 2007). The Red Lionfish and Devil Firefish have strong vertical banding that extends the entire length of the body. Tips of the long spines can be white in color. Dorsal and anal fins are transparent with dark spots. Pectoral fins are large with dark spots. Coloration can be variable depending on size and habitat, and can range from dark black to deep red. The head contains fleshy appendages with large tentacles above the eyes (Morris and Freshwater 2008). Dorsal fin XIII (9-11), anal fin III (6-7).

Similar Species: No similar-appearing Atlantic species has the prominent body barring characteristic of lionfish. Searobins (Family Triglidae) have similarly large pectoral fins but lack the maroon coloration and striping patterns of lionfish.

Native Range: The species are widely distributed throughout the western Pacific from southern Japan to Micronesia, Australia, and the Philippines. *Pterois volitans* occurs throughout most of Oceania (including the Marshall Islands, New Caledonia and Fiji) east to French Polynesia. *Pterois miles* is from the Indian Ocean and Red Sea, although its range extends to Sumatra.

Ecology: Lionfishes inhabit shallow and deep reefs, preferring areas of high structural complexity. The diet consists primarily of fishes and some invertebrates. Lionfishes are pair spawners, and release two gelatinous egg balls during each spawning event. Spawning can occur multiple times per month during the spawning season that extends throughout the calendar year. Lionfishes have become established in the Western North Atlantic and Caribbean over the last decade, representing one of the most rapid marine fish invasions recorded to date.

Nonindigenous Occurrences: Lionfishes are widespread from the Caribbean to Cape Hatteras, North Carolina. Juveniles are found north of Cape Hatteras, but do not overwinter (Kimball et al. 2004).



Family Serranidae (groupers)

Groupers are a highly-exploited family of fishes taken in sport, artisanal, and commercial fisheries. The larger species are often territorial (with high site fidelity), grow slowly to maturity over several years, and congregate in large offshore spawning aggregations. These behavioral and life-history characteristics, as well as the market for their meat, make them especially vulnerable to overfishing. Groupers are present in various habitats, including coral reefs, estuaries, and rocky reefs of the tropical and subtropical regions of the world. Juveniles generally inhabit seagrass beds. Many species are top-predators, consuming other fishes, crustaceans (e.g., crabs, shrimps), and squids. From Heemstra and Randall (1993).

Cephalopholis argus Bloch & Schneider 1801
Peacock Hind

Photo by J. Randall, Bishop Museum

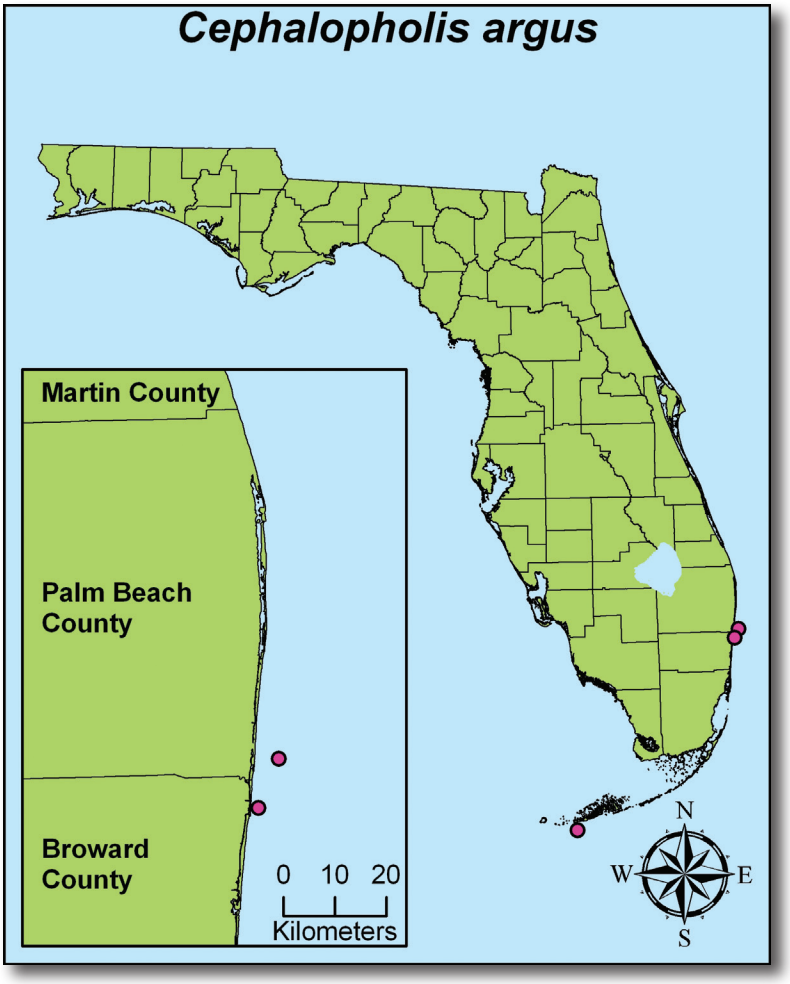
Identification: Overall, the body is dark brown. Small blue spots ringed in black cover the body. Five to six pale vertical bars are often apparent posterior to the pectoral fins and a large white patch occurs on the breast. Dorsal, anal, and caudal fins generally have a narrow white band along their posterior margins. The distal part of the pectoral fins are often edged in maroon-brown. Peacock Hind can pale or darken rapidly and grows to about 60 cm TL. Other common names include Blue-spotted Grouper, Peacock Grouper and Peacock Rockcod. Dorsal fin IX (15-17), anal fin III (9). Pectoral rays 16 or 17. From Randall and Ben-Tuvia (1983), Heemstra and Randall (1993), Randall et al. (1996), Carpenter and Niem (1999), Allen et al. (2003) and Randall (1983 and 2005).

Similar Species: Coney (*Cephalopholis fulva*) has two black spots on lower lip and two black spots at base of caual fin. Graysby (*C. cruentatus*) has red spots on the body and a rounded caudal fin. Red Hind (*Epinephelus guttatus*) has dark margins on rear dorsal, anal, and caudal fins.

Native Range: From the Red Sea to South Africa and east to French Polynesia and the Pitcairn Islands group, including northern Australia, Lord Howe Island and southern Japan. Throughout the Indo-Pacific except the Persian Gulf and Gulf of Oman. Early reports (from Valenciennes in 1828 and Quoy & Gammard in 1824) listed the species from Hawai'i; however, these reports are considered erroneous. From Randall and Ben-Tuvia (1983), Randall and Heemstra (1991), Heemstra and Randall (1993), Carpenter and Niem (1999), Randall (1983 and 2005) and Mundy (2005).

Ecology: In its native range, this common grouper occurs on coral reefs over a depth range of 1 to 40 m, typically less than 10 m. The species is territorial, and partitions its habitat into large (up to 2000 m^2) territories occupied by a male and up to 12 females and sub-territories, each inhabited by a single female. The species is an important food-fish throughout the Indo-West Pacific region; however, due to its carnivorous nature, it has been blamed for numerous cases of *Ciguatera* poisoning in both the native and introduced ranges. About 80% of the diet is fishes, while the remainder is mostly crustaceans. From Shpigel and Fishelson (1989, 1991), Heemstra and Randall (1993), Randall et al. (1996), Allen et al. (2003) and Randall (1983, 1987 and 2005).

Nonindigenous Occurrences: The Peacock Hind was observed off Boca Raton in 2004, Pompano Beach in 2005 and Key West in 2006. The species has been established in Hawai'i since the 1950s (Randall and Kanayama 1972; Randall 1987; Mundy 2005).



Chromileptes altivelis (Valenciennes 1828)
Humpback Grouper

Photo by J. Randall, Bishop Museum

Identification: The body is distinctly spotted (dark spots on a light background). The head profile is unique amongst the groupers, as it is depressed anteriorly and elevated posteriorly, rising sharply at the nape. Pectoral and caudal fins rounded. Dorsal fin X (17-19), anal fin III (9-10); pectoral rays 17-18. The genus *Chromileptes* contains only one species, the Humpback Grouper. Grows to 66 cm TL. Also called the Barramundi Cod or Panther Grouper. From Heemstra and Randall (1993) and Randall et al. (1996).

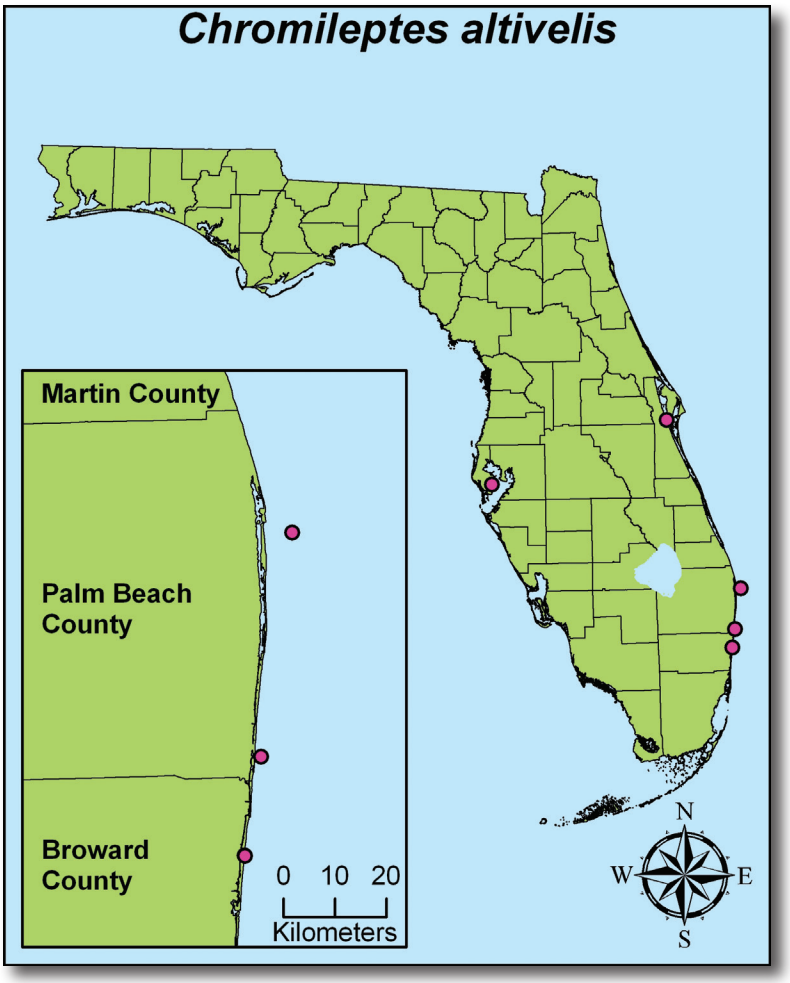
Similar Species: Greater Soapfish (*Rypticus saponaceus*) has grey to dark body color, lacks dark body spots. Spotted Soapfish (*R. subbifrenatus*) has tan to brown body color and pale borders around dark spots.

Native Range: In the Western Pacific; southern Japan to Palau, Guam, New Caledonia and southern Queensland, Australia. In the eastern Indian Ocean; from the Nicobar islands to Broome, Western Australia. Reports from the western Indian Ocean (Heemstra and Randall 1984, 1986) are unsubstantiated, except one from Kenya (Smith 1954) which seems valid (Heemstra and Randall 1993).

Ecology: The Humpback Grouper is a reef-associated species and will inhabit reefs that are highly complex as well as those that are dead or silty. The species is found at depths ranging from 1 to 40 m, and is often found in very shallow water – even stranded in pools at low tide. It is very secretive, and feeds on fishes and crustaceans. From Heemstra and Randall (1993), Randall et al. (1996), Myers (1999) and Allen et al. (2003).

Due to habitat degradation and heavy pressure on native stocks (from the aquarium and fishing industries), it is one of only two groupers assessed by the IUCN as “Endangered” (Morris et al. 2000).

Nonindigenous Occurrences: The species has been observed in Tampa Bay (1984), off Boca Raton (pre-1995), in the Indian River Lagoon near Cocoa (2003), off Pompano Beach (2005 and 2006) and off West Palm Beach (2007). It was also introduced to Hawai’i, but is now considered extirpated (Munday 2005).



Family Grammatidae (basslets)

Basslets are small-bodied (up to 10 cm TL), brightly-colored fishes (up to about 10 cm total length) that inhabit coral reefs and rocky ledges. They are closely related to the groupers (Family Serranidae). Characteristic of the group are elongated first rays of the pelvic fins that sometimes extend beyond the end of the anal fin. The basslets are sight-feeders, with large eyes, and typically feed on plankton and ectoparasites from larger fishes. From Randall (1996) and Mooi and Gill (2002).

Gramma loreto Poey 1868
Fairy Basslet

Photo by J. Randall, Bishop Museum

Identification: Head, pelvic fins, and anterior portion of the body violet; posterior half of the body yellow. Two narrow stripes on the head. Distinctive black spot on anterior portion of the dorsal fin. Pelvic rays elongate, reaching well beyond the origin of the anal fin. Lateral line interrupted (in two parts), the anterior part high on the body and ending at the last soft ray of the dorsal fin, the posterior part midlateral on caudal peduncle. A small fish that grows to about 8 cm TL. Also called Royal Gramma. Dorsal fin XI-XIII (9-11); anal fin III (10). Pectoral fin soft rays 14-17. From Böhlke and Randall (1963), Randall (1996) and Mooi and Gill (2002).

Similar Species: Juvenile Spanish Hogfish (*Bodianus pulchellus*) lacks the dark dorsal spot and has diagonal separation of body colors. Heliotrope Basslet (*Gramma klayi*) lacks the dorsal spot and has a pink to rose-colored forebody (not violet, as seen in Fairy Basslet).

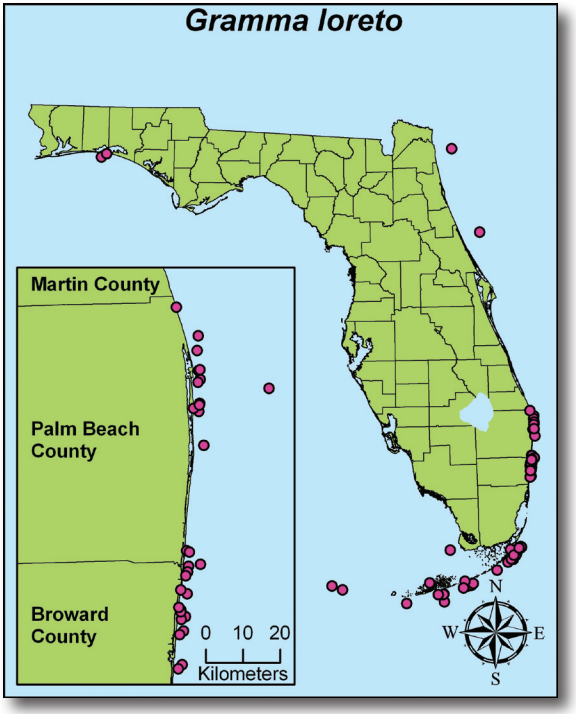
Native Range: Bahamas, Mexico (Quintana Roo), Belize, Honduras, Colombia, Venezuela, Greater Antilles (Cuba, Haiti, Dominican Republic, Jamaica, Grand Cayman), and Lesser Antilles (Böhlke and Randall 1963; Mooi and Gill 2002). Often erroneously reported from Bermuda (see Smith-Vaniz et al. 1999).

Ecology: The Fairy Basslet generally occurs in groups, often hanging upside-down under ledges. It has been recorded at depths to 65 m (Mooi and Gill 2002). The species preferentially occupies high vertical relief within the general reef areas occupied (Freeman and Alevizon 1983). Individual fish (both males and females) hover close to the substratum and defend a small area against intruders (Freeman and Alevizon 1983). Fish

generally occupy the same feeding sites for many months (Asoh 1996). Fairy Basslet groups live in a social structure consisting of dominance hierarchies arranged by size, with the largest fish at each coral head being the dominant one (Freeman and Alevizon 1983). The diet of the Fairy Basslet consists primarily of free-living planktonic crustaceans, but the species will also eat parasitic crustaceans (i.e., ectoparasites picked from the bodies of other fishes; Böhlke and Randall 1963).

In the Caribbean, the species has been used as a model to understand the effects of interactions between size classes and the effects of density dependence on juvenile recruitment and mortality (Webster and Hixon 2000; Webster 2003, 2004). These studies showed that the Fairy Basslet occupies the undersides of open reef ledges where it lives in dominance hierarchies maintained by aggression between size classes such that larger fish occupy prime plankton-feeding positions closer to the outer edge of the ledge (Webster and Hixon 2000).

Nonindigenous Occurrences: There are numerous reports of Fairy Basslet from southeastern Florida (Courtenay 1995). Starck (1968) reported the species was collected by aquarium collectors along the east coast of Florida between Fort Lauderdale and Palm Beach. Although the Fairy Basslet is widely cited as being introduced to Florida (e.g., Nelson et al. 2004), its presence there could be due to natural range expansion from nearby populations. It is also possible that both aquarium releases and range expansion have occurred.



Family Chaetodontidae (butterflyfishes)

Butterflyfishes are deep-bodied, laterally-compressed oval-shaped fishes. Most species have a dark bar across the head that obscures the eye and an ocellated “false-eye” spot along the posterior portion of the body. Most butterflyfishes are brightly-colored with complex, striking color patterns by which they are identified. Summarized from Pyle (2001a).

Chaetodon lunula (Lacepède 1802)
Raccoon Butterflyfish

Photo by J. Randall, Bishop Museum

Identification: The body is primarily yellow with a dusky dorsum and thin, brownish diagonal bars. There is a broad black bar on the head through the eye, followed by an equally broad white bar. These two bars together give the appearance of a raccoon's mask. There is a black blotch at the caudal peduncle. The dorsal, caudal, and anal fins are edged in black. Juveniles have a black blotch at the posterior base of the caudal fin. The pectoral fins are rounded, not elongated. The snout is only slightly pronounced and the head profile is steep. Maximum size is approximately 20 cm TL. Also called the Moon Butterflyfish. Dorsal fin XI-XIII (22-25), anal fin III (17-19). Pectoral rays 15 or 16. From Randall et al. (1996), Pyle (2001a), Allen et al. (2003), and Randall (2005).

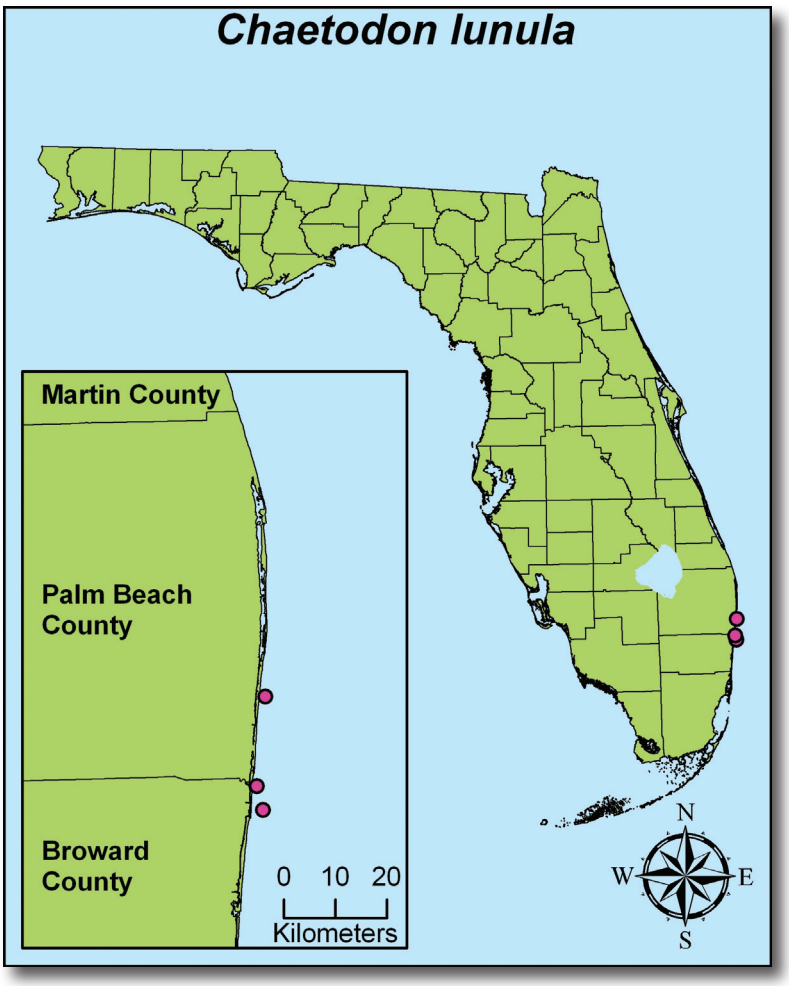
Similar Species: Reef Butterflyfish (*Chaetodon sedentarius*) lacks white markings on head and has wide dark wedge on rear dorsal and body.

Native Range: The species is native to most of the Indo-Pacific, including East and South Africa, Hawai'i, southern Japan, Western Australia and throughout Micronesia. It also occurs around the Cape of Good Hope reaching narrowly into the southeastern Atlantic along the South African coast. It is absent from the Red Sea, Gulf of Aden, Persian Gulf, and

Arabian Sea. In the eastern Pacific, single individuals have been seen at Cocos Island and the Galápagos Islands. From Randall et al. (1996), Pyle (2001a), Robertson et al. (2004), and Randall (2005).

Ecology: In the native range, the species typically inhabits coral reefs from 1 to 60 m in depth where it occurs as single individuals, pairs, or small groups. The Raccoon Butterflyfish is an omnivore, feeding on a variety of benthic prey, including polychaetes, scleractinians (hard corals), hydroids, gastropods, mollusk eggs, and algae. From Harmelin-Vivien (1989), Hourigan (1989), Randall et al. (1996), Pyle (2001a), Allen et al. (2003) and Pratchett (2005).

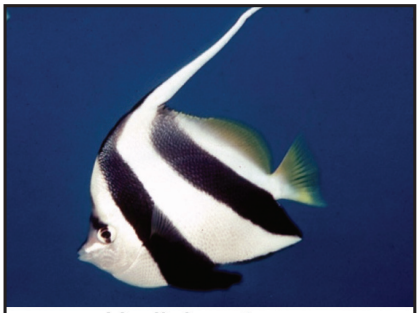
Nonindigenous Occurrences: Raccoon Butterflyfishes have been observed on reefs off Boca Raton (2000-2002), Deerfield Beach (2004), and Delray Beach (2008).



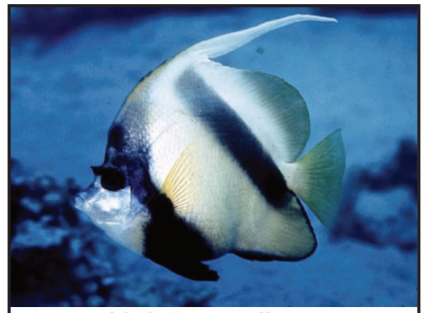
Heniochus diphreutes Jordan 1903
Schooling Bannerfish

Heniochus intermedius Steindachner 1893
Red Sea Bannerfish

Heniochus monoceros Cuvier 1831
Masked Bannerfish



H. diphreutes



H. intermedius

H. monoceros

Photos by J. Randall, Bishop Museum

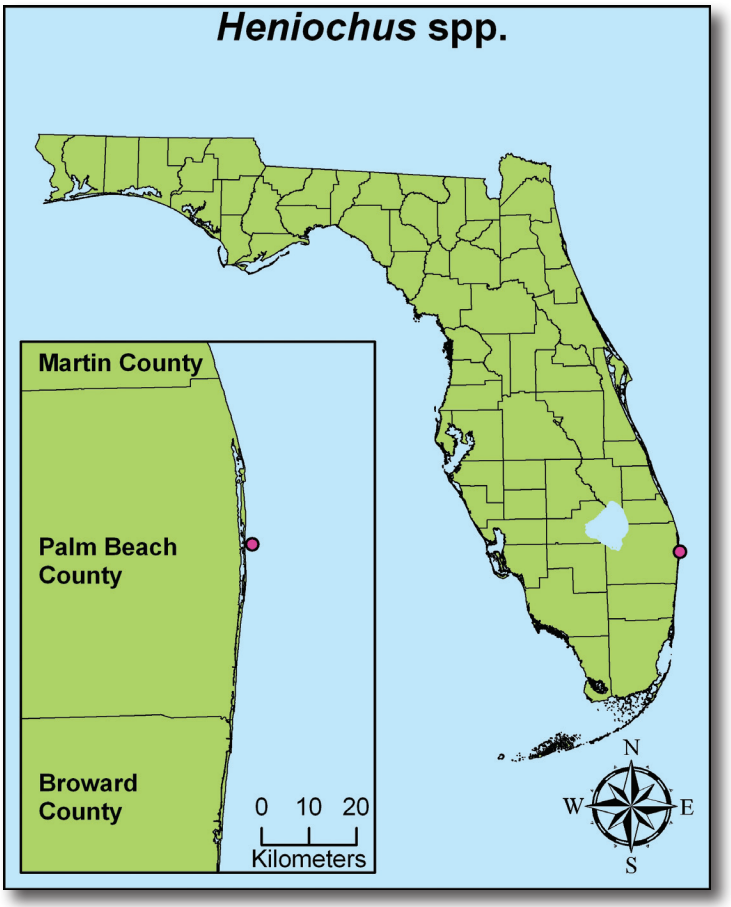
Identification: All three species have an elongate white dorsal filament and black pelvic fins. The Schooling Bannerfish has a white body with two broad black stripes, yellow soft-dorsal and caudal fins and dark marks above the eye and top of snout. The Red Sea Bannerfish has a body color that is whitish dorsally and grades to yellow ventrally, two black bands along the side (the most anterior band passes just behind the head and encompasses the eye) and yellow soft-dorsal, pectoral, anal, and caudal fins. The Masked Bannerfish has a white body background color with a central broad black band that tapers dorsally, a black face with pale stripes between the eyes and on the forehead, and yellow dorsal, caudal, and anal fins. All three species typically grow to about 20 cm TL. Common names for *H. diphreutes* include: Bannerfish, False Moorish Idol, Pennant Bannerfish, Poor Man's Moorish Idol (no additional common names for *H. intermedius* and *H. monoceros*). From Allen et al. (1998) and Randall (2005).

Similar Species: Atlantic butterflyfishes lack the long dorsal filament of bannerfishes. Angelfishes and spadefishes have both dorsal and anal fin filaments.

Native Range: The Red Sea Bannerfish has the most restricted native distribution of the three, occurring in the Red Sea and Gulf of Aden. The Schooling Bannerfish and Masked Bannerfish are widely distributed in the Indo-Pacific and central Pacific. From Allen et al. (1998).

Ecology: The Schooling Bannerfish is usually encountered in large shoals (thus its common name), while the other two species are generally found alone or in pairs. Juvenile Schooling Bannerfish have been seen cleaning parasites from other fishes; otherwise, the species feeds on zooplankton. The diet of the Red Sea Bannerfish includes zooplankton and benthic invertebrates. Masked Bannerfish also eat benthic invertebrates (e.g., polychaete worms). From Allen et al. (1998).

Nonindigenous Occurrences: Several bannerfish have been seen off West Palm Beach; however, it is unclear which of the three species was observed.



Family Pomacanthidae (angelfishes)

The Family Pomacanthidae is distinguished from similar families by the presence of one or more prominent spines at the angle of the preopercle. Angelfishes have a single, continuous dorsal fin; some species have filamentous extensions of one or more dorsal rays. Most angelfishes are brightly colored and several species are imported for the aquarium trade. Juveniles of the genus *Pomacanthus* often have strikingly different color patterns than adults of the same species.

Pomacanthus annularis (Bloch 1787)
Bluering Angelfish

Photo by J. Randall, Bishop Museum

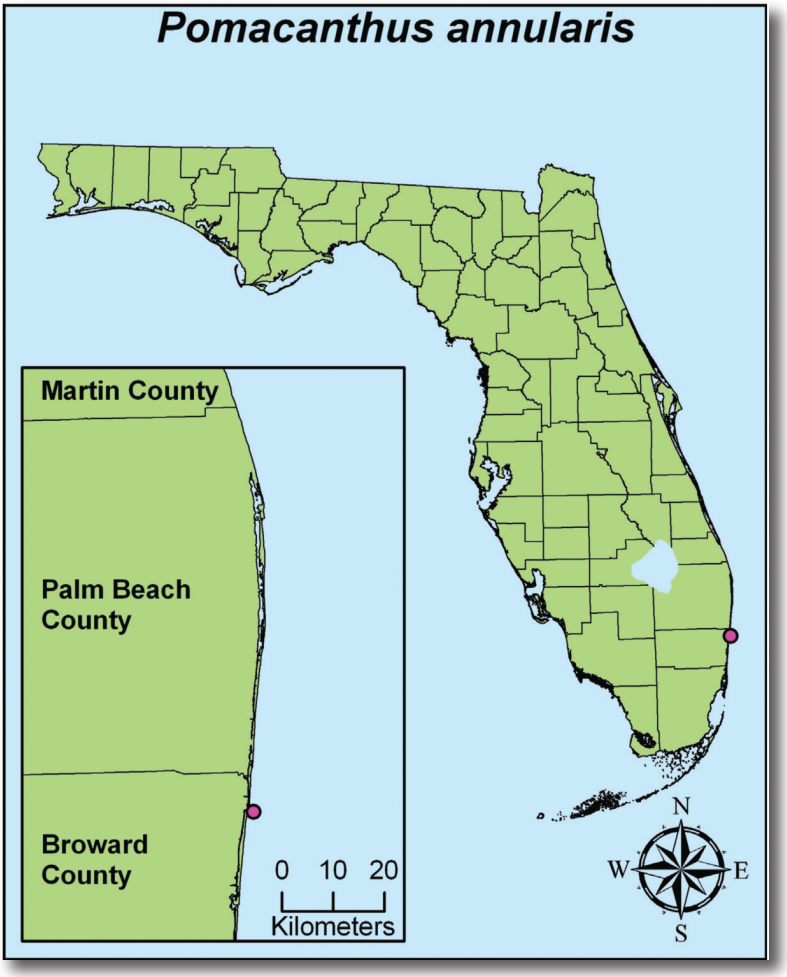
Identification: Juveniles are dark blue to black with alternating thin white and light-blue, well-spaced stripes on the sides. The stripes curve backward slightly, creating shallow crescents. The caudal fin is transparent. Adults are golden-brown with horizontal stripes radiating from the pectoral-fin base area, running along the sides towards the posterior portion of the dorsal fin. The stripes along the flanks are well-spaced, curved slightly towards the belly, and brilliant blue in color. Two similar blue stripes run horizontally across the face, one running through the eye, from above the snout to the edge of the operculum. The blue stripes continue onto the soft parts of the dorsal and anal fins. A distinct blue ring is behind and slightly above the edge of the operculum. Caudal fin is white with bright yellow margin. Grows to 34 cm TL. Also called the Blue-ringed Angelfish. From Allen et al. (1998 and 2003).

Similar Species: Juvenile Queen Angelfish (*Holacanthus ciliaris*) and Blue Angelfish (*Holacanthus bermudensis*) have vertical blue body bars. No other Atlantic angelfish has blue body markings.

Native Range: Widespread throughout the Indo-West Pacific, including East Africa (north of Natal), Madagascar, Sri Lanka and Indonesia east to New Guinea and the Solomon Islands and north to southern Japan (Allen et al. 1998).

Ecology: The species inhabits coastal reefs at depths of one to 60 m, where it may occur singly or in pairs. It feeds on zooplankton, tunicates and sponges. From Allen et al. (1998 and 2003).

Nonindigenous Occurrences: The species was sighted off Pompano Beach in 2001.



Pomacanthus asfur (Forsskål 1775)
Arabian Angelfish

adult

juvenile

Photos by J. Randall, Bishop Museum

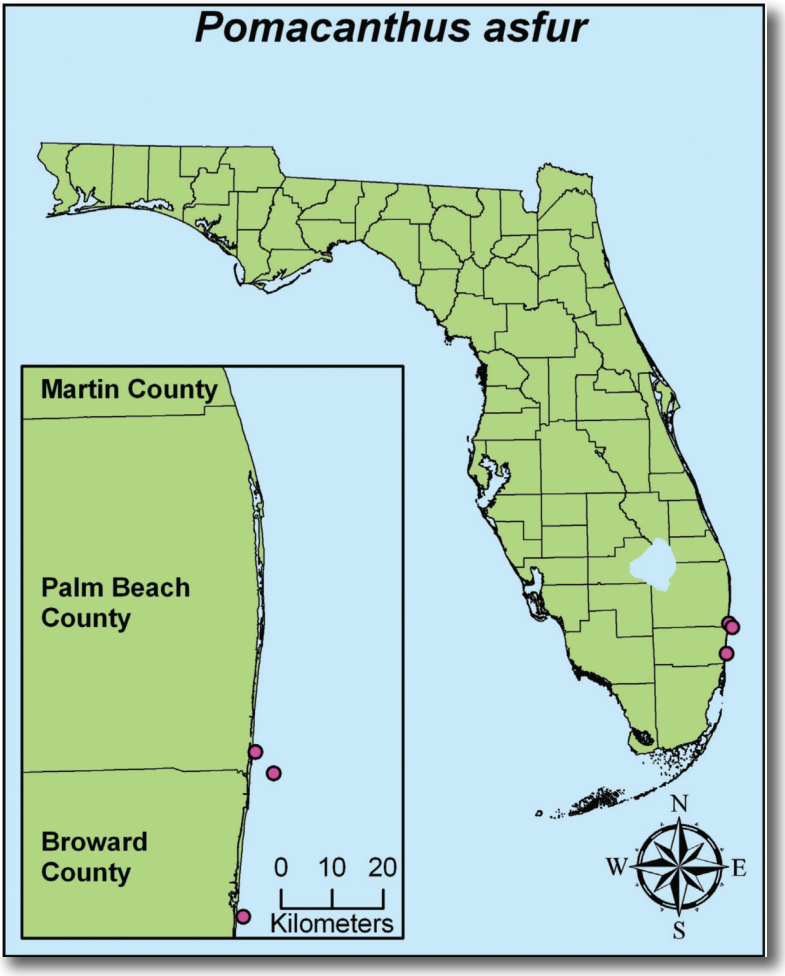
Identification: The body of the adult Arabian Angelfish is dark overall with a broad, vertical yellow marking along the middle of the body that resembles a crescent. The dorsal and anal fins are dark and end in filaments that extend beyond the caudal fin; the caudal fin is solid yellow. Juvenile Arabian Angelfish look distinctly different from the adults. The body of juveniles is blue-black with a series of narrow white and pale-blue bars; there are usually three distinct white bars. Grows to 40 cm TL. Dorsal fin XII (19-20); anal fin III (18-20); pectoral rays 17 or 18. From Randall (1983) and Allen et al. (1998).

Similar Species: The Rock Beauty (*Holacanthus tricolor*) has a yellow head and tail with black body. Juvenile Queen Angelfish (*Holacanthus ciliaris*) and Blue Angelfish (*Holacanthus bermudensis*) have bright blue body bars. Juvenile French Angelfish (*Holacanthus paru*) and Gray Angelfish (*Holacanthus arcuatus*) have bright yellow body bars on black body.

Native Range: Western Indian Ocean, from the Red Sea and Gulf of Aden south to Zanzibar (Randall 1983; Allen et al. 1998).

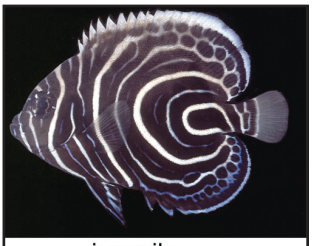
Ecology: In their native habitat, Arabian Angelfish live along shallow (3 to 15 m depth), protected shoreline reefs with a mix of hard and soft corals. The species has been noted as shy, and not easy to approach. Generally, it is observed near caves or crevices along the reef, and rarely ventures far from these refugia. Feeds primarily on sponges and tunicates. From Allen et al. (1998).

Nonindigenous Occurrences: There is a vague record of the occurrence of the species in south Florida offshore Broward and Palm Beach counties (Courtenay 1995). It was also observed in 2001 off Dania.



Pomacanthus imperator (Bloch 1787)
Emperor Angelfish

adult



juvenile

Photos by J. Randall, Bishop Museum

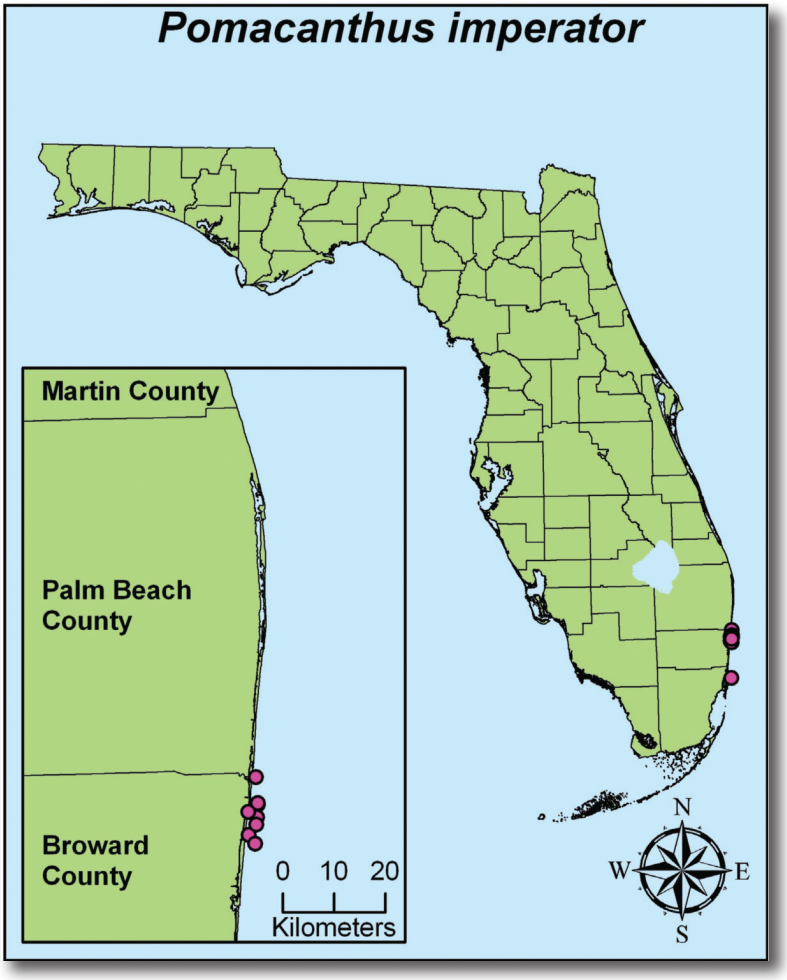
Identification: Juvenile Emperor Angelfish are blue-black with concentric white circles, a white dorsal-fin margin and a transparent caudal fin. Adults have alternating thin yellow and blue stripes along the flanks, a greenish-yellow nape, a dark "mask" over the eyes and a light-blue snout. The dorsal fin is edged in white; caudal fin is yellow; anal fin has light-blue stripes along a dark blue background. Transformation from the juvenile to the adult color-pattern occurs at 8 to 12 cm TL. Grows to 38 cm TL. Also known as the Imperial Angelfish. Dorsal fin XII-XIV (17-21), anal fin III (18-21); pectoral rays 19 to 20. From Randall (1983 and 2005), Allen et al. (1998 and 2003), Myers (1999) and Pyle (2001b).

Similar Species: No Atlantic angelfish has horizontal stripes of any color. Juvenile Queen Angelfish (*Holacanthus ciliaris*) and Blue Angelfish (*Holacanthus bermudensis*) have bright blue body bars. Juvenile French Angelfish (*Holacanthus paru*) and Gray Angelfish (*Holacanthus arcuatus*) have bright yellow body bars on black body.

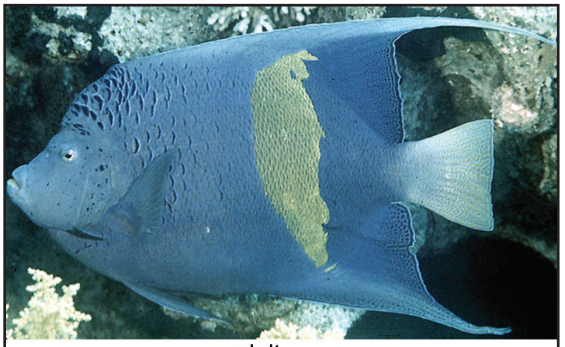
Native Range: Throughout the Indo-West and Central Pacific region, excluding Easter Island, Rapa, and the Marquesas Islands. Ranges from the East African coast and Red Sea to the Tuamotu, Line and (rarely) Hawaiian Islands southward to New Caledonia and north to southern Japan. From Allen et al. (1998) and Pyle (2001b).

Ecology: The Emperor Angelfish inhabits patch reefs and reef flats (often with rich coral growth) at depths from six to 60 m. When disturbed, the species emits a peculiar knocking sound. Juveniles are solitary, but as adults the species forms harems. The species feeds on sponges and tunicates. From Allen et al. (1998 and 2003), Randall et al. (1996), Myers (1999) and Pyle (2001b).

Nonindigenous Occurrences: In Florida, the species has been observed off Pompano Beach, Deerfield Beach and Hillsboro Beach between 2001 to 2006. The species was also observed in the marine waters off Puerto Rico in 2007.



Pomacanthus maculosus (Forsskål 1775)
Yellowband Angelfish



adult

juvenile

Photos by J. Randall, Bishop Museum

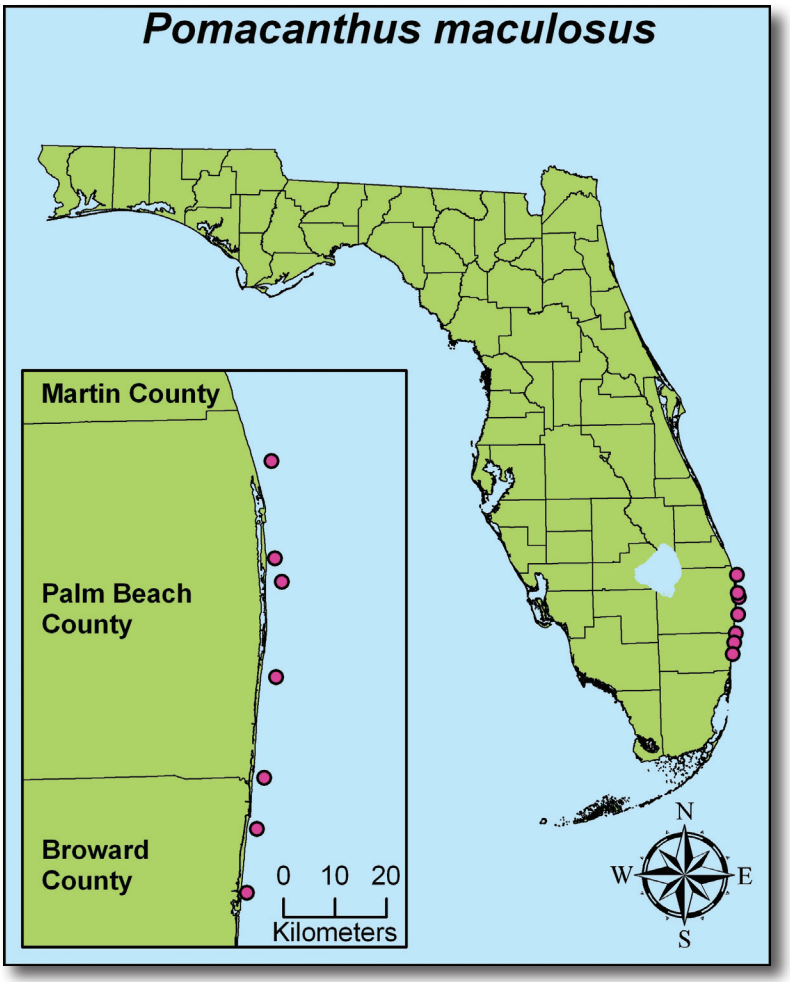
Identification: Adults are violet-blue with a large yellow blotch on the middle of the body. Scales on the forehead and nape have dark edges. Dorsal and caudal fins have yellow patches with light-blue markings. Dorsal and anal fins end in filaments. Juveniles have a dark blue body color with several white and pale blue bars along the sides (similar to *P. asfur)*. The caudal fin is transparent. Yellow markings along the sides of juveniles generally appear around the size of 6 cm, while full transformation to adult coloration occurs at a size from 10 to 15 cm TL. Can grow to 40 cm TL. Also known as the Halfmoon Angelfish or Yellowbar Angelfish. From Allen et al. (1998).

Similar Species: The Rock Beauty (*Holacanthus tricolor*) has a black body with yellow head and tail. Juvenile Queen Angelfish (*Holacanthus ciliaris*) and Blue Angelfish (*Holacanthus bermudensis*) have bright blue body bars. Juvenile French Angelfish (*Holacanthus paru*) and Gray Angelfish (*Holacanthus arcuatus*) have bright yellow body bars on black body.

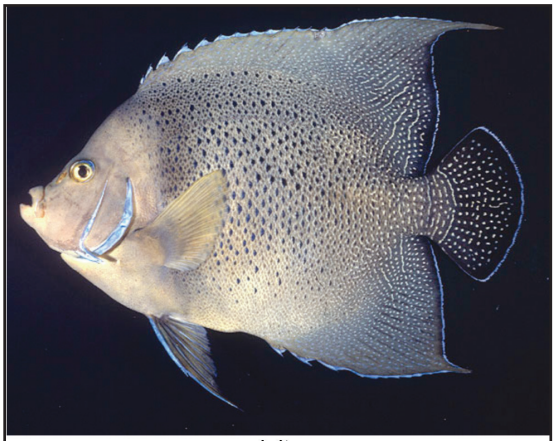
Native Range: Western Pacific around the Arabian Peninsula, including the Red Sea, Gulf of Oman and the Arabian Gulf. Ranges south to Kenya (Allen et al. 1998).

Ecology: The species has been noted as curious and not shy around divers (Allen et al. 1998).

Nonindigenous Occurrences: The species has been observed off Pompano Beach (2000 – 2002), West Palm Beach (2003, 2005, 2007), Boynton Beach (2003) and Juno Beach (2004).



Pomacanthus semicirculatus (Cuvier 1831)
Semicircle Angelfish



adult

juvenile

Photos by J. Randall, Bishop Museum

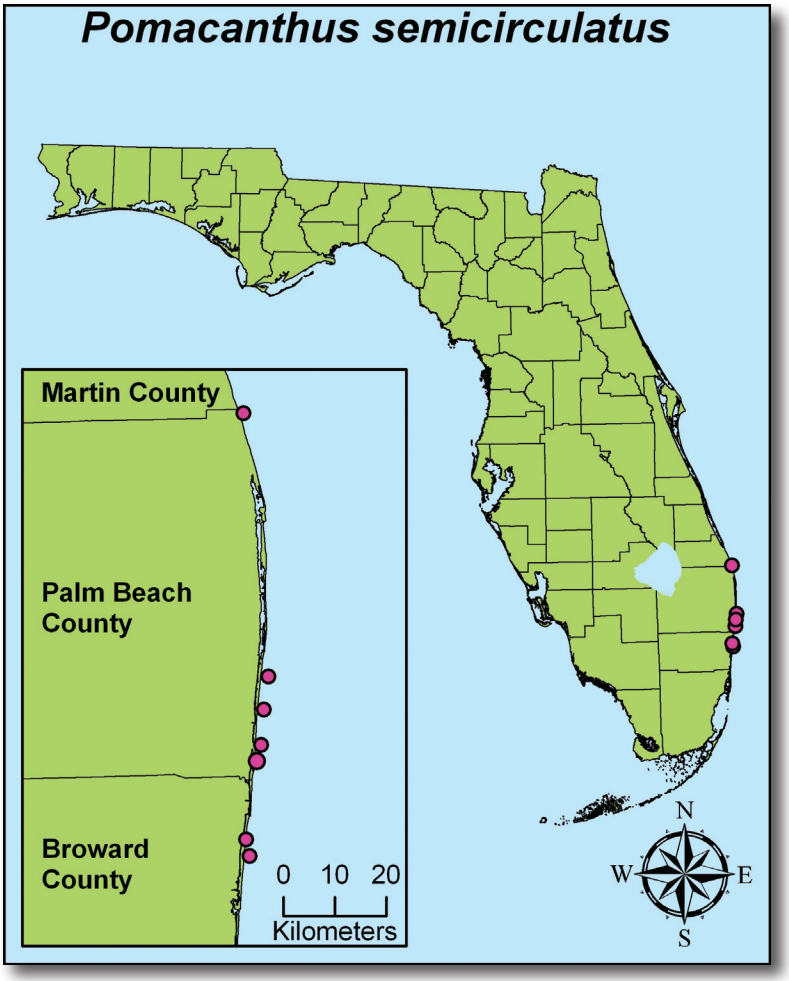
Identification: Adults are dusky brownish-green along the anterior and posterior thirds of the body; the center third is a paler yellow-green. Scales along the flanks are blue at the base. All fins are edged in blue except pectoral fins; dorsal and anal fins end in filaments. Mouth is pale yellow. Blue margins on cheek, spine and gill cover. Juveniles have a dark blue to black base color, with distinct narrow white and blue stripes. The stripes are more vertical near the head (i.e., anteriorly), and semicircular towards the posterior of the body. Juveniles intergrade to adult coloration at 8 to 16 cm TL. Grows to 35 cm TL. Also known as the Koran Angelfish. Dorsal fin XIII (20-23), anal fin III (18-22); pectoral rays 19-21. From Allen et al. (1998 and 2003), Randall et al. (1996) and Randall (2005).

Similar Species: Intermediate Gray Angelfish (*Pomacanthus arcutatus*) lacks blue margins on opercle and opercular spine, and lacks markings in tail. Juvenile Queen Angelfish (*Holacanthus ciliaris*) and Blue Angelfish (*Holacanthus bermudensis*) have bright blue body bars. Juvenile French Angelfish (*Holacanthus paru*) and Gray Angelfish (*Holacanthus arcuatus*) have bright yellow body bars on black body.

Native Range: Widely dispersed in the Indo-West Pacific, from East Africa to Palau and Fiji; southern Japan to New South Wales, Lord Howe Island and New Caledonia. From Allen et al. (1998), Randall et al. (1996) and Randall (2005).

Ecology: The species is found on protected coral reefs with well-developed coral growth to depths of 40 m. Juveniles are secretive and difficult to approach. Adults feed mainly on sponges, tunicates and algae. From Allen et al. (1998 and 2003) and Randall (2005).

Nonindigenous Occurrences: In Florida, the Semicircle Angelfish has been seen off Boca Raton (1999), Boynton Beach (2001), Deerfield Beach (2001), Delray Beach (2002), Pompano Beach (2004) and Lauderdale-By-The-Sea (2004). The species has also been observed in Oahu, Hawai'i (Mundy 2005).



Pomacanthus xanthometopon (Bleeker 1853)
Yellowface Angelfish

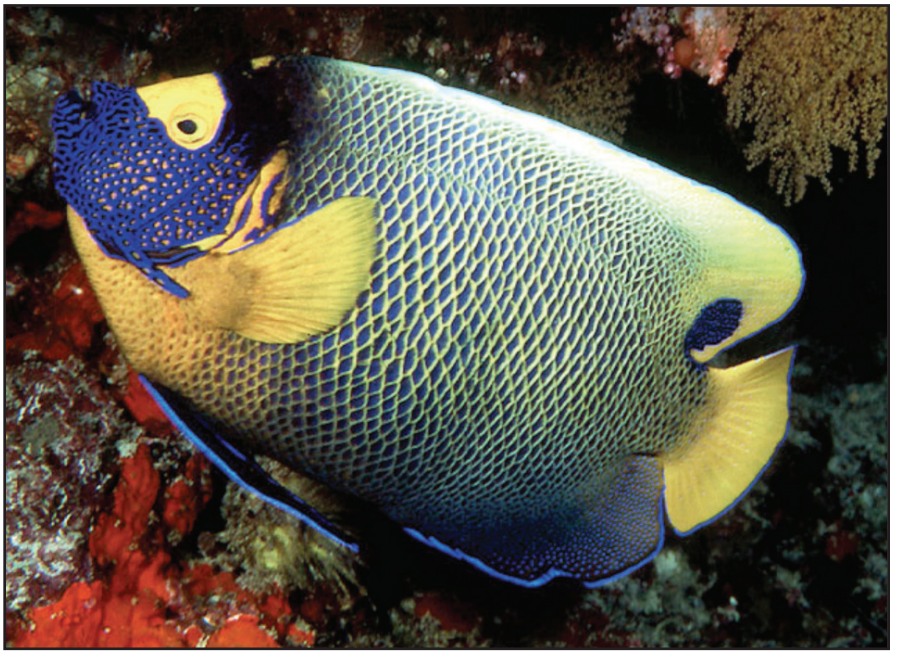


Photo by J. Randall, Bishop Museum

Identification: Juveniles have six white bars along the sides with smaller, less-conspicuous pale-blue lines in between them. There is a blue margin around the body and the caudal fin is dark blue with blue bars. Adults have yellow dorsal and caudal fins edged in blue. There is a prominent blue spot at the posterior base of the dorsal fin. Scales on the body are blue with yellow edges, giving the effect of a net-like pattern. The breast and pectoral region are yellow with blue spotting; the head is blue with yellow spots and a yellow eye-mask. Juveniles assume coloration of adults at 7-12 cm TL. Grows to 38 cm TL. Also known as the Yellow-mask Angelfish or Blue-face Angelfish. Dorsal fin XIII or XIV (16-17), anal fin III (16-18). From Allen et al. (1998) and Randall et al. (1996).

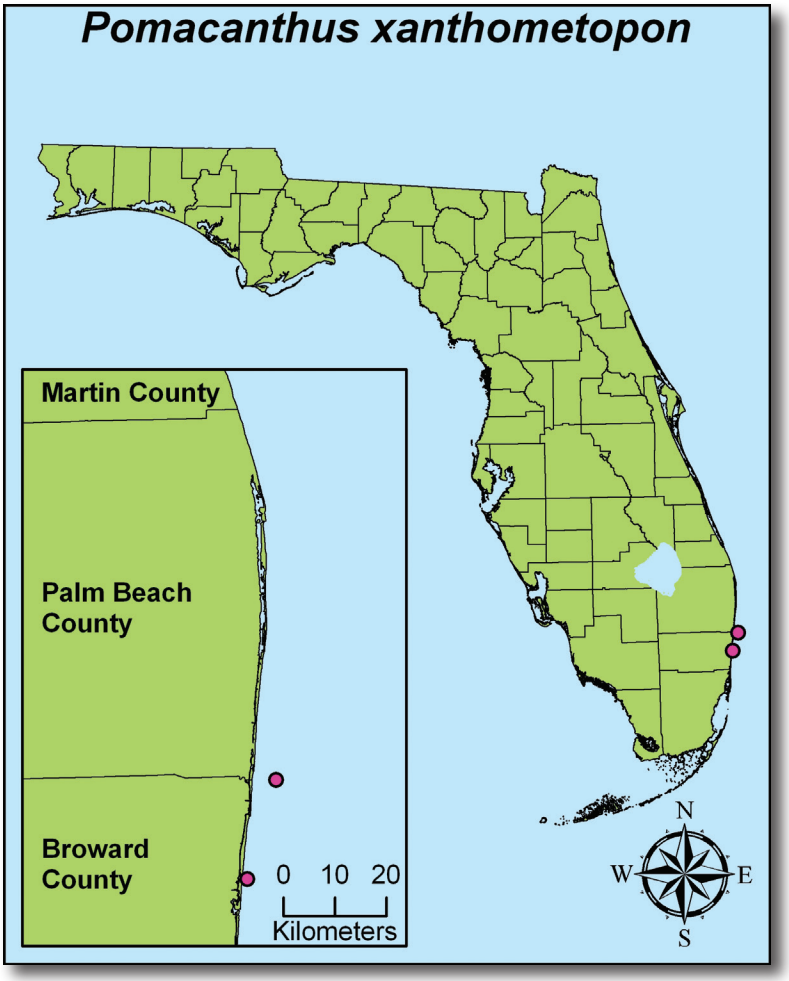
Similar Species: Queen Angelfish (*Holacanthus ciliaris*) has dark blue crown on forehead. Blue Angelfish (*Holacanthus bermudensis*) has blue wash on forehead. Neither have a dark spot at the base of the dorsal fin.

Native Range: Broadly distributed in the Indo-West Pacific from the Maldives, Indo-Australian Archipelago to Vanuatu, northward to Ryuku Islands and south to the Great Barrier Reef (Allen et al. 1998).

Ecology: The species inhabits lagoons, channels and outer-reef slopes where coral growth is prolific; especially areas with caves or large crevices. Found in depths from six to 60 m. It feeds on sponges and tunicates, and

is generally solitary. From Allen et al. (1998 and 2003).

Nonindigenous Occurrences: There is an unconfirmed record of the occurrence of the species in south Florida offshore Broward and Palm Beach counties (Courtenay 1995). It was also observed in 2006 off Ft. Lauderdale.



Family Cichlidae (cichlids)

No cichlids are native to Florida; however, several introduced species are established and reproducing (see http://nas.er.usgs.gov for more information). Most of these species are popular aquarium fishes; however, some of them are also prized gamefishes. Cichlid fishes occur primarily in inland (freshwater) habitats, but many species can also tolerate salinity and may occasionally be found in estuarine habitats. Cichlids are superficially similar to native sunfishes (family Centrarchidae) but can be distinguished by a two-part lateral line and one nostril on each side of the head. Centrarchids have a single, continuous lateral line and two nostrils on each side of the head. From Page and Burr (1991) and Nelson (2006).

Cichlasoma urophthalmus (Günther 1862)
Mayan Cichlid

Photo by H. Jelks, USGS

Identification: The Mayan Cichlid has five to seven dark bars on the side and a large black blotch surrounded by a blue halo and a yellow iris on the upper caudal peduncle. The body is olive green dorsally and laterally. The caudal and dorsal fins are edged in red, and the chin, throat, and breast are also red. The species typically grows to 30 cm SL. Often called the Mexican Mojarra. Anal spines V to VII. From Page and Burr (1991).

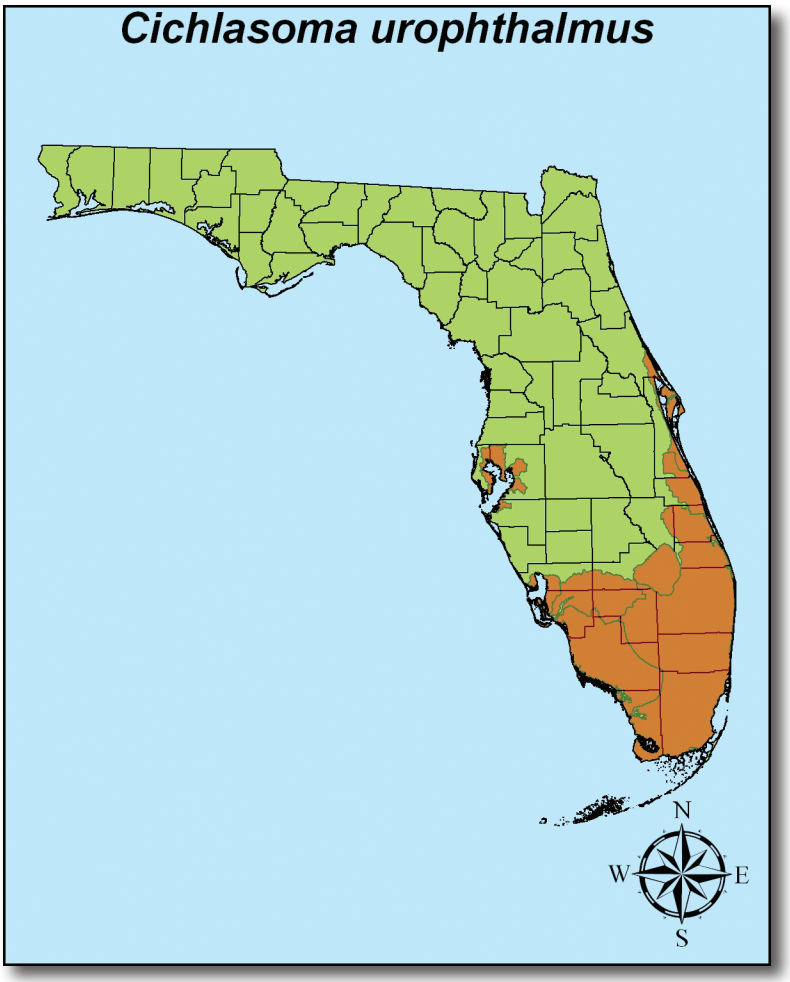
Similar Species: Sheepshead (*Archosargus probatocephalus*) has black bars on a white body and lacks the blotch on the caudal peduncle. Sergeant Major (*Abudefduf saxatilis*) has a more rounded body shape and yellow dorsum.

Native Range: Atlantic slope drainages from Rio Coatzcoalcos, Mexico to the Rio Prinzapolka, Nicaragua. It occurs in freshwater, estuaries, and marine habitats in the native range. From Page and Burr (1991), Martinez-Palacios and Ross (1992), Greenfield and Thomerson (1997), Chávez-López et al. (2005), and Miller (2005).

Ecology: The Mayan Cichlid breeds in freshwater and estuarine environments. It eats a variety of prey including fishes, crustaceans, and other benthic invertebrates. The species reaches sexual maturity between 75 and 80 mm TL. It is exploited in artisanal fisheries in the native range as it is easily caught on hook and line. From Miller (2005).

Mayan Cichlid populations in Florida Bay were studied by Faunce and Lorenz (2000) and Faunce et al. (2002). Adams and Wolf (2007) studied the species in southwest Florida (Charlotte Harbor).

Nonindigenous Occurrences: This species is one of the most abundant and widespread species in south Florida, occurring in nearly all fresh- and brackish-water habitats south of Lake Okeechobee (Shafland et al. 2008). The species is widespread in freshwater and coastal habitats of southern Florida, including Everglades National Park and Big Cypress National Preserve (Loftus 1987; Faunce and Lorenz 2000; Faunce et al. 2002; Rehage and Loftus 2007; Shafland et al. 2008). It ranges north along the east coast to Merritt Island and along the west coast to Tampa Bay (Paperno et al. 2008).



Hemichromis letourneuxi Sauvage 1880
African Jewelfish

Photo by H. Jelks, USGS

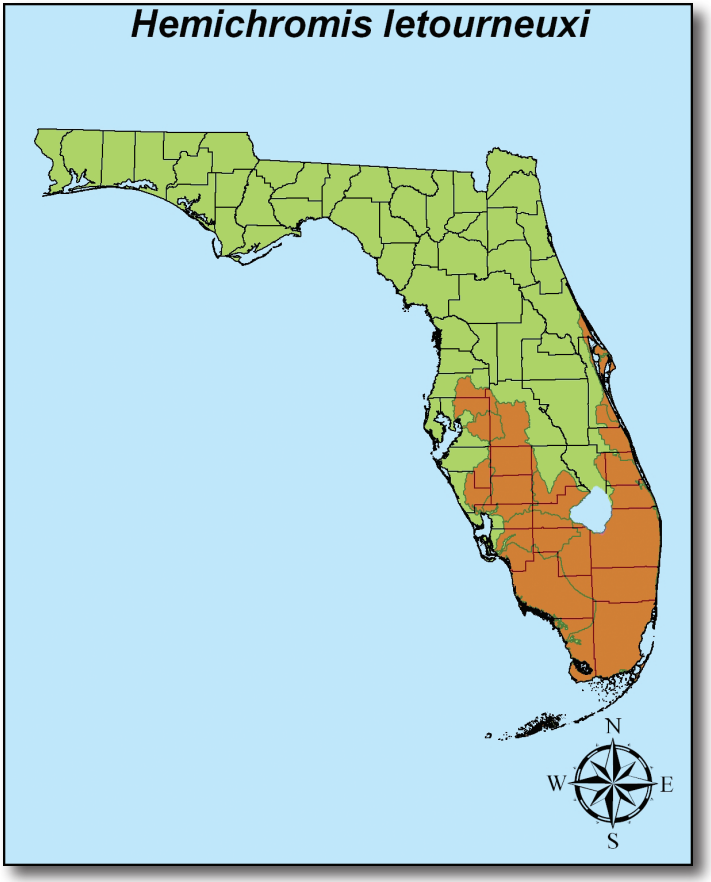
Identification: The species is a small, oval-shaped fish that is brightly colored, especially during the mating season. Background body coloration is highly variable, and can be green-yellow to bright red or even dark (almost black), depending on the time of year, habitat and/or disposition (e.g., fear or aggression level) of the fish. It has blue spangling on the head, body, and fins that is more pronounced in breeding adults. There is a dark black lateral spot above the lateral line, although it is not always visible. A relatively small fish, it grows to about 7 cm SL (maximum size is approximately 12 cm SL). It is difficult to discriminate amongst *Hemichromis* species, in part due to the wide variation in coloration within species and small meristic and morphological differences between species. Loiselle (1979) revised the genus *Hemichromis* and provided diagnoses, photographs, and synonyms for the species. An updated key to the genus was given in Loiselle (1992). Most published references to populations of this species from Florida before the 1990s were listed as *H. bimaculatus*, but are now thought to have been *H. letourneuxi*. Often misspelled as *H. letourneauxi*. Dorsal spines XIII to XV, anal spines III (Page and Burr 1991).

Similar Species: Clown Wrasse (*Halichoeres maculipinna*) has a dark spot on the dorsal fin.

Native Range: The species is native to Central and Western Africa. It occurs south of the Sahara Desert in the savannah floodplain and in the middle and lower reaches of the Nile River (Bailey 1994; Hickley and Bailey 1986 and 1987; Lamboj 1994; Loiselle 1979 and 2000; Lowe-McConnell 1991).

Ecology: The species occurs in shallow vegetated or rocky areas in marshes, along river banks, and on the margins of canals and culverts. It is occasionally observed in shallow estuarine areas, such as mangrove-lined creeks. It is an aggressive species, and it is thought that this characteristic has allowed it to spread across the southern portion of the Florida peninsula in syntopy with other (larger) cichlid species (Loftus and Kushlan 1987). The African Jewelfish is an opportunistic carnivore, feeding on invertebrates and small fishes (Hickley and Bailey 1987; Loftus et al. 2006). When spawning, females deposit their adhesive eggs on hard substrates.

Nonindigenous Occurrences: The species was first documented in south Florida in the Hialeah Canal-Miami River Canal system, Miami area, by Rivas (1965). It is now established and abundant in many canals in and around the Miami/Homestead area (Courtenay et al. 1974; Hogg 1976; Loftus and Kushlan 1987) as well as Everglades National Park and Big Cypress National Preserve. The African Jewelfish is present along the Gulf coast of Florida in Charlotte Harbor and in the lower Caloosahatchee, Peace and Alafia rivers. It is tolerant of salinity, and is periodically collected in estuarine regions adjacent to freshwater systems where it is established.



Oreochromis mossambicus (Peters 1852)
Mozambique Tilapia

Photo of breeding male Mozambique tilapia
by Department of Fisheries and Allied Aquacultures, Auburn University

Identification: The body is dull yellow to olive green along the sides and grey on the back. The large, oblique mouth extends underneath the front of the eye (or beyond). In adult males, the body and fins are black, the upper lip is blue, the underside of the head is white, and the fins are edged in red. Females and non-breeding males are silver with two to five blotches along the midline. Grows to about 30 cm SL. Also called the Mozambique Mouthbrooder. Dorsal fin XV to XVII (10-12), anal rays III-IV (9-12), pectoral fin rays 14-15. Lateral scale rows 29-33. From Trewavas (1983), Page and Burr (1991), and Boschung and Mayden (2004).

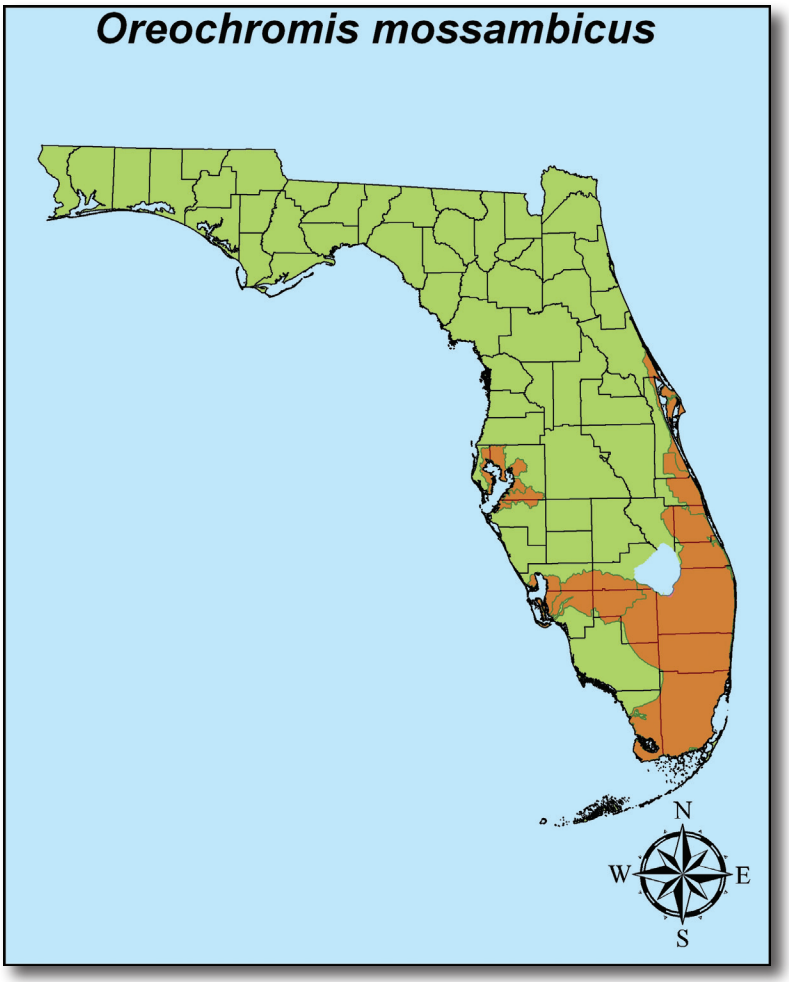
Native Range: The species is from southeastern Africa (Page and Burr 1991). It occurs in fresh, brackish, and saline waters (Whitfield and Blaber 1979; Whitfield et al. 2006).

Similar Species: No tilapias are native to Florida, and no native species are similar to tilapias.

Ecology: The species is normally found in freshwater, but can live and breed in salt water (e.g., Salton Sea). Breeding males establish territories in shallow, weedy areas and excavate a shallow nest. Females are enticed onto the nest where they deposit their eggs then take eggs and sperm into their mouth where the embryos are incubated. Sexual maturity is obtained at lengths of 12-14 cm TL, a size roughly equivalent to about six months after hatching. The species is an opportunistic carnivore. From Boschung and Mayden (2004).

Nonindigenous Occurrences: Within Florida, the species was first introduced into and became established in Dade County during the 1960s (Courtenay and Stauffer 1990). It now ranges north along the Atlantic coast to Satellite Beach. Along the Gulf coast of Florida, the species has been documented in the Caloosahatchee drainage, Charlotte Harbor, and Tampa Bay (Courtenay et al. 1974).

Outside Florida, it is established in six states (Arizona, California, Colorado, Hawai'i, Idaho, and Texas). The species was formerly considered locally established, but no longer extant in Georgia, Montana, and North Carolina. It has been reported from Alabama, Illinois, and New York, although the status of those populations is unclear.



Oreochromis niloticus (Linnaeus 1758)
Nile Tilapia

Photo by Department of Fisheries and Allied Aquacultures, Auburn University

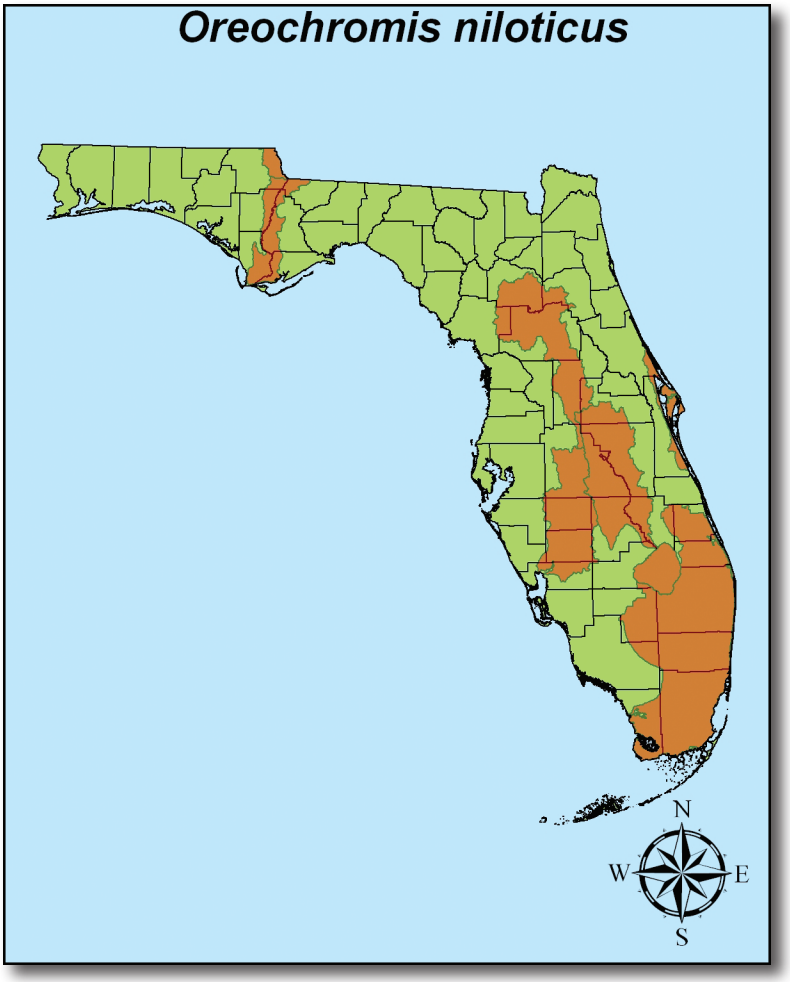
Identification: The Nile Tilapia closely resembles the Blue Tilapia, *Oreochromis aureus*, but can generally be distinguished by its strongly-barred caudal fin. Trewavas (1983) provided distinguishing characteristics with a key and a discussion of hybrids. In the U.S.A. and other regions where they have been introduced, hybrid tilapias have been used in aquaculture and subsequently escaped into freshwater and estuarine water bodies. In the wild, reproductively viable hybrids have likely back-crossed or further crossed with other hybrids, and therefore identification to species for most tilapia populations in the U.S.A. is difficult (Costa-Pierce 2003). Maximum size is approximately 60 cm SL.

Native Range: Tropical and subtropical Africa as well as the Middle East (Trewavas 1983).

Similar Species: No tilapias are native to Florida and no native species are similar to tilapias.

Ecology: Nile Tilapia is a hardy species, capable of withstanding a variety of environmental conditions (low oxygen, salinity), and is consequently one of the most common species in aquaculture. Females can reproduce as early as a size of 10 cm TL (an age of approximately 50 days). Reproduction is similar to *O. mossambicus* and females can brood up to 2,000 eggs in their mouth. The species is a substrate feeder, consuming cladocerans, copepods, chironomids, and filamentous algae. From Boschung and Mayden (2004) and Peterson et al. (2006).

Nonindigenous Occurrences: There are spotty occurrences of Nile Tilapia throughout the U.S.A. In Florida it is only known to be established in one locality (Orange Lake, Alachua County). The species has been captured in brackish water at Crane Creek near Melbourne and in a pond in the Kissimmee drainage. Shafland et al. (2008) provides details of other Florida occurrences and taxonomic difficulties associated with this species. The Nile Tilapia occurs primarily in inland (freshwater) habitats; however, like many cichlid fishes it can tolerate salinity and can occasionally be found in estuarine habitats. For example, an estuarine population has persisted in southern Mississippi for several years (Peterson et al. 2004 and 2005; Schofield et al. 2007).



Sarotherodon melanotheron Rüppell 1852
Blackchin Tilapia

Photo by J. D. Williams, Florida Museum of Natural History

Identification: The species is orange or gold dorsally and light blue ventrally. Patches of black in variable patterns are sometimes present. Males can sometimes exhibit an overall darkened body coloration (as in the photo above). The mouth is small, its posterior edge does not reach the front of the eye. The underside of the head of adult males is black, giving the name "blackchin". Grows to about 26 cm SL. Dorsal fin XV to XVI (10-12). Lateral line scales 27-30. From Trewavas (1983), Page and Burr (1991).

Native Range: The species is west-African in origin and inhabits brackish estuaries and lagoons from Senegal to Zaire (Trewavas 1983).

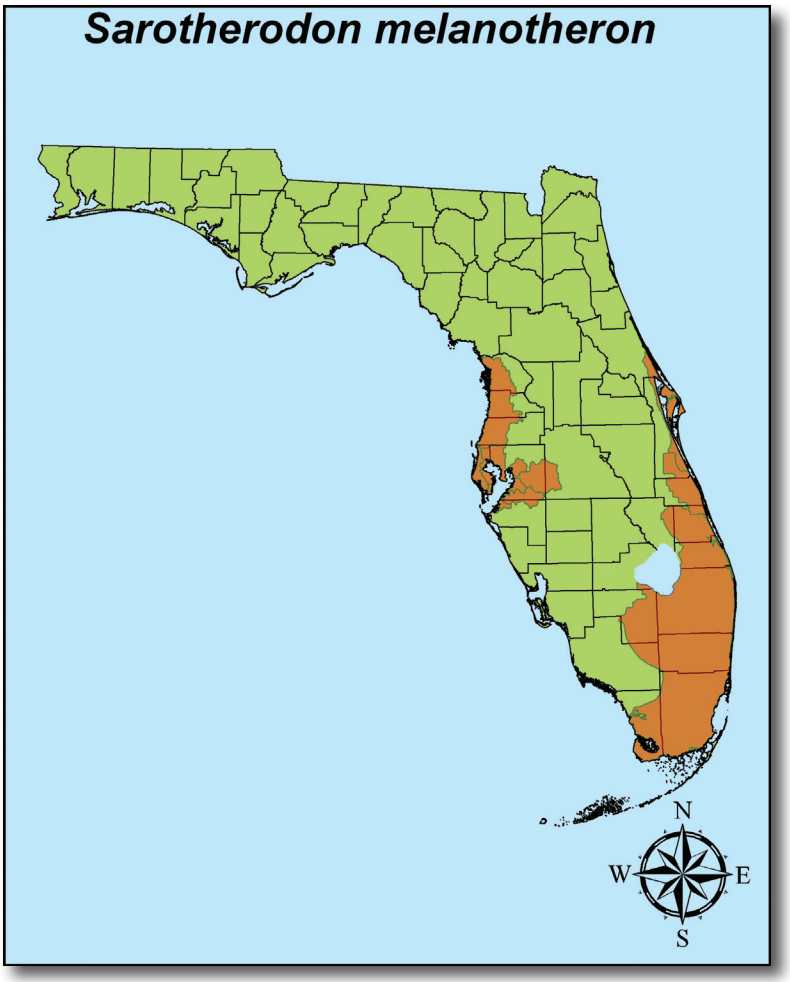
Similar Species: No tilapias are native to Florida and no native species are similar to tilapias.

Ecology: The species is primarily estuarine, but also found in freshwater and marine habitats. It can tolerate salinities of up to 100 ppt for brief periods and will spawn in waters to 35 ppt (Jennings and Williams 1992). Low winter temperatures are thought to be the most important factor limiting the geographic range expansion of the Blackchin Tilapia as it cannot tolerate temperatures below about 10 ºC (Shafland and Pestrak 1982; Jennings 1991; Jennings and Williams 1992). Like other tilapias, a nest is built by excavating a shallow pit. However, unlike most tilapias where the nest is built solely by the male, both male and female Blackchin Tilapia participate in nest-building and guarding (Trewavas 1983). Generally males brood young in their mouths, but sometimes females will as well (Trewavas 1983). Trewavas (1983) reported the smallest mature female (in the native range) as 6.9 cm SL and the smallest mature male as

7.8 cm SL. Adults feed on detritus, while juveniles are more carnivorous (Trewavas 1983).

Nonindigenous Occurrences: In Florida, the species was first collected near Tampa in 1959 (Springer and Finucane 1963). It is established in fresh and brackish waters in and around Tampa Bay, as well as the Banana and Indian River lagoon system on the Atlantic coast.

In Hawai'i, the species is abundant in brackish-water lagoons including Pearl Harbor and several coastal marine environments (Randall 1987).



Tilapia mariae Boulenger 1899
Spotted Tilapia

Photo by H. Jelks, USGS

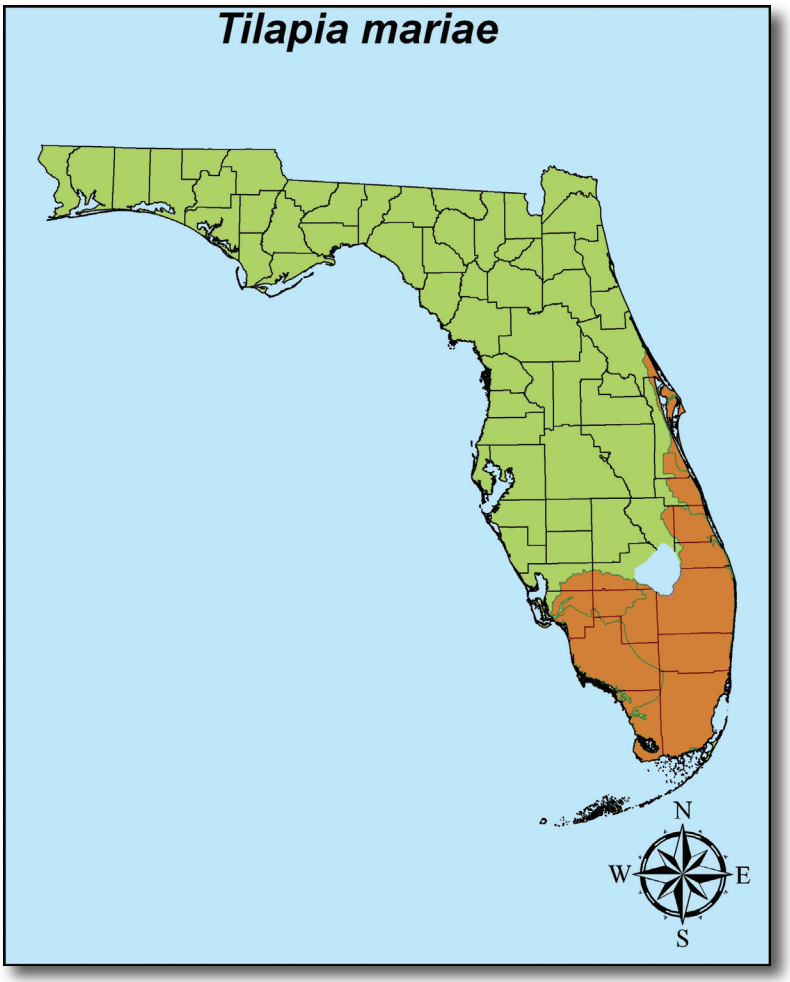
Identification: The species has six to nine black lateral blotches that fade into bars and continue up onto the dorsal fin. Maximum size is approximately 30 cm SL. Dorsal fin XV to XVI (12-15); anal fin III (X to XII). From Page and Burr (1991).

Native Range: The species is native to the Atlantic slope of western and central Africa, from Ivory Coast to southwestern Ghana and from southeastern Benin to southwestern Cameroon (Thys van den Audenaerde 1966; Trewavas 1974).

Similar Species: No tilapias are native to Florida and no native species are similar to tilapias.

Ecology: Although most tilapias are mouth brooders, the Spotted Tilapia does not brood eggs or young in its mouth. It lays turquoise-blue eggs on the substrate and both parents aggressively guard the newly-hatched young (Taylor et al. 1986; Loftus and Kushlan 1987; Annett et al. 1999). In southern Florida, it breeds from the spring to the fall (Loftus and Kushlan 1987). Like most other non-native cichlids established in Florida, it is an aggressive species and can disrupt the ecologies of other fishes (Courtenay and Hensley 1979). The Spotted Tilapia sometimes hybridizes with the Redbelly Tilapia (*Tilapia zillii*; Taylor et al. 1986).

Nonindigenous Occurrences: First reported from the Snapper Creek canal in Miami (Hogg 1974), the species is now common in most freshwater habitats of south Florida, sometimes venturing into estuarine areas. Along the Atlantic coast, it ranges north to Melbourne (Shafland et al. 2008). The species has also been introduced into Arizona and Nevada.



Family Pomacentridae (damselfishes)

The damselfishes are one of the most abundant groups of coral-reef fishes. They are laterally-compressed fishes with a single, continuous dorsal fin and an anal fin with two spines. Most damselfishes are tropical; however, a few species inhabit cooler temperate waters. Many species are territorial and will zealously defend their small plots against intruders. The family Pomacentridae includes the anemonefish (*Amphiprion* and *Premnas*) that occur exclusively with large tropical sea anemones. From Randall et al. (1996).

Dascyllus aruanus (Linnaeus 1758)
Whitetail Dascyllus

Photo by J. Randall, Bishop Museum

Identification: The species is distinctly colored; white with black bars and solid black pelvic fin. Large white spot between eyes. Dorsal fin XII (11-13), anal fin II (11-13), pectoral rays 17-19. Grows to 8 cm TL. Also called Humbug Damselfish, Threestripe Damselfish, White-tailed Damselfish. From Allen et al. (2003) and Randall (2005). A key to the *Dascyllus* is given in Randall and Allen (1977).

Similar Species: Sergeant Major *(Abudefduf saxatilis)* and Night Sergeant *(Abudefduf taurus)* have black bars on body, similar to the Whitetail Dascyllus. However, the bars on these species do not extend onto pelvic fins as in Whitetail Dascyllus. The body bars of the Night Sergeant extend only partially onto the belly. Additionally, the Sergeant Major is distinguished by the yellow background coloration across upper dorsal region.

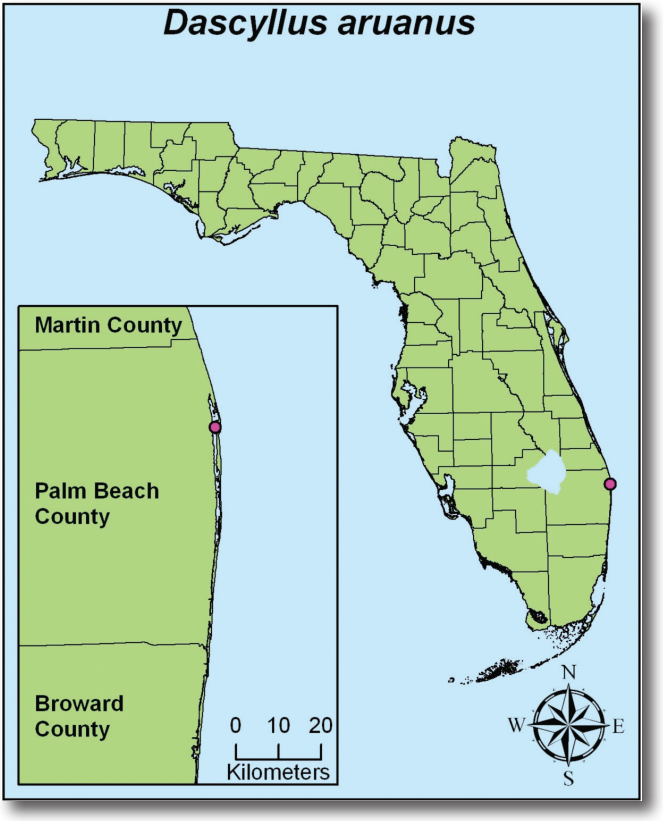
Native Range: Throughout most of the Indo-Pacific from the Red Sea and east coast of Africa to French Polynesia, and Ryuku Islands to New South Wales and Lord Howe Island. From Randall (2005).

Ecology: The species lives in groups of up to about 30 individuals that shelter among branching corals at depths of one to 12 meters. Individuals leave their coral shelter to forage in the water column on zooplankton. Home territories are small and guarded fiercely. Mating occurs among fish that either form pairs or small groups of three to six that operate as a harem with a dominant male and several females. Female rank in the harem system is based on body size, with the largest female having the

highest rank. Males create a nest by clearing algae and detritus from the site, usually at the base of a coral colony. Females are then enticed to spawn with the male when he performs a characteristic courtship dance composed of a series of rapid up and down swimming movements about one meter above the nest. One male may spawn with several females, each depositing up to 2,000 eggs into the nest. Eggs are elliptical and 0.7 to 0.8 mm in length. Males aggressively guard the eggs while in the nest, fanning them with his pectoral fins and keeping the site clean of debris. Eggs hatch after about 44-51 hours into larvae that are approximately 2 mm total length. The species is known to live for at least nine years in captivity. From Randall and Allen (1977), Allen et al. (2003) and Randall (1983 and 2005).

For more information on the ecology of the Whitetail Dascyllus, see Fricke and Holzberg (1974), Sale (1970, 1971a, 1971b,1972a, 1972b), Coates (1980), Sweatman (1983 and 1988), Forrester (1991) and Planes et al. (1993).

Nonindigenous Occurrences: In Florida, one individual was observed off Riviera Beach (Palm Beach County) in April, 2009. This fish was removed by REEF the next day and sent to the National Aquarium (Baltimore, Maryland).



Dascyllus trimaculatus (Rüppell 1829)
Threespot Dascyllus

Photo by J. Randall, Bishop Museum

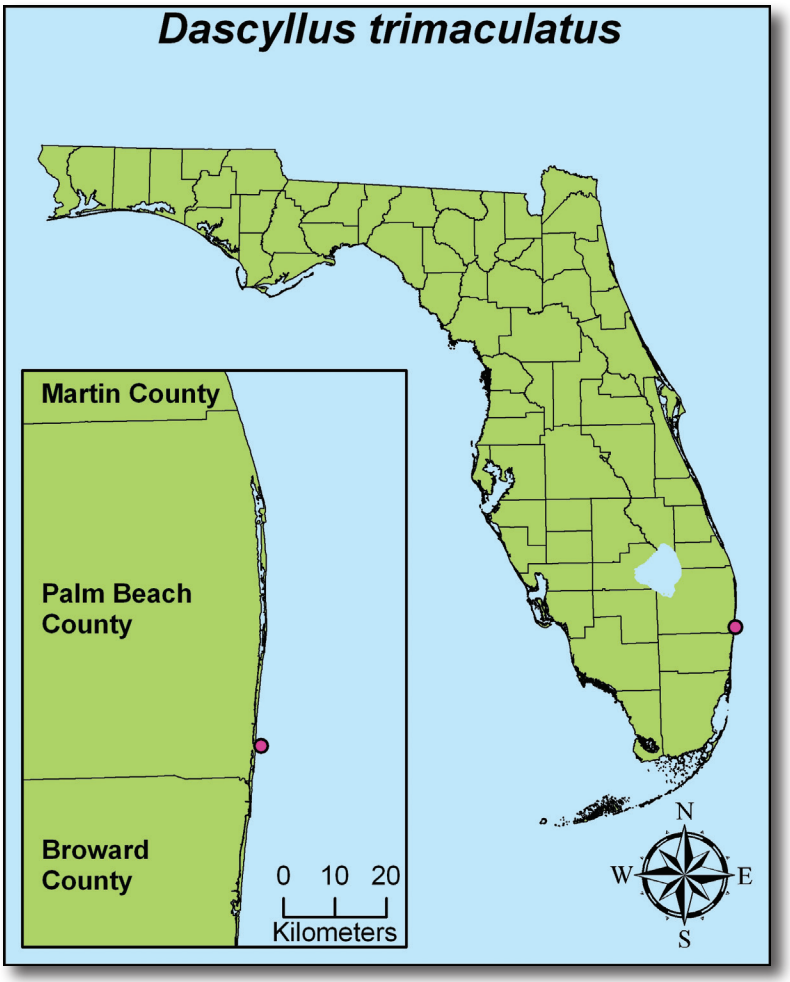
Identification: The body is the color of charcoal with black scale margins. Orangish-brown head and breast. Some specimens have yellow on the caudal, anal, and pelvic fins. Juveniles have two distinctive white spots; one on the head above the eyes and one positioned dorso-laterally. Maximum size is approximagely 13 cm TL. Also called the Domino Damselfish. Dorsal fin XII (14-16), anal fin II (14-15). Pectoral rays 19-21. From Randall et al. (1996).

Similar Species: Sunshinefish (*Chromis insolata*) has yellow, pale or clear rear dorsal and caudal fins.

Native Range: East Africa and the Red Sea to the Line Islands and Pitcairn Group; southern Japan to New South Wales and Lord Howe Island. From Randall et al. (1996) and Randall (2005).

Ecology: Juveniles are sometimes found with sea anemones or venomous long-spined sea urchins in their native habitat. The species can be found on coral reefs and rocky substrata from depths of one to 55 m. From Randall (2005) and Randall et al. (1996).

Nonindigenous Occurrences: The Threespot Dascyllus was seen off Boca Raton in 2006.



Family Blenniidae (combtooth blennies)

Combtooth blennies are small (generally less than 15 cm TL), benthic fishes that often have cirri or fleshy flaps above the eyes and lack scales. They generally live in shallow water and can be found on coral, rock and oyster reefs, as well as in tide pools and along dock/wharf pilings. Combtooth blennies have a lateral line (series of tubes or canals along the flank), unlike the otherwise similar tubeblennies (Chaenopsidae). From Williams (2002).

Hypsoblennius invemar Smith-Vaniz & Acero P. 1980
Tessellated Blenny

Photo by T. Rauch

Identification: Numerous orange or brick-colored spots outlined in black (smaller than the eye) cover most of the head, pectoral-fin base, and anterior body over a bright blue background. Spots often merge on the top of the head to form a reticulated pattern. The species is small-bodied, attaining a maximum size of approximately 6 cm SL. Dorsal fin XI-XII (12-13); anal fin II (13-14). From Smith-Vaniz (1980) and Hoese and Moore (1998).

Smith-Vaniz (1980) revised the western Atlantic *Hypsoblennius*. A key to the Blenniidae of the western central Atlantic is given in Williams (2002); this key was modified for the Gulf of Mexico by McEachran and Fechhelm (2005). Gulf species can also be keyed with Hoese and Moore (1998). Meristics for adults and larvae were given by Ditty et al. (2005). Larvae of five common Gulf of Mexico species are described and illustrated in Ditty et al. (2005).

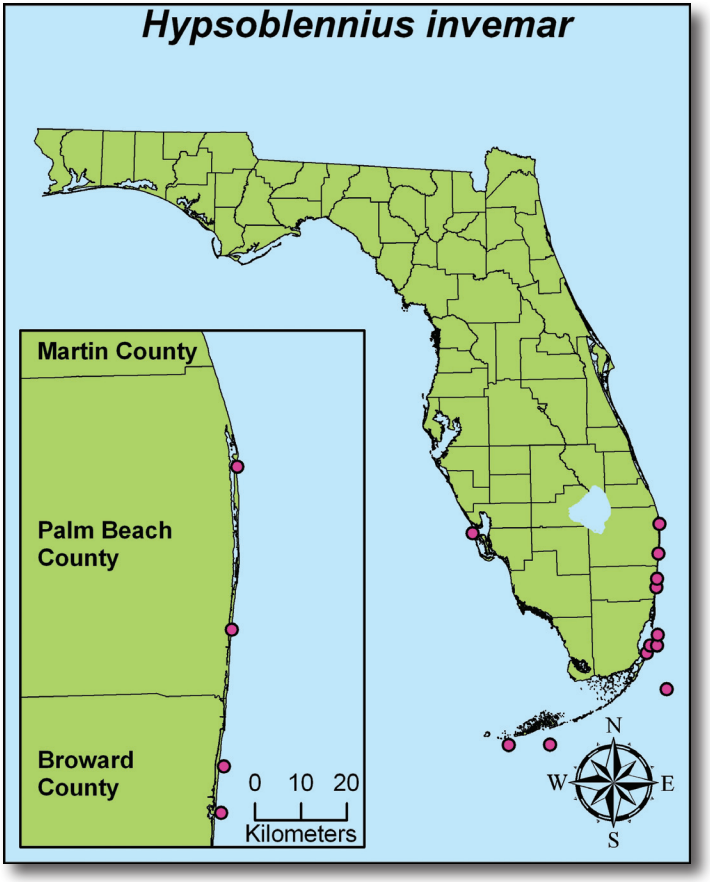
Similar Species: Orangespotted Blenny (*Hypsoblennius springeri*) lacks black outline surrounding red spots.

Native Range: The species is native to the Lesser Antilles, Venezuela, Colombia, and Brazil. It might be native to the northern Gulf of Mexico, but is generally thought to be introduced, possibly through shipping (either in barnacles attached to hulls or in ballast water) or during the transport of oil rigs from South America.

Ecology: The species lives in empty barnacle tests of the Mediterranean

barnacle (*Megabalanus antillensis* [= *Balanus tintinnabulum*]) on pilings and oil platforms. It is usually recorded from depths of less than 4.5 m, but can rarely range to 18 m (Topolski and Szedlmayer 2004). The species is found in abundance where the hydroid *Cnidoscyphus marginatus* is abundant (Smith-Vaniz 1980). Males brood egg masses inside the barnacles (Smith-Vaniz 1980). Rauch (2000, 2003) observed that blenniid assemblages on petroleum platforms in the Gulf of Mexico are highly structured (through competition) and change little over time. Additionally, blenniid assemblages appear to remain relatively constant, even after the passage of a hurricane (Rauch 2000, 2003).

Nonindigenous Occurrences: Established in the northern Gulf of Mexico, including Alabama, Texas, and Louisiana. Inhabits the tests of barnacles on oil platforms from Cameron, Louisiana to south Texas (Hoese and Moore 1998) and off Dauphin Island, Alabama (Ditty et al. 2005). First documented from oil platforms off Cameron, Louisiana and Galveston, Texas in 1979; not present at Galveston before 1979 (Dennis and Bright 1988). Observed off Palm Beach, Florida since 1992 (P. Humann, pers. comm.). In Florida, spotty occurrences along the Atlantic coast of south Florida and the Florida keys, with several occurrences off Boca Grande.



Family Ephippidae (spadefishes)

Spadefishes are found in the Pacific, Atlantic and Indian oceans and are distinguished by their laterally-compressed body shape, small mouth, and deep body. The anal fin typically has three spines. Spadefishes are thought to be pelagic spawners and feed primarily on algae and small invertebrates.

Platax orbicularis (Forsskål 1775)
Orbicular Batfish

Photo by J. Randall, Bishop Museum

Identification: Juveniles exhibit broad, elevated dorsal and anal fins while adults are orbiculate (i.e., nearly circular). The body color of juveniles is light reddish brown to brownish yellow with a brown bar through the eye. Adult body color is silvery grey with black bars through the pectoral fin and eye. Anal and dorsal fins exhibit black margin. Small black spots sometimes scattered on side. Concave snout profile with large bone between eyes. Grows to about 50 cm TL. Also called Narrowbanded Batfish. Dorsal fin V (34-38), anal fin III (26-28). From Randall et al. (1996); Heemstra (2001).

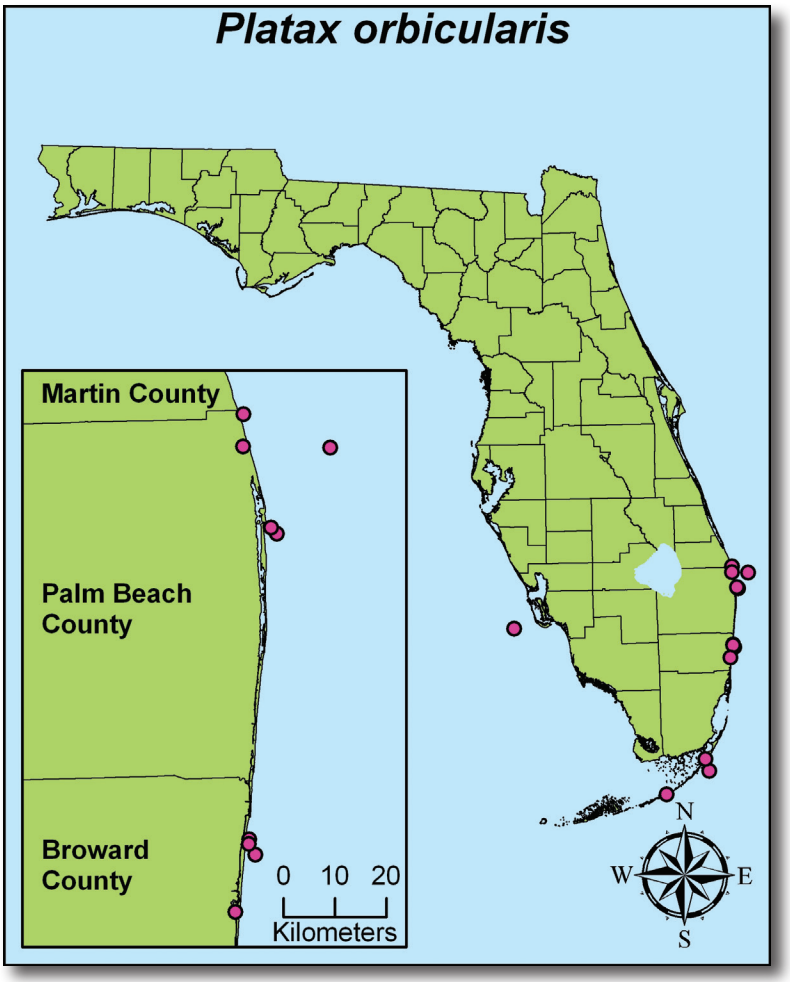
Similar Species: Atlantic Spadefish (*Chaetodipterus faber*) has multiple dark body bars, and pointed dorsal and anal fins.

Native Range: Orbicular Batfish is distributed across the Indo-Pacific, from the Red Sea and eastern Africa to Indonesia, Micronesia and Polynesia. Also from southwest Japan to northeast Australia and New Caledonia. From Allen et al. (2003).

Ecology: Orbicular Batfish inhabits shallow and deep reefs with juveniles occurring in small groups among mangroves and also within inner lagoons.

Juveniles resemble a floating leaf in appearance and behavior. Young adults are found in channels and lagoons where they sometimes form schools. Orbicular Batfish diet consists of algae, invertebrates, and small fishes. From Myers (1999).

Nonindigenous Occurrences: The species was observed at numerous locations in south Florida and Florida Keys from 1996 to 2005. REEF divers removed four Orbicular Batfish from the Florida Keys (two in 1999, two in 2002). There have been no re-occurences of this species in the Florida Keys since these removals.



Family Scatophagidae (scats)

The family Scatophagidae is characterized by a small, non-protractile mouth, a deep notch between the spines and rays of the dorsal fin and an anal fin with IV spines. From Kottelat (2001).

Scatophagus argus (Linnaeus 1766)
Spotted Scat

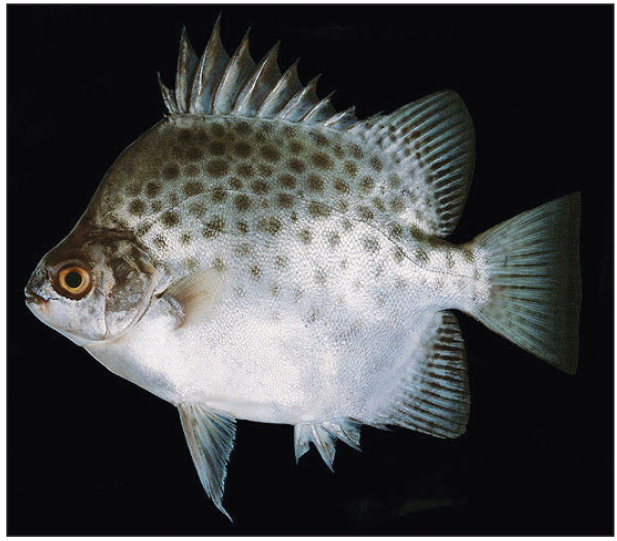


Photo by J. Randall, Bishop Museum

Identification: The body of the Spotted Scat is quadrangular and strongly compressed. The dorsal head profile is steep and the snout is rounded. Spines and rays of the dorsal fin are separated by a deep notch. Small ctenoid scales cover the body. The body is greenish-brown to silvery with many brown to red-brown spots. Males have a concave curvature of the head above the eye, whereas in females the head ascends at a constant slope. Juveniles are greenish-brown with either a few large, rounded blotches (approximately the size of the eye) or 5-6 broad, dark vertical bars. Individuals greater than about 4 cm SL have blackish spots (typically slightly smaller than eye) loosely arranged in vertical rows. In large adults, the spots can fade and appear only dorso-laterally. Adults can reach approximately 30 cm TL, but occasionally larger individuals are observed (see Khan 1979). Sometimes called the Spotted Butterfish (especially in literature from India) or Common Scat. Dorsal fin XI (16-18); anal fin IV (14-15). Pectoral fins with 16-17 rays. Pelvic fins with I spine and 5 soft rays. From Barry and Fast (1992), Kottelat (2001) and Allen et al. (2003).

It is unclear whether nominal *S. argus* is in fact composed of more than one species. Differences in the marking pattern (i.e., bars versus spots, size of spots) of juveniles has lead to contention over whether the species should be partitioned. The “Red Scat” (*Scatophagus argus rubifrons*) might not be a distinct variety of scat, but merely a developmental stage of the common Spotted Scat (Barry and Fast 1992).

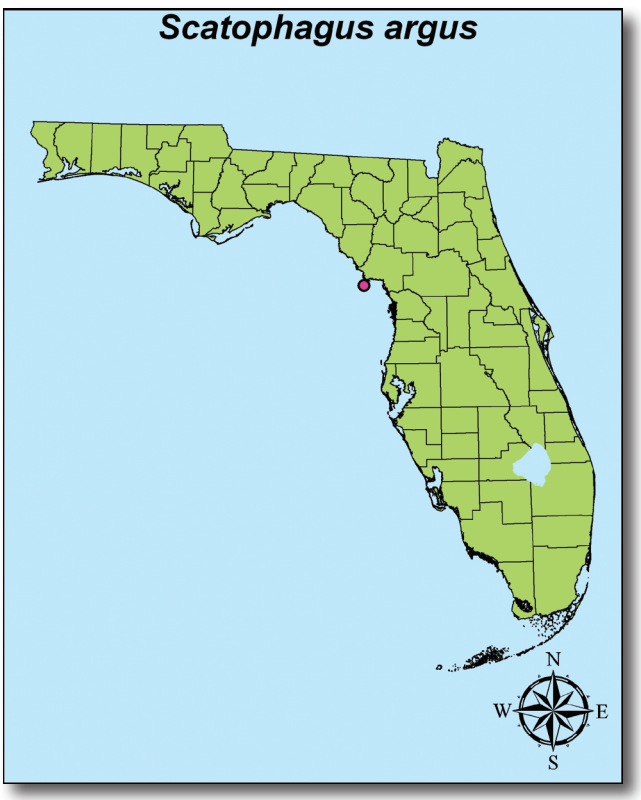
Similar Species: No similar species in Florida.

Native Range: Nearshore waters of the Indo-Pacific, from southern India and Sri Lanka to southern Japan and Tahiti. Includes northern Australian coast, Philippines, Indonesia, and the Southeast Asian coast (Kottelat 2001). The species occurs in fresh, brackish, and marine waters.

Ecology: The species lives in coastal muddy areas including estuaries, mangroves, harbors, and the lower courses of rivers (Bianchi 1985; Rainboth 1996). The Spotted Scat has a broad diet and eats detritus, filamentous algae, phytoplankton, aquatic macrophytes, zooplankton, benthic invertebrates, and other macrozoobenthos (Khan 1979; Datta et al. 1984; Rainboth 1996). Barry and Fast (1992) reported that adults from the Philippines were primarily herbivorous while the juveniles preferred zooplankton. Females mature at about 7-9 months of age and 150 g, while males mature at a smaller size (Barry and Fast 1992). In the Philippines, spawning is triggered by monsoon rains that begin in June and July and bring rainfall, cooler temperatures, increased river outflows, and lower salinities (Barry and Fast 1992).

The scat has venomous spines that can inflict painful wounds that ache for several hours (Barry and Fast 1992).

Nonindigenous Occurrences: The species was collected at Seahorse Key (near Cedar Key) in 1992.



Family Zanclidae (Moorish Idol)

The family Zanclidae consists of only one species: *Zanclus cornutus*, the Moorish Idol. It is characterized by a lack of spines along the caudal peduncle, a spine at the corner of the mouth in juveniles and protuberances in front of the eyes of adults. It bears a resemblance to the butterflyfish *Heniochus acuminatus*, another popular aquarium fish. From Nelson (2006).

Zanclus cornutus (Linnaeus 1758)
Moorish Idol

Photo by J. Randall, Bishop Museum

Identification: The body is deep and strongly compressed, with three wide black and two pale yellow bars. The protruding, tubular snout has a yellow saddle across the top. Short horn-like projections arise above the eyes; these are larger in males. Dorsal spines elongated into a whip-like filament. Grows to about 23 cm TL. Dorsal fin VII (40-43), anal fin III (33-35); pectoral rays 19. Grows to about 20 cm TL. From Galván-Magaña et al. (1996), Allen et al. (2003), and Randall (2005).

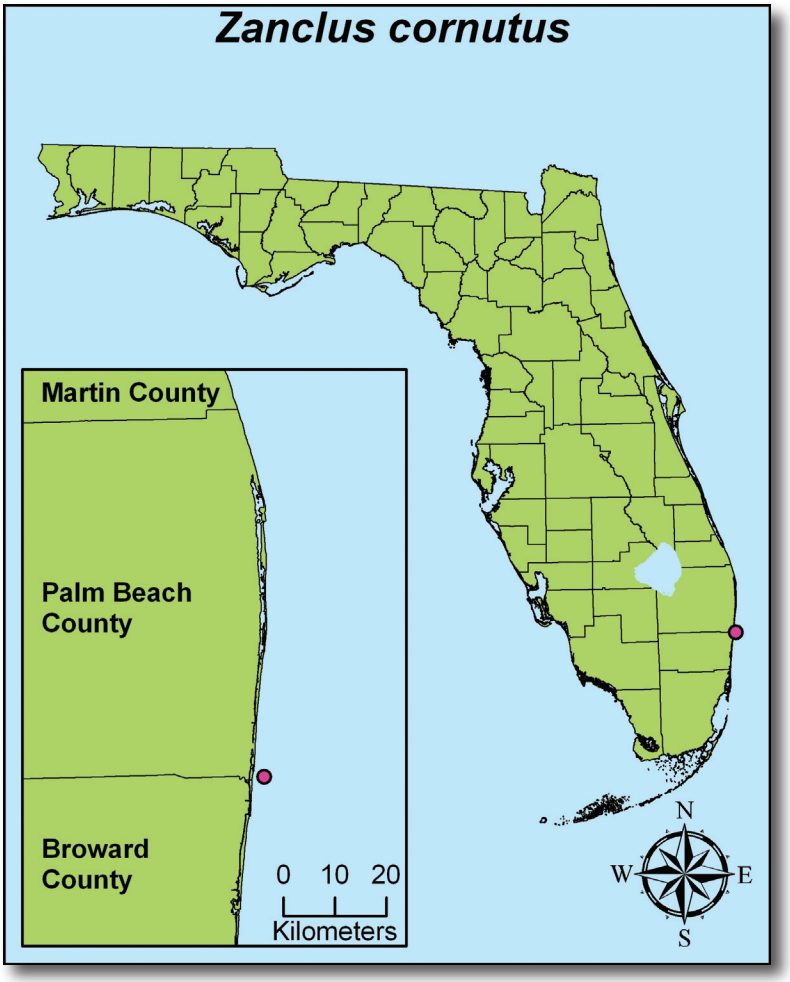
Similar Species: No similar species in Florida.

Native Range: Wide-ranging in the Indo-Pacific and tropical Eastern Pacific, from East Africa to Micronesia, Hawai'i, Polynesia, México, and the Galápagos Islands. From Galván-Magaña et al. (1996), Allen et al. (2003) and Randall (2005).

Ecology: This reef-associated species occurs in a variety of hard-bottom habitats, from turbid harbors to reef flats and seaward reefs to 180 m. Usually, the species occurs in small groups, but it can form large schools of over 100 individuals. The species feeds on algae, sponges, and other benthic invertebrates. From Randall et al. (1996), Myers (1999), Allen et

al. (2003), and Randall (2005).

Nonindigenous Occurrences: The species was observed in 2001 in the Pompano Beach area.



Family Acanthuridae (surgeonfishes, tangs, unicornfishes)

Surgeonfishes, tangs, and unicornfishes are found around coral reefs in all tropical seas. All have a deeply-compressed body with an unnotched dorsal fin. Some surgeonfishes have one or more spines on the caudal peduncle and are brightly colored. Most surgeonfishes are pelagic spawners and feed on zooplankton, detritus, and benthic algae. Summarized from Nelson (1994).

Acanthurus guttatus Forster 1801
Whitespotted Surgeonfish

Photo by J. Randall, Bishop Museum

Identification: Body is deep with small caudal fin. Grey-brown in color with white bars towards the head. One bar reaches from nape across operculum and the other reaches from dorsal to pelvic just behind the pelvic fin. Numerous white spots toward the posterior are scattered across body. Pelvic fins are bright yellow. Caudal fin is pale yellow towards the caudal peduncle. Grows to about 26 cm TL. Also called Mustard Surgeonfish or Spotted Surgeonfish. Dorsal fin IX (27-30), anal fin III (23-26), pectoral fin (15-17). From Randall et al. (1996) and Randall (2005).

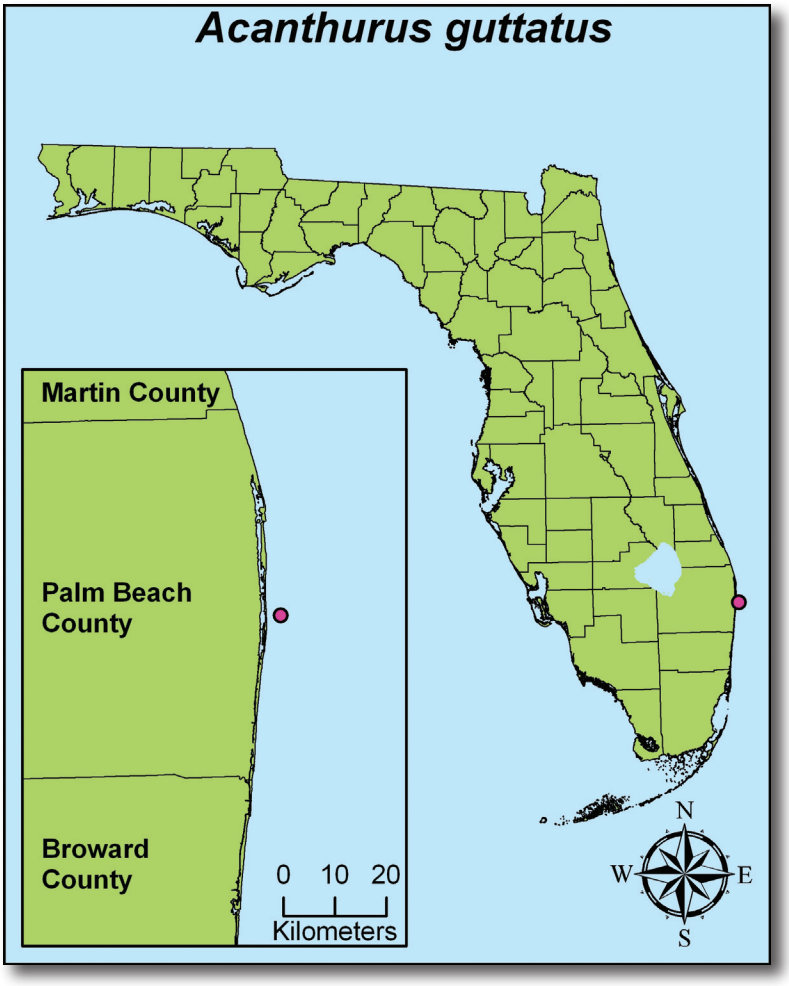
Similar Species: No Atlantic surgeonfishes are known to have similar spots.

Native Range: The Whitespotted Surgeonfish is distributed in the Indo-Pacific from Mauritius to Indonesia, Micronesia, Hawai'i, and French Polynesia and southwest Japan to Great Barrier Reef and New Caledonia. From Allen et al. (2003).

Ecology: The Whitespotted Surgeonfish is typically found in schools within the surge zone of exposed reefs and rocky shores (Randall 2005). White spots on posterior body might help conceal them in the turbulent bubble-filled waters of the surf zone (Myers 1999). The diet of Whitespotted Surgeonfish consists largely of filamentous algae (Randall 2005). The species has been known to provide a critical trophic link between primary production (algae) and the detrital food web in the Pacific (Chartock 1983). Year-round spawning has been reported in American Samoa where Whitespotted Surgeonfish has been observed to reproduce

at dusk in channels draining fringe reefs (Craig 1998).

Nonindigenous Occurrences: The species was observed in 2003 at Horseshoe Reef, near West Palm Beach.



Acanthurus sohal (Forsskål 1775)
Sohal Surgeonfish

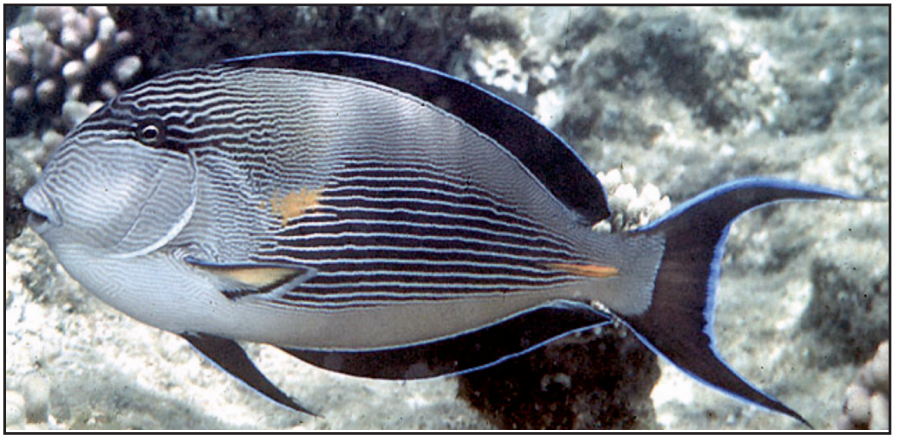


Photo by J. Randall, Bishop Museum

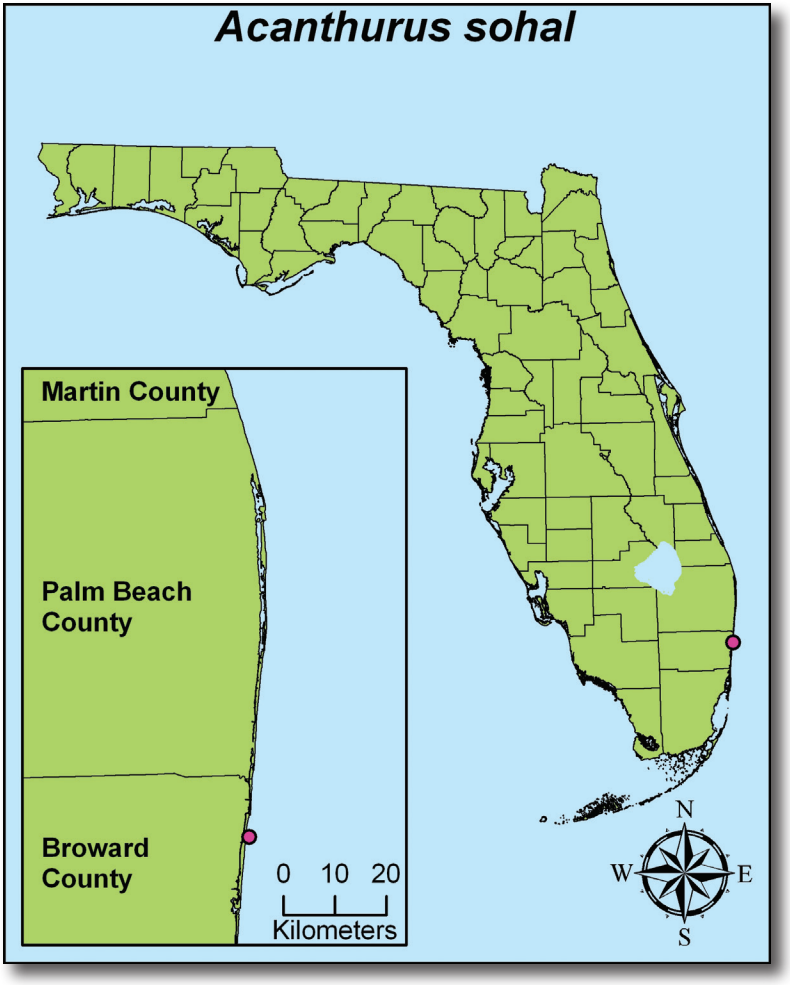
Identification: Slightly compressed body shape with well-defined lunate caudal fin. Pale grey in body color gradually turning whitish ventrally. Narrow blackish stripes on head above the eye. Orange patch beneath pectoral fins and around the sheath and socket of caudal spine. Pelvic and median fins are blackish with blue outline. Grows to about 40 cm TL. Also known as the Red Sea Surgeonfish. Dorsal fin IX (30-31), anal fin III (28-29), pectoral fin (17). From Randall (1983).

Similar Species: No Atlantic surgeonfish is known to have stripes on the body. However, faint body lines can be seen on the Blue Tang (*Acanthurus coeruleus*), which has a solid blue body and yellow scalpel.

Native Range: Western Indian Ocean including the Red Sea to the Persian Gulf (Randall 1983).

Ecology: The preferred habitat of the Sohal Surgeonfish is the outer edge of reef flats that are exposed to surge (Randall 1983). The species grazes on *Sargassum* and filamentous green algae (Vine 1974; Lieske and Myers 1994). It is known to be a very aggressive territorial species (Alwany et al. 2005).

Nonindigenous Occurrences: The species was observed in 2002 in the Pompano Beach area.



Naso lituratus (Forster 1801)
Orangespine Unicornfish

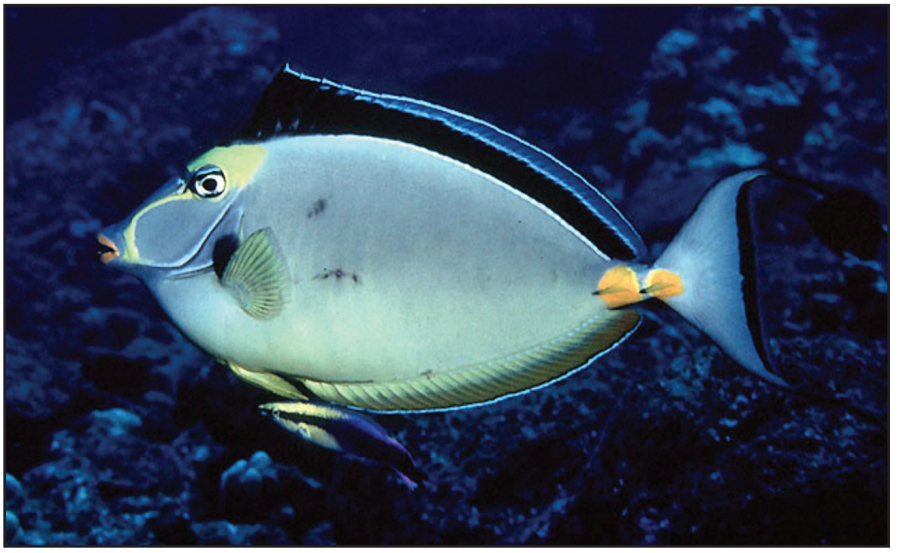


Photo by J. Randall, Bishop Museum

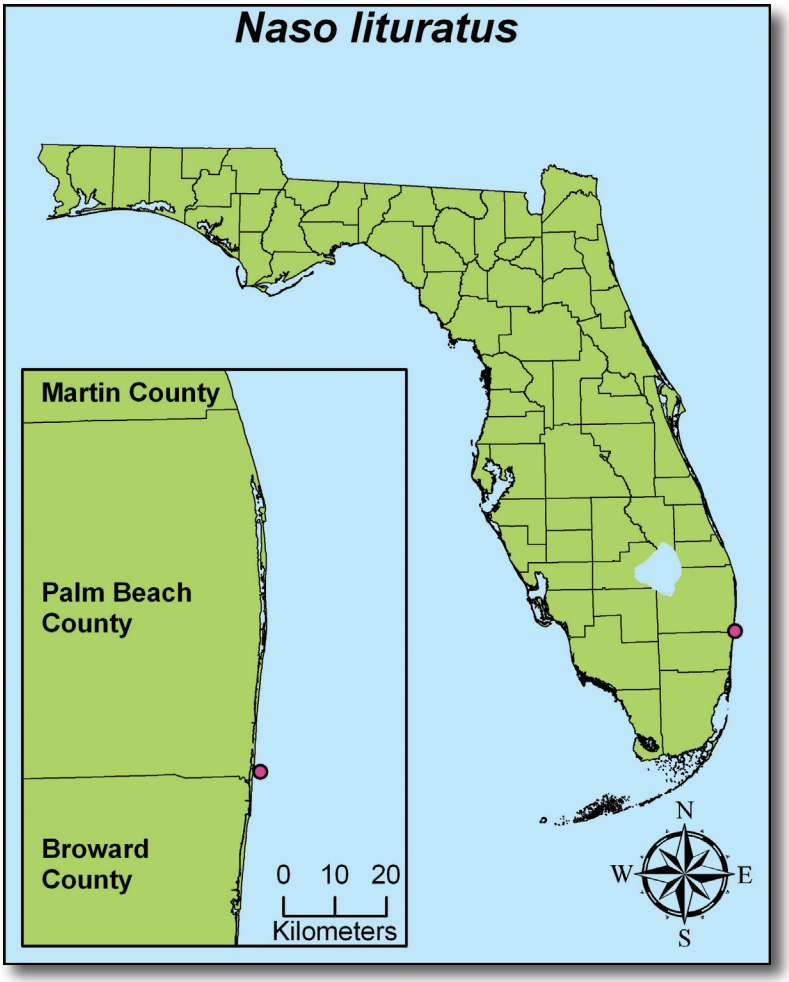
Identification: Greyish-brown in color with black dorsal fin having blue line at base. Dorsal and anal fins exhibit a light blue/whitish banding towards their tips. Anal fin mostly orange. Curved yellow band from mouth to eye and orange lips. Caudal fin of adult males can have trailing filaments from corners. Grows to about 46 cm TL. Also known as the Masked Unicornfish. Dorsal fin VI (28-31), anal fin II (29-31), pectoral fin (17-18). From Randall (2001).

Similar Species: No Atlantic surgeonfish has an orange spot at the base of the tail. Whitespotted Filefish (*Cantherhines macrocerus*) have orange recurved spines, however, they also have a stout first dorsal spine and orange to brown body color.

Native Range: The Orangespine Unicornfish is distributed in the Indo-Pacific from the Red Sea and East Africa to Hawai'i, Pitcairn Islands – southwest Japan to Great Barrier Reef and New Caledonia. From Allen et al. (2003).

Ecology: The Orangespine Unicornfish can be found as solitary or in aggregations (Allen et al. 2003) in both lagoonal and outer reef waters (Randall 2005). The species feeds on leafy brown algae including *Sargassum* and *Dictyota* (Myers 1999).

Nonindigenous Occurrences: The species was observed off Boca Raton in 2000 and 2001. It was also seen at Gray's Reef National Marine Sanctuary, Georgia, in 2006.



Zebrasoma desjardinii (Bennett 1836)
Desjardin's Sailfin Tang


adult


juvenile

Photos by J. Randall, Bishop Museum

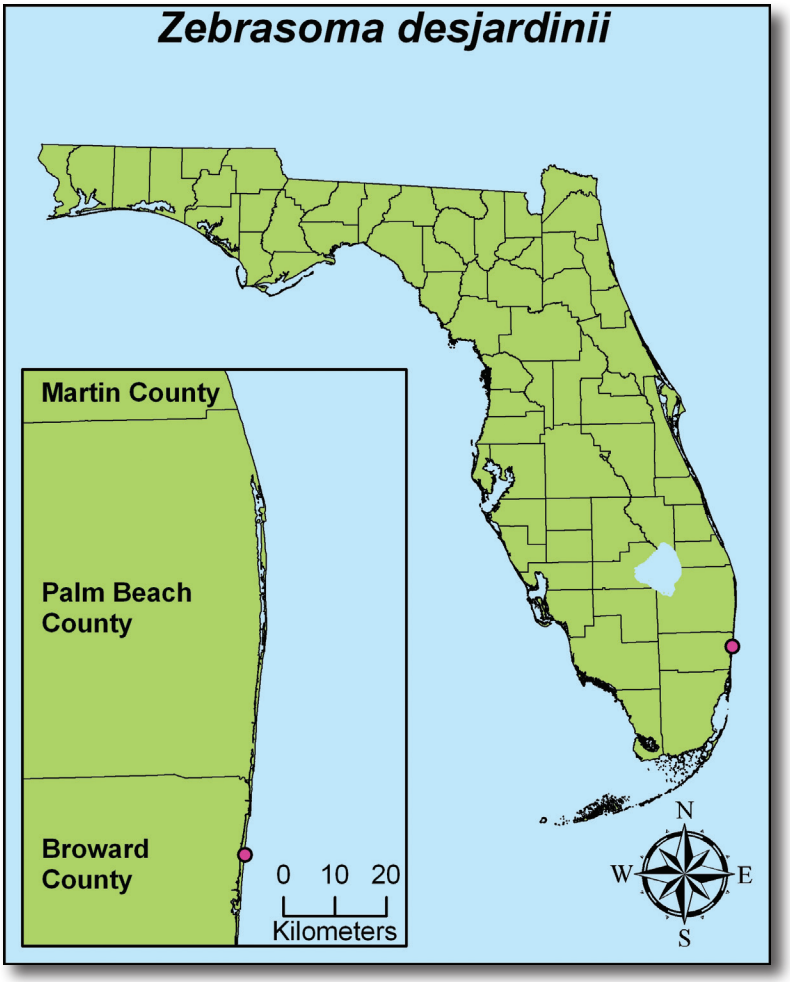
Identification: Highly variable in color and banding patterns. Strongly marked with colors ranging from bright yellow to black. Large dorsal and anal fins with pale yellow lines. Caudal fin dark with blue spots. Juveniles (photo on right) are similar in banding but appear yellow-gold. Grows to about 40 cm TL. Dorsal fin VI (28-33), anal fin III (22-26). From Allen et al. (2003).

Similar Species: No Atlantic surgeonfish has white spots on the face or the very tall dorsal fin of the *Zebrasoma* species.

Native Range: The species is distributed in the Indian Ocean from the Red Sea and East Africa to Andaman Sea and north Sumatra, Indonesia (Allen et al. 2003).

Ecology: The species is typically found in lagoonal areas and exposed reefs up to 30 m (Allen et al. 2003). Juveniles are prevalent in the inner reef zone. Adults can be found in pairs, but juveniles are typically solitary (Lieske and Myers 1994). The species is known to be territorial and frequently exhibits agonistic behaviors (Alwany et al. 2005).

Nonindigenous Occurrences: The species was observed at a commercial pier in Lauderdale-By-The-Sea, Broward County in 1999.



Zebrasoma flavescens (Bennett 1828)
Yellow Tang

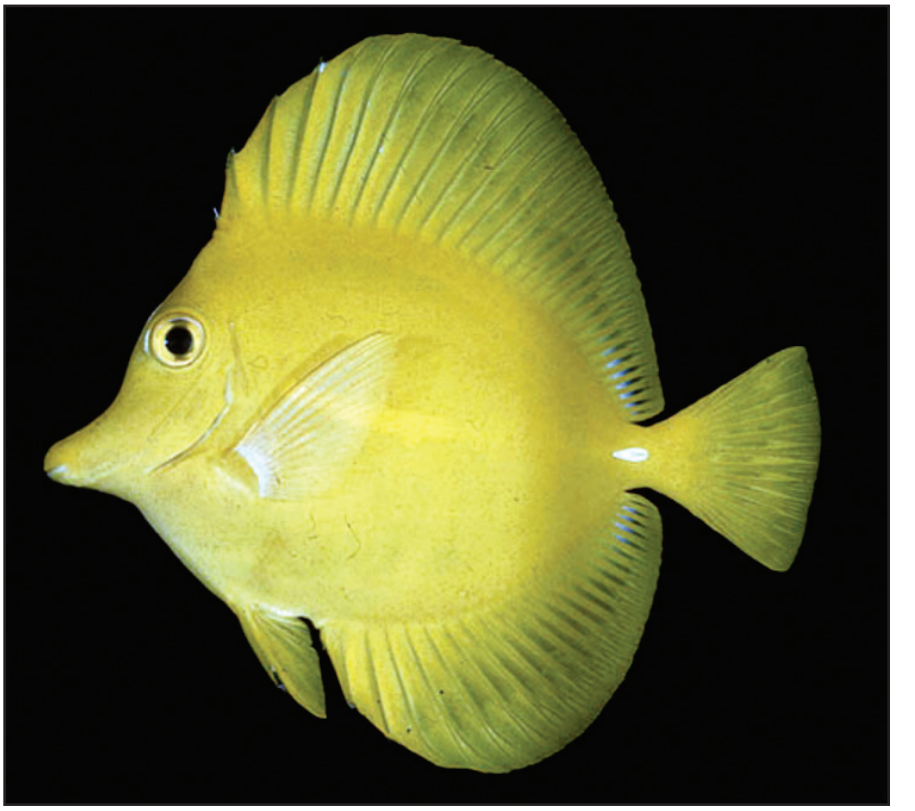


Photo by J. Randall, Bishop Museum

Identification: Deep body with a slightly protruding snout and large dorsal and anal fins toward the posterior. Bright yellow in color with white caudal spine (scalpel) (Allen et al. 2003). White stripe along the lateral line in some specimens. Grows to about 20 cm TL. Dorsal fin V (23-26), anal fin III (19-22). From Lieske and Myers (1994).

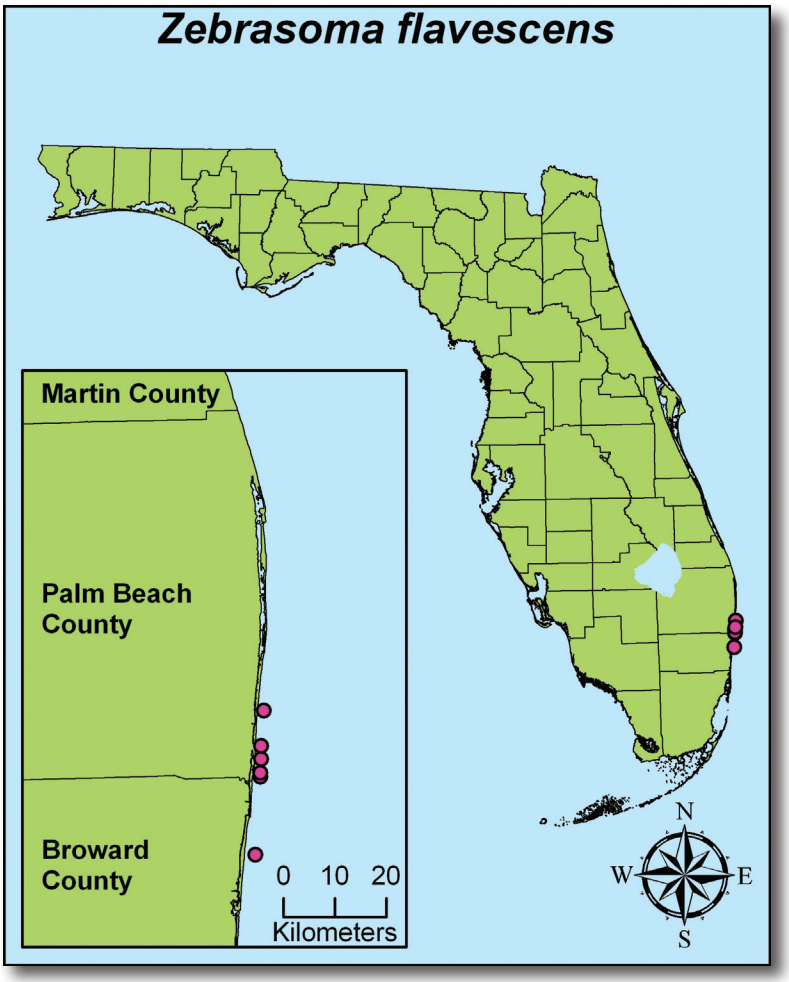
Similar Species: Juvenile Blue Tang (*Acanthurus coeruleus*) has a yellow scalpel and less-protruding mouth.

Native Range: The Yellow Tang is found in the Northwest and Central Pacific Ocean from southwest Japan to Marianna Islands, Marshall Islands, Marcus Island, Wake Island, and Hawai'i. From Allen et al. (2003).

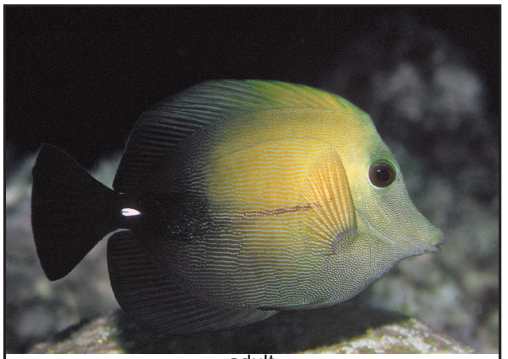
Ecology: The Yellow Tang is found in lagoonal and seaward reefs (Lieske and Myers 1994). It is diurnally active, exhibiting a wide variety of social organization. The species can be found in social groups ranging from solitary to hundreds of individuals while feeding during the day, but can also be found solitary in shelter sites during the night (Atkins 1981). The

Yellow Tang is the most frequently collected aquarium fish in Hawaii (Tissot et al. 2004). It has been observed to spawn seasonally, timing its reproduction to periods when the oceanographic currents are favorable for local recruitment to island populations (Lobel 1989). The caudal spine is erectable as a defense mechanism (Winterbottom 1971).

Nonindigenous Occurrences: The species has been observed off Boca Raton, Pompano Beach, and Delray Beach from 2001 to 2005.



Zebrasoma scopas (Cuvier 1829)
Brown Tang


adult


juvenile

Photos by J. Randall, Bishop Museum

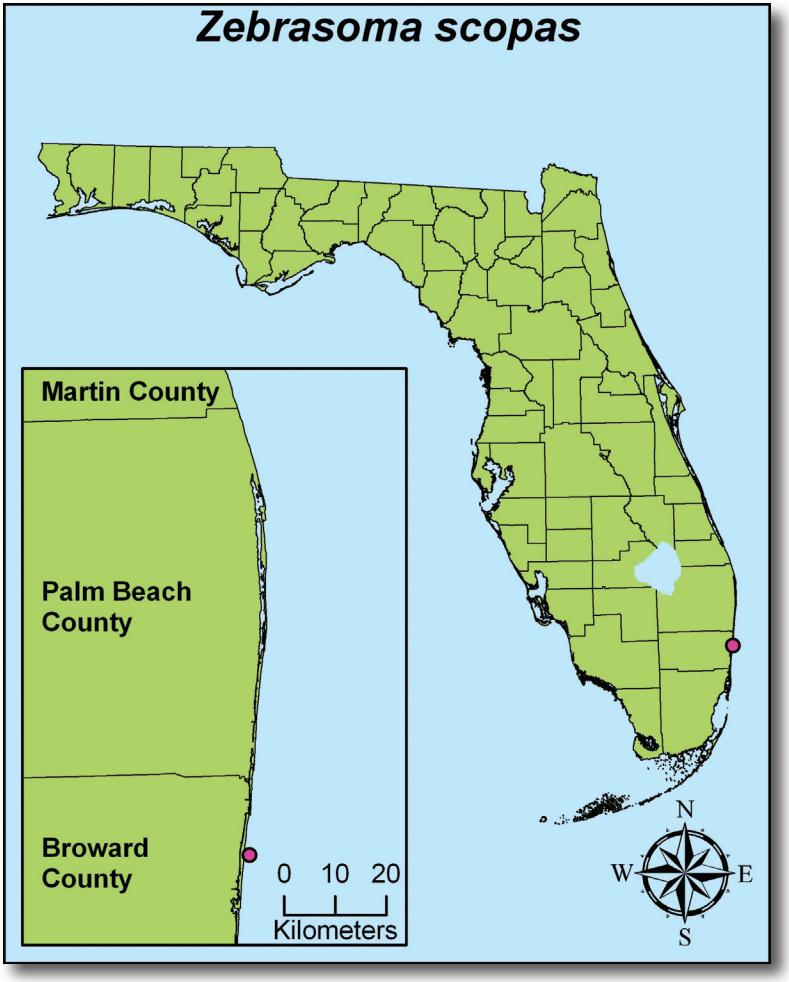
Identification: Deeply-compressed body with protruding snout. Black to brown body with pale-green longitudinal lines becoming dots towards the head and caudal fin. Juvenile coloration may be lighter with yellowish bars and whitish shading towards the head. Pectoral fin might be dull reddish-brown (Robertson 1983). Dorsal fin more elevated in juveniles than adults. White caudal spine apparent in adults. Grows to about 40 cm SL. Sometimes called Brushtail Tang or Twotone Tang. Dorsal fin IV-V (23-25) anal fin III (19-21). From Randall (2001).

Similar Species: No Atlantic surgeonfish is similarly colored.

Native Range: The Brown Tang is distributed in the Indian and Pacific oceans from East Africa to the Pitcairn Islands, north to southern Japan, south to Lord Howe and Rapa islands (Randall 2005).

Ecology: The species inhabits intertidal and subtidal reef slopes. The diet consists primarily of fleshy benthic red microalgae. Pairs of adults will defend joint feeding territories similar to other *Zebrasoma* spp. In the Pacific, the species reproduced from February to April, whereas in the Indian ocean they were observed to reproduce from August to December. Individuals change color and engage in courtship in and away from the reef edge. From Robertson (1983).

Nonindigenous Occurrences: The species was observed near Fort Lauderdale in 2008.



Zebrasoma veliferum (Bloch 1795)
Sailfin Tang

Photo by J. Randall, Bishop Museum

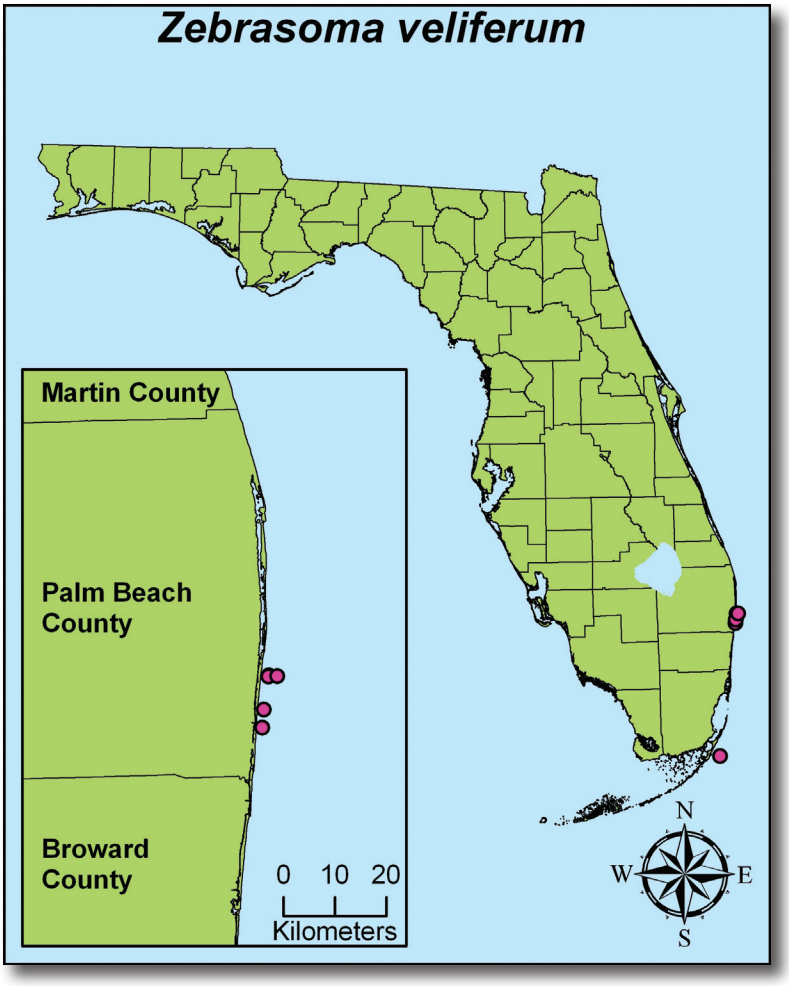
Identification: Deep body with slightly protruding snout. Body and head mostly dark grey-brown with vertical yellow lines. Coloration of adults can be darker. Entire snout can be white or yellow. Elevated dorsal fin (Randall 2005). Caudal fin can be white, yellowish, or brown with no spots (Allen et al. 2003). Overall, the species tends to be dully colored, but is capable of rapidly changing color and can lighten the pale bars or darken them to match the remaining body color (Robertson 1983). Grows to about 40 cm SL. Also called Ringed Tang. Dorsal fin IV (29-33) anal fin III (23-26), pectoral fin (15-17; Randall 2005).

Similar Species: No Atlantic surgeonfish has prominent white body bars.

Native Range: Sailfin Tang is distributed in the Western Indian Ocean and the Pacific Ocean from Indonesia, Micronesia, Hawai'i to French Polynesia. Also found from southwest Japan to Great Barrier Reef and New Caledonia. From Allen et al. (2003).

Ecology: The Sailfin Tang inhabits lagoons and seaward reef areas out to 45 m (Allen et al. 2003). The diet consists mainly of fleshy green and red algae (Robertson 1983). Pairs of adult Sailfin Tangs will defend joint feeding territories (Robertson et al. 1979) with the more territorial fish becoming darker in color (Robertson 1983). Sailfin Tang reproduction has been documented in Palau (Micronesia) and Aldabra (Seychelles) where spawning occurs during ebb tides on the reef slope (10 m depth; Robertson 1983). Detailed courtship and pair mating behaviors of the species are provided in Robertson (1983).

Nonindigenous Occurrences: The species was observed near Key Largo, Boynton Beach, and Delray Beach from 2001 to 2003.



Zebrasoma xanthurum (Blyth 1852)
Purple Tang

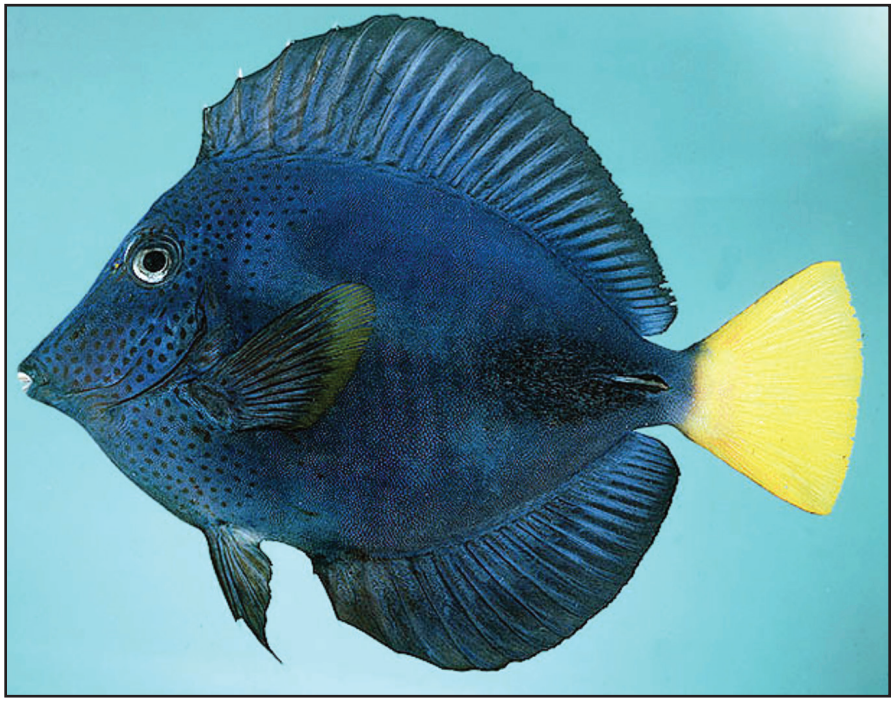


Photo by J. Randall, Bishop Museum

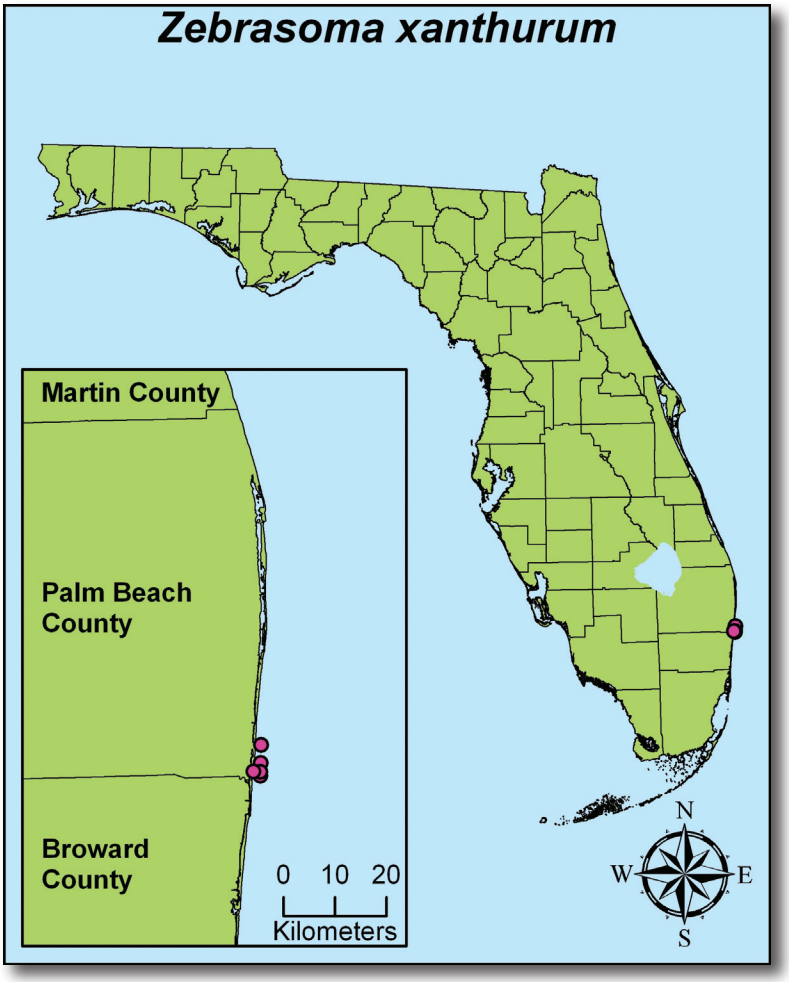
Identification: Body is deep with moderately elevated dorsal and anal fins. Protruding snout with mottled dark lines anteriorly. Rich blue in body coloration with bright yellow and slightly rounded caudal fin. Pectoral fins bright yellow towards posterior. Dark spots on abdomen, anterior body, and head. Velvet-like path setae anterior of caudal spine. Dark thin banding extend from anterior to posterior. Grows to about 22 cm TL. Also called Yellowtail Tang, Red Sea Sailfin and Yellowtail Surgeonfish. Dorsal fin V (24-25), anal fin III (19-20) pectoral fin (15). From Randall (1983).

Similar Species: Juvenile Blue Tang (*Acanthurus coeruleus*) rarely show blue body with yellow tail and lacks yellow coloration on pectoral fins. Juvenile Yellowtail Damselfish (*Microspathodon chrysurus*) has bright blue body spots and a less-protruding mouth.

Native Range: Western Indian Ocean, including the Red Sea and Persian Gulf. Also recorded in Maldives. From Randall and Anderson (1993).

Ecology: Inhabits reef zone including coral (Lieske and Myers 1994) and rocky bottoms (Sommer et al. 1996). The diet consists mainly of filamentous algae (Guiasu and Winterbottom 1998; Mill et al. 2007). Surgeonfishes have been found to spawn mainly during late winter and early spring (Robertson 1983).

Nonindigenous Occurrences: The species was observed from 2001 to 2005 near Boca Raton.



Family Balistidae (triggerfishes)

Triggerfishes dwell near coral and rocky substrates and can be found in the Atlantic, Indian, and Pacific oceans. Triggerfishes are distinguished by their highly compressed body shape and do not have pelvic fins or a protractible upper jaw. The first dorsal spine of triggerfishes exhibits a locking ability when erect, deterring predators.

Rhinecanthus aculeatus (Linnaeus 1758)
White-banded Triggerfish

Photo by J. Randall, Bishop Museum

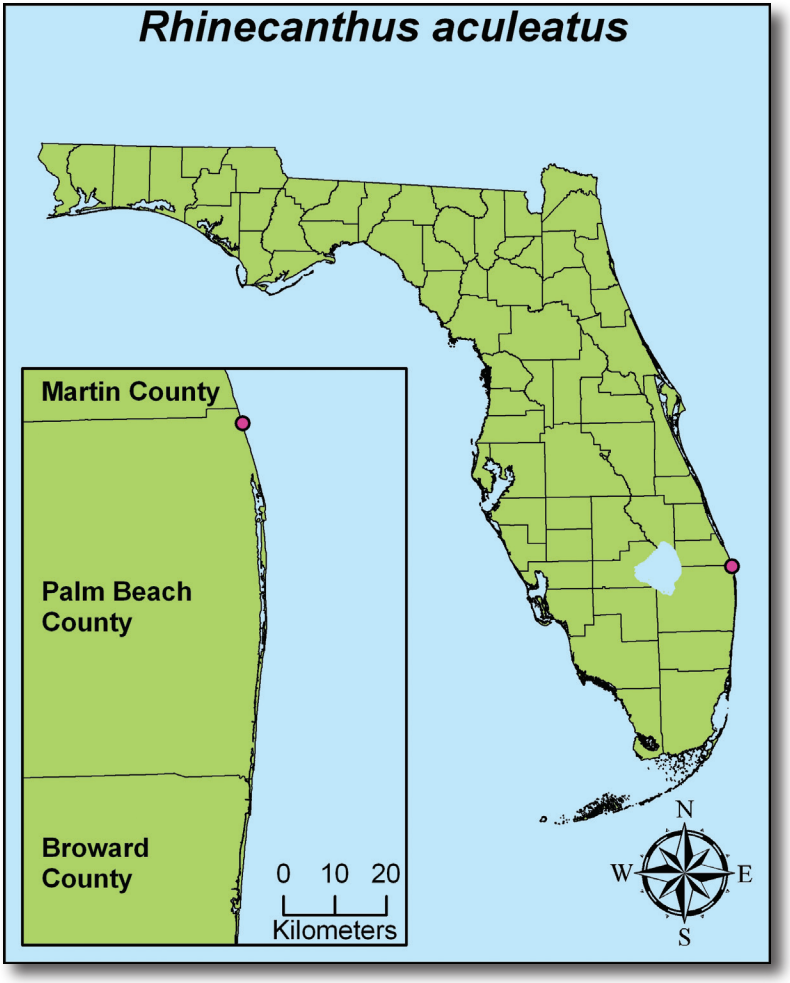
Identification: Body compressed with elongated head. Blue line above upper lip. Small mouth with yellow area surrounding mouth and extending to base of pectoral fin. Dark thick black banding near lateral line with smaller banding extending ventrally. Grows to about 30 cm TL. Also called Blackbar Triggerfish or Lagoon Triggerfish. Dorsal fin III (23-26), anal fin 0 (21-23), pectoral fin (13-14). From Randall (2005) and Allen et al. (2003).

Similar Species: Queen Triggerfish (*Balistes vetula*) lacks diagonal white ventral markings.

Native Range: The species is distributed in the Indo-Pacific from East Africa to Hawai'i and French Polynesia and south Japan to east Australia and Lord Howe Island. From Allen et al. (2003).

Ecology: The species inhabits lagoonal reef flats typically dominated by sand (Klausewitz 1974; Randall 2005). It feeds on a variety of benthic organisms including sea urchins, crustaceans, polychaetes, gastropods, ostracods, sipunculids, and algae (Kuwamura 1991). It is also very territorial and will engage in intra- and interspecific border fights (Chen et al. 2001). Reproduction has been documented by Kuwamura (1997) who found that the species is haremic with male territories overlapping with approximately two or three female territories. Both males and females maintain territories for long periods, with some documented over eight years. Pair-spawning occurs around sunrise and females care for the demersal eggs until hatching.

Nonindigenous Occurrences: The species was observed near Jupiter Inlet in 2006.



Rhinecanthus verrucosus (Linnaeus 1758)
Blackbelly Triggerfish

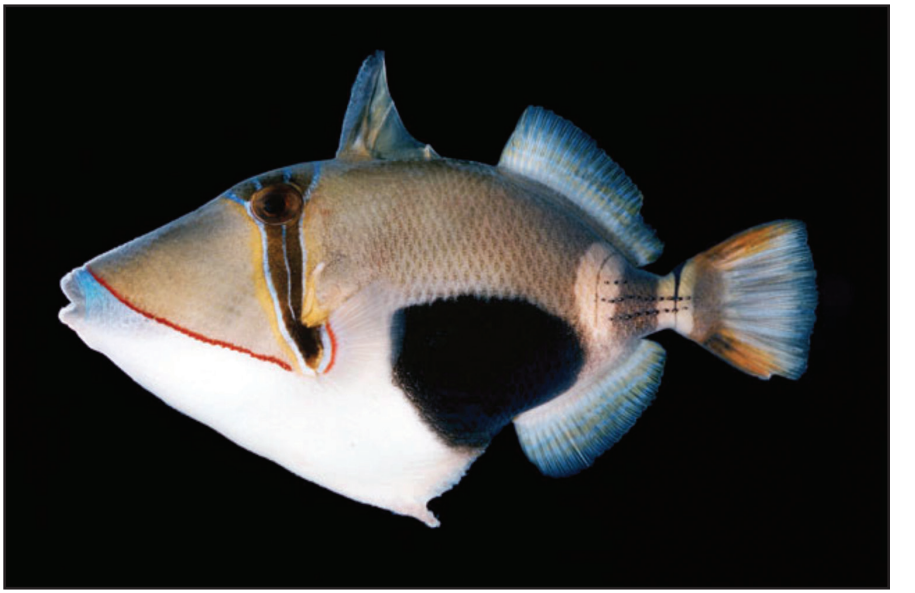


Photo by J. Randall, Bishop Museum

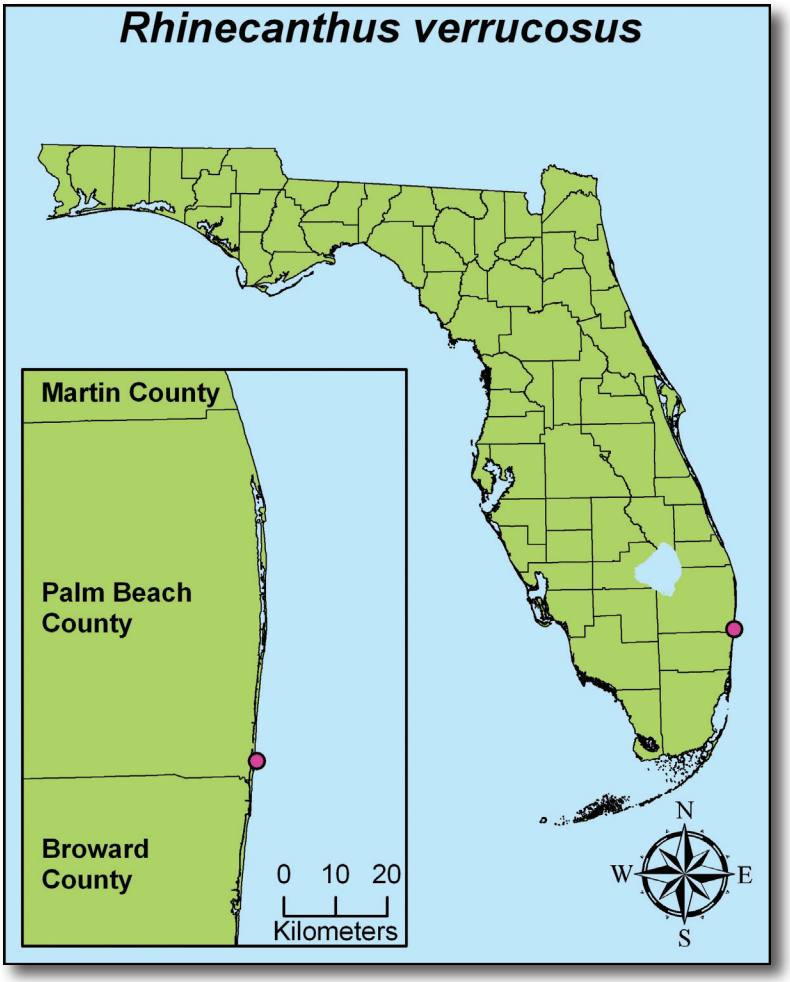
Identification: Body compressed with protruding snout. Brown to light blue in color with white coloration below lateral line. Greyish brown dorsally. Three rows of forward-curving spines posteriorly on side of body along and anterior to caudal peduncle with the upper row shorter than the lower. Second dorsal fin and anal fin similar in shape. Large elliptical black spot located ventrally and mostly anterior to anal fin. Grows to about 23 cm TL. Dorsal fin III (23-26), anal fin 0 (21-23), pectoral fin (13-14). From Randall et al. (1996).

Similar Species: Queen Triggerfish (*Balistes vetula*) lacks dark elliptical body spot.

Native Range: The Blackbelly Triggerfish is distributed in the Indo-West Pacific from the Seychelles and Chagos islands to Vanuatu and south Japan to the Great Barrier Reef. From Allen et al. (2003).

Ecology: The Blackbelly Triggerfish is frequently found in lagoons and shallow waters of reef flats among macroalgae, rubble and coral among seagrasses (Lieske and Myers 1994; Bean et al. 2002). Juveniles frequent holes (Kuiter and Tonozuka 2001). Chen et al. (2001) reported that the species moves to the reef flat at high tide and returns to the sandy subtidal zone during low tide. This movement occurred when water depth fell below 40–60 cm. Adult Blackbelly Triggerfish are territorial, engaging in frequent agonistic behavior with other triggerfishes including *Rhinecanthus aculeatus* (Chen et al. 2001).

Nonindigenous Occurrences: The species was observed near Boca Raton in 1995.



Family Tetraodontidae (puffers)

Puffers are largely marine but also can be found in brackish and freshwater habitats. They typically do not have scales but can have spines or prickles on the body. The caudal fin of puffers can be either forked or rounded. Puffers are capable of inflating themselves with water as a deterrent to predation. Some puffers are omnivorous while others prefer invertebrates and algae. Puffers reproduce by laying eggs in a nest; some species defend nests while others do not. Summarized from Nelson (1994).

Arothron diadematus (Rüppell 1829)
Masked Puffer

Photo by J. Randall, Bishop Museum

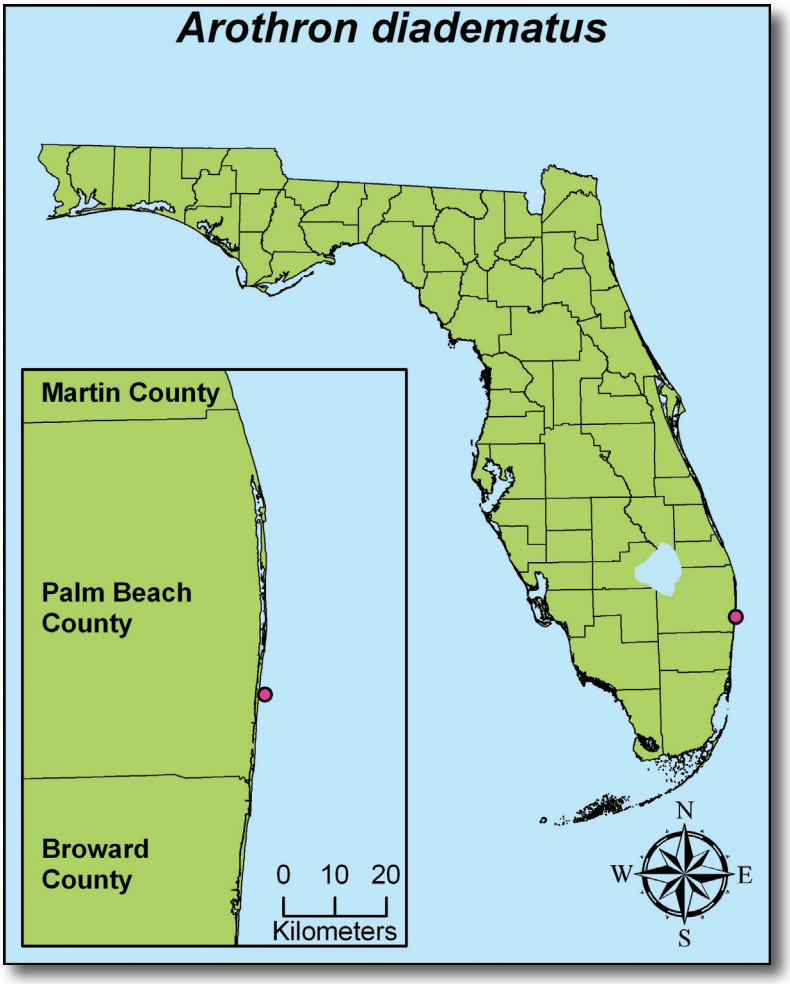
Identification: Body shape is orbicular with short obtuse snout. Small spinules present on body excluding the snout and caudal peduncle. Rounded caudal fin. Body color is tan to brown with distinct dark banding around eyes resembling a mask. Dark spots or splotches sometimes occur on the body. Fins typically darker in color. Fins with no spines. A single short dorsal fin that sits far back on the body; a short anal fin under the dorsal. No pelvic fins. Grows to about 30 cm TL. From Randall (1983).

Similar Species: No Atlantic smooth pufferfishes (Family: Tetraodontidae) have dark mask on face.

Native Range: Red Sea and Indian Ocean.

Ecology: The Masked Puffer closely resembles and is considered conspecific to *A. nigropunctatus* by some authors. The species inhabits coral-rich fringe reefs (Lieske and Myers 1994) and likely feeds on coral tips, some crustaceans, and mollusks (Myers 1999).

Nonindigenous Occurrences: The species was observed in 1994 near Delray Beach.



References

Adams, A. J. and R. K. Wolfe. 2007. Occurrence and persistence of non-native *Cichlasoma urophthalmus* (family Cichlidae) in estuarine habitats of south-west Florida (USA): environmental controls and movement patterns. Marine and Freshwater Research 58: 921-930.

Allen, G. R., R. Steene and M. Allen. 1998. A Guide to Angelfishes and Butterflyfishes. Odyssey Publishing/Tropical Reef Research, Perth.

Allen, G., R. Steene, P. Humann and N. DeLoach. 2003. Reef Fish Identification. Tropical Pacific. New World Publications, Inc., Jacksonville, Florida and Odyssey Publications, El Cajon, California.

Alwany, M., E. Thaler, and M. Stachowitsch. 2005. Territorial behaviour of *Acanthurus sohal* and *Plectroglyphidodon leucozona* on the fringing Egyptian Red Sea reefs. Environmental Biology of Fishes 72: 321-334.

Annett, C. A., R. Pierotti and J. R. Baylis. 1999. Male and female parental roles in the monogamous cicihlid, *Tilapia mariae*, introduced in Florida. Environmental Biology of Fishes 54: 283-293.

Asoh, K. 1996. Reproductive behavior and mating system of the fairy basslet, *Gramma loreto*. Copeia 1996: 1037-1043.

Atkins, P. 1981. Behavioral determinants of the nocturnal spacing pattern of the yellow tang *Zebrasoma flavescens* (Acanthuridae). Pacific Science 35: 263-264.

Bailey, R. G. 1994. Guide to the fishes of the River Nile in the Republic of the Sudan. Journal of Natural History 28: 937-970.

Barry, T. P. and A. W. Fast. 1992. Biology of the spotted scat (*Scatophagus argus*) in the Philippines. Asian Fisheries Science 5: 163-179.

Bean, K, G. P. Jones and M. J. Caley. 2002. Relationships among distribution, abundance and microhabitat specialization in a guild of coral reef triggerfish (family Balistidae). Marine Ecology Progress Series 233: 263-272.

Belshe, J. F. 1961. Observations of an introduced tropical fish (*Belonesox belizanus*) in southern Florida. M.S. Thesis, University of Miami, Coral Gables, Florida.

Bianchi, G. 1985. FAO species identification sheets for fishery purposes. Field guide to the commercial marine and brackish-water species of Pakistan. FAO, Rome.

Böhlke, J. E. and J. E. Randall. 1963. The fishes of the western Atlantic serranoid genus *Gramma*. Proceedings of the Academy of Natural Sciences, Philadelphia 115: 33-52.

Boschung, H. T. and R. L. Mayden. 2004. Fishes of Alabama. Smithsonian Books, Washington.

Carpenter, K. E. and V. H. Niem. 1999. The living marine resources of the Western Central Pacific. FAO Species Identification Guides for Fishery Purposes. Volume 4. Bony fishes part 2 (Mugilidae to Carangidae). FAO, Rome.

Cavanagh, R. D., P. K. Kyne, S. L. Fowler, J. A. Musick, and M. B. Bennett. 2003. Report of the IUCN Shark Specialist Group Australia and Oceania Regional Red List Workshop. The University of Queensland, School of Biomedical Sciences, Brisbane.

Chartock, M. A. 1983. The role of *Acanthurus guttatus* (Bloch and Schneider 1801) in cycling algal production to detritus. Biotropica 15: 117-121.

Chávez-López, R., M. S. Peterson, N. J. Brown-Peterson, A. A. Morales-Gómez and J. Franco-López. 2005. Ecology of the Mayan cichlid, *Cichlasoma urophthalmus* Günther, in the Alvarado lagoonal system, Veracruz, Mexico. Gulf and Caribbean Research 17: 123-131.

Chen, T., R. F. Ormond and H. Mok. 2001. Feeding and territorial behaviour in juveniles of three coexisting triggerfishes. Journal of Fish Biology 59: 524-532.

Coates, D. 1980. Prey-size intake in humbug damselfish, *Dascyllus aruanus* (Pisces, Pomacentridae) living within social groups. Journal of Animal Ecology 49: 335-340.

Compagno, L. J. V. 1984. Sharks of the world. An annotated and illustrated catalogue of sharks species known to date. FAO Fisheries Synopsis 125: 1-655.

Compagno, L. J. V. and V. H. Niem. 1998. Hemiscylliidae. Longtail carpetsharks. Pages 1249-1259 ***in:*** Carpenter, K. E. and V. H. Niem (Eds.). FAO identification guide for fishery purposes. The Living Marine Resources of the Western Central Pacific. FAO, Rome.

Costa-Pierce, B. A. 2003. Rapid evolution of an established feral tilapia (*Oreochromis spp.*): the need to incorporate invasion science into regulatory structures. Biological Invasions 5: 71-84.

Courtenay, W. 1995. Marine fish introductions in southeast Florida. American Fisheries Society Introduced Fish Section Newsletter 14: 2-3.

Courtenay, W. R., Jr. and D. A. Hensley. 1979. Range expansion in southern Florida of the introduced spotted tilapia, with comments on its environmental impress. Environmental Conservation 6: 149-151.

Courtenay, W. R., Jr. and J. R. Stauffer, Jr. 1990. The introduced fish problem and the aquarium fish industry. Journal of the World Aquaculture Society 21: 145-159.

Courtenay, W. R., Jr., H. F. Sahlman, W. W. Miley, II and D. J. Herrema. 1974. Exotic fishes in fresh and brackish waters of Florida. Biological Conservation 6: 292-302.

Craig, P. C. 1998. Temporal spawning patterns of several surgeonfishes and wrasses in American Samoa. Pacific Science 52: 35-39.

Datta, N. C., B. K. Bandyopadhyay and S. S. Barman. 1984. On the food of an euryhaline perch *Scatophagus argus* (Cuv. and Val.) and the scope of its culture in fresh water. International Journal of the Academy of Ichthyology, Modinagar 5: 121-124.

Dennis, G. D., III and T. J. Bright. 1988. New records of fishes in the northwestern Gulf of Mexico, with notes on some rare species. Northeast Gulf Science 10: 1-18.

Ditty, J. G., R. F. Shaw and L. A. Fuiman. 2005. Larval development of five species of blenny (Teleostei: Blenniidae) from the western central North Atlantic, with a synopsis of blennioid family characters. Journal of Fish Biology 66: 1261-1284.

Eschmeyer, W. N., C. J. Ferraris, M. D. Hoang and D. J. Long. 1998. A Catalog of the Species of Fishes. California Academy of Sciences. http://www.calacademy.org/research/ichthyology/species/

Faunce, C. H. and J. J. Lorenz. 2000. Reproductive biology of the introduced Mayan cichlid, *Cichlasoma urophthalmus*, within an estuarine mangrove habitat of southern Florida. Environmental Biology of Fishes 58: 215-225.

Faunce, C. H., H. M. Patterson and J. J. Lorenz. 2002. Age, growth and mortality of the Mayan cichlid (*Cichlasoma urophthalmus*) from the southeastern Everglades. Fishery Bulletin 100: 42-50.

Forrester, G. E. 1991. Social rank, individual size and group composition as determinants of food consumption by humbug damselfish, *Dascyllus aruanus*. Animal Behaviour 42: 701-711.

Freeman, S. and W. Alevizon. 1983. Aspects of the territorial behavior and habitat distribution of the fairy basslet, *Gramma loreto*. Copeia 1983: 829-831.

Fricke, H. W. and S. Holzberg. 1974. Social units and hermaphroditism in pomacentrid fish. Naturwissensch 8: 1 un-numbered page.

Fuller, P. L., L. G. Nico and J. D. Williams. 1999. Nonindigenous Fishes Introduced into Inland Waters of the United States. Special Publication 27, American Fisheries Society, Bethesda, MD.

Galván-Magaña, F., L. A. Abitia-Cárdenas, J. Rodríguez-Romero, H. Pérez-España and H. Chávez-Ramos. 1996. Systematic list of the fishes from Cerralvo Island, Baja California Sur, México. Ciencieas Marinas 22: 295-311.

Greenfield, D. W. and J. E. Thomerson. 1997. Fishes of the Continential Waters of Belize. University Press of Florida, Gainesville, Florida.

Guiasu, R. C. and R. Winterbottom. 1998. Yellow juvenile color pattern, diet switching and the phylogeny of the surgeonfish genus *Zebrasoma* (Percomorpha, Acanthuridae). Bulletin of Marine Science 63: 277-294.

Hamner, R. M., D. W. Freshwater and P. E. Whitfield. 2007. Mitochondrial cytochrome *b* analysis reveals two invasive lionfish species with strong founder effects in the western Atlantic. Journal of Fish Biology 71: 214-222.

Harahush, B. K., A. B. P. Fischer and S. P. Collin. 2007. Captive breeding and embryonic development of *Chiloscyllium punctatum* Muller & Henle, 1838 (Elasmobranchii: Hemiscyllidae). Journal of Fish Biology 71: 1007-1022.

Harmelin-Vivien, M. L. 1989. Implications of feeding specialization on the recruitment processes and community structure of butterflyfishes. Environmental Biology of Fishes 25: 101-110.

Heemstra, P. C. 2001. Ephippidae. Spadefishes (batfishes). Pages 3611-3622 ***in:*** Carpenter, K. E. and V. Niem (Eds.). FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles. FAO, Rome.

Heemstra, P. C. and J. E. Randall. 1984. Serranidae. Page 4319 ***in:*** Fischer, W. and G. Bianchi (Eds.). FAO species identification sheets for fishery purposes. Western Indian Ocean (fishing area 51). Vol. IV. 241. FAO, Rome.

Heemstra, P. C. and J. E. Randall. 1986. Serranidae. Pages 509-537 ***in:*** Smith, M. M. and P. C. Heemstra (Eds.). Smiths' Sea Fishes. Springer-Verlag, Berlin.

Heemstra, P. C. and J. E. Randall. 1993. FAO Species Catalogue Vol. 16. Groupers of the World (Family Serranidae, Subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail species known to date. FAO Fisheries Synopsis, No. 125, Vol. 16. FAO, Rome.

Hickley, P. and R. G. Bailey. 1986. Fish communities in the perennial wetland of the Sudd, southern Sudan. Freshwater Biology 16: 695-709.

Hickley, P. and R. G. Bailey. 1987. Food and feeding relationships of fish in the Sudd swamps (River Nile, Southern Sudan). Journal of Fish Biology 30: 147-159.

Hoese, H. D. and R. H. Moore. 1998. Fishes of the Gulf of Mexico. Texas, Louisiana, and Adjacent Waters. 2nd Edition. Texas A & M University Press, College Station, Texas.

Hogg, R. G. 1974. Environmental hazards posed by exotic fish species newly established in Florida. Environmental Conservation 1: 176.

Hogg, R. G. 1976. Established exotic cichlid fishes in Dade County, Florida. Florida Scientist 39: 97-103.

Horth, L. 2004. A brief description of the courtship display of male pike killifish (*Belonesox belizanus*). Florida Scientist 67: 159-165.

Hourigan, T. F. 1989. Environmental determinants of butterflyfish social systems. Environmental Biology of Fishes 25: 61-78.

Jennings, D. P. 1991. Behavioral aspects of cold tolerance of blackchin tilapia *Sarotherodon melanotheron* (Pisces, Cichlidae) at different salinties. Environmental Biology of Fishes 31: 185-198.

Jennings, D. P. and J. D. Williams. 1992. Factors influencing the distribution of blackchin tilapia *Sarotherodon melanotheron* (Osteichthys: Cichlidae) in the Indian River System, Florida. Northeast Gulf Science 12: 111-117.

Khan, M. Z. 1979. A note on the occurrence of a large sized spotted butterfish *Scatophagus argus* (Linnaeus) at Rajpara (Gujarat). Journal of the Marine Biological Association of India 21: 193-194.

Kimball, M. E., J. M. Miller, P. E. Whitfield and J. A. Hare. 2004. Thermal tolerance and potential distribution of invasive lionfish (*Pterois volitans/ miles complex*) on the east coast of the United States. Marine Ecology Progress Series 283: 269-278.

Klausewitz, W. 1974. Littoral fish from the Maldive Islands. 4. The triggerfish family, Balistidae (Pisces: Tetraodontiformes, Balistoides). Senckenbergiana Biologica 55: 39-67.

Kottelat, M. 2001. Scatophagidae. Scats. Pages 3623-3626 ***in:*** Carpenter, K. E. and V. Niem (Eds.). FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vo. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles. FAO, Rome.

Kuiter, R. H. and T. Tonozuka. 2001. Pictorial guide to Indonesian reef fishes. Part 3. Jawfishes - Sunfishes, Opistognathidae - Molidae. Zoonetics, Australia.

Kuwamura, T. 1991. Habitat segregation, coexistence or interspecific territoriality between two triggerfishes, *Rhinecanthus aculeatus* and *Sufflamen chrysopterus*, with notes on distribution of other balistids at Sesoko Island, Okinawa. Galaxea 10: 65–78.

Kuwamura, T. 1997. Evolution of female egg care in haremic triggerfish, *Rhinecanthus aculeatus*. Ethology 103: 1015-1023.

Lamboj, A. 1994. The Cichlid Fishes of Western Africa. Bornheim, Germany: Birgit Schmettkamp Verlag.

Last, P. R. and J. D. Stevens. 1994. Sharks and rays of Australia. Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia.

Lieske, E. and R. Myers. 1994. Collins Pocket Guide. Coral reef fishes. Indo-Pacific & Caribbean including the Red Sea. Harper Collins Publishers, London.

Lobel, P. 1989. Ocean current variability and the spawning season of Hawaiian reef fishes. Environmental Biology of Fishes 24: 161-171.

Loftus, W. F. 1987. Possible establishment of the Mayan cichlid, *Cichlasoma urophthalmus* (Günther) (Pisces: Cichlidae) in Everglades National Park, Florida. Florida Scientist 50: 1-6.

Loftus, W. F. and J. A. Kushlan. 1987. Freshwater fishes of southern Florida. Bulletin of the Florida State Museum of Biological Science 31: 1-255.

Loftus, W. F., J. C. Trexler, K. Dunker, S. E. Liston and J. S. Rehage. 2006. Introduced fishes in short-hydroperiod wetlands: evaluation of sampling, status, and potential effects. Final report from USGS to Everglades National Park for Agreement # CESI IA F5284-04-0039. US Geological Survey, Homestead, Florida.

Loiselle, P. V. 1979. A revision of the genus *Hemichromis* Peters 1858 (Teleostei: Cichlidae). Museé Royal de L'Afrique Central-Tervuren-Belgique-Annales-Serie in-8-Sciences Zoologiques-No. 228.

Loiselle, P. V. 1992. An annotated key to the genus *Hemichromis* Peters 1858. Buntbarsche Bulletin 148: 2-19.

Loiselle, P. V. 2000. Natural history and aquarium husbandry of the savannah jewel fish, *Hemichromis letourneauxi* Sauvage, 1880. Cichlid News Magazine 9: 24-31.

Lowe-McConnell, R. H. 1991. Ecology of cichlids in South American and African waters, excluding the African Great Lakes. Pages 60-85 ***in:*** Cichlid Fishes: Behavior, Ecology and Evolution. M. H. A. Keenleyside (Ed.). Chapman and Hall, London.

Martinez-Palacios, C. A. and L. G. Ross. 1992. The reproductive biology and growth of the Central American cichlid *Cichlasoma urophthalmus* (Günther). Journal of Applied Ichthyology 8: 99-109.

McEachran, J. D. and J. D. Fechhelm. 2005. Fishes of the Gulf of Mexico. Volume 2: Scorpaeniformes to Tetraodontiformes. University of Texas Press, Austin, Texas.

Mill, A. C., J. K. Pinnegar and N. V. C. Polunin. 2007. Explaining isotope trophic-step fractionation: why herbivorous fish are different. Functional Ecology 21: 1137-1145.

Miller, R. R. 2005. Freshwater Fishes of México. University of Chicago Press, Chicago, Illinois.

Mooi, R. D. and A. C. Gill. 2002. Grammatidae. Basslets. Pages 1370-1373 ***in:*** Carpenter, K. E. (Ed.). The living marine resources of the western central Atlantic. Volume 2. Bony fishes part 1 (Acipenseridae to Grammatidae). FAO Species Identification Guide for Identification Purposes and American Society of Ichthyologists and Herpetologists Special Publication No. 5. FAO, Rome.

Morris, A. V., C. M. Roberts and J. P. Hawkins. 2000. The threatened status of groupers (Epinephelinae). Biodiversity and Conservation 9: 919-942.

Morris, J. A., Jr. and D. W. Freshwater. 2008. Phenotypic variation of lionfish supraocular tentacles. Environmental Biology of Fishes 83: 237-241.

Mundy, B. C. 2005. Checklist of Fishes of the Hawaiian Archipelago. Bishop Museum Bulletins in Zoology, Number 6.

Myers, R. F. 1999. Micronesian Reef Fishes. A Field Guide for Divers and Aquarists. Coral Graphics, Davie, Florida.

Nelson, J. S. 1994. Fishes of the World. Third Edition. John Wiley and Sons, Inc., New York.

Nelson, J. S. 2006. Fishes of the World. Fourth Edition. John Wiley and Sons, Inc., Hoboken, New Jersey.

Nelson, J. S., E. J. Crossman, H. Espinosa-Pérez, L. T. Findley, C. R. Gilbert, R. N. Lea and J. D. Williams. 2004. Common and Scientific Names of Fishes from the United States, Canada and Mexico. American Fisheries Society, Special Publication 29, Bethesda, Maryland.

Page, L. M. and B. M. Burr. 1991. A Field Guide to Freshwater Fishes. Houghton Mifflin Co., New York.

Paperno, R., R. Ruiz-Carus, J. M. Krebs and C. C. McIvor. 2008. Range expansion of the Mayan cichlid, *Cichlasoma urophthalmus* (Pisces, Cichlidae), above 28º N latitude in Florida. Florida Scientist 71: 293-304.

Peterson, M. S., W. T. Slack, N. J. Brown-Peterson and J. L. McDonald. 2004. Reproduction in nonnative environments: establishment of Nile Tilapia *Oreochromis niloticus*, in coastal Mississippi watersheds. Copeia 2004: 842-849.

Peterson, M. S., W. T. Slack and C. M. Woodley. 2005. The occurrence of non-indigenous Nile tilapia, *Oreochromis niloticus* (Linnaeus) in coastal Mississippi, USA: ties to aquaculture and thermal effluent. Wetlands 25: 112-121.

Peterson, M. S., W. T. Slack, G. L. Waggy, J. Finley, C. M. Woodley and M. L. Partyka. 2006. Foraging in non-native environments: comparison of Nile tilapia and three co-occurring native centrarchids in invaded coastal Mississippi watersheds. Environmental Biology of Fishes 76: 283-301.

Planes, S., F. Bonhomme and R. Galzin. 1993. Genetic structure of *Dascyllus aruanus* populations in French Polynesia. Marine Biology 117: 665-674.

Pratchett, M. S. 2005. Dietary overlap among coral-feeding butterflyfishes (Chaetodontidae) at Lizard Island, Great Barrier Reef. Marine Biology 148: 373-382.

Pyle, R. 2001a. Chaetodontidae. Butterflyfishes. Pages 3224-3265 ***in:*** Carpenter, K. E. and V. H. Niem (Eds.). FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Volume 5. Bony fishes part 3 (Menidae to Pomacentridae). FAO, Rome.

Pyle, R. 2001b. Pomacanthidae. Angelfishes. Pages 3266-3286 ***in:*** Carpenter, K. E. and V. Niem (Eds.). FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vo. 5. Bony fishes part 3 (Menidae to Pomacentridae). FAO, Rome.

Rainboth, W. J. 1996. Fishes of the Cambodian Mekong. FAO Species Identification Field Guide for Fishery Purposes. FAO, Rome.

Randall, J. E. 1983. Red Sea Fishes. IMMEL Publishing, London.

Randall, J. E. 1987. Introductions of marine fishes to the Hawaiian Islands. Bulletin of Marine Science 41: 490-502.

Randall, J. E. 1996. Caribbean Reef Fishes. Third Edition. TFH Publications, Inc., Neptune City, New Jersey.

Randall, J. E. 2001. Acanthuridae. Surgeonfishes (tangs, unicornfishes). Pages 3653-3683 ***in:*** Carpenter, K.E. and V. Niem (Eds.). FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Vol. 6. Bony fishes part 4 (Labridae to Latimeriidae), estuarine crocodiles. FAO, Rome.

Randall, J. E. 2005. Reef and Shore Fishes of the South Pacific. New Caledonia to Tahiti and the Pitcairn Islands. University of Hawai'i Press, Honolulu.

Randall, H. A. and G. R. Allen. 1977. A revision of the damselfish genus *Dascyllus* (Pomacentridae) with description of a new species. Records of the Australian Museum 31: 349-385.

Randall, J. E. and C. Anderson. 1993. Annotated checklist of the epipelagic and shore fishes of the Maldives Islands. Ichthyogical Bulletin of the J. L. B. Smith Institute of Ichthyology 59: 1-47.

Randall, J. E. and A. Ben-Tuvia. 1983. A review of the groupers (Pisces: Serranidae: Epinephelinae) of the Red Sea, with description of a new species of *Cephalopholis*. Bulletin of Marine Science 33: 373-426.

Randall, J. E. and P. C. Heemstra. 1991. Revision of Indo-Pacific groupers (Perciformes: Serranidae: Epinephelinae), with descriptions of five new species. Indo-Pacific Fishes, No. 20, Bishop Museum, Hawaii.

Randall, J. E. and R. K. Kanayama. 1972. Report on the introduction of serranid and lutjanid fishes from French Polynesia to the Hawaiian Islands. Pacific Science Congress Proceedings 12: 231.

Randall, J. E., G. R. Allen and R. C. Steene. 1996. Fishes of the Great Barrier Reef and Coral Sea. Second Edition. University of Hawaii Press, Honolulu, Hawaii.

Rauch, T. J. 2000. Blennies on offshore petroleum platforms in the Gulf of Mexico: Factors influencing assemblage structure. Ph.D. Dissertation. Department of Biological Sciences, University of Southern Mississippi, Hattiesburg, Mississippi.

Rauch, T. J. 2003. Equilibrial blenniid assemblages on offshore petroleum platforms. Environmental Biology of Fishes 68: 301-305.

Reef Environmental Education Foundation (REEF). 2008. Exotic Species Sighting Program and Volunteer Survey Project Database. World Wide Web electronic publication. www.reef.org, accessed March 10, 2008.

Rehage, J. S. and W. F. Loftus. 2007. Seasonal fish community variation in headwater mangrove creeks in the southwestern Everglades: an examination of the their role as dry-down refuges. Bulletin of Marine Science 80: 625-645.

Rivas, L. R. 1965. Florida fresh water fishes and conservation. Quarterly Journal of the Florida Academy of Science 28: 255-258.

Robertson, D. R. 1983. On the spawning behavior and spawning cycles of eight surgeonfishes (Acanthuridae) from the Indo-Pacific. Environmental Biology of Fishes 9: 193-223.

Robertson, D. R., J. S. Grove and J. E. McCosker. 2004. Tropical transpacific shore fishes. Pacific Science 58: 507-565.

Robertson, D. R., N. V. C. Polunin and K. Leighton. 1979. The behavioral ecology of three Indian Ocean surgeonfishes (*Acanthurus lineatus, A. leucosternon* and *Zebrasoma scopas*): their feeding strategies and social and mating systems. Environmental Biology of Fishes 4: 125-170.

Rosen, D. C. and R. M. Bailey. 1963. The poeciliid fishes (Cyprindontiformes), their structure, zoogeography, and systematics. Bulletin of the American Museum of Natural History 126: 1-176.

Ruiz, G. M., J. T. Carlton, E. D. Grosholz and A. H. Hines. 1997. Global invasions of marine and estuarine habitats by non-indigenous species: mechanisms, extent, and consequences. American Zoologist 37: 621-632.

Sale, P. F. 1970. Behaviour of the humbug fish. Australian Natural History, Sept. 1970: 362-366.

Sale, P. F. 1971a. Extremely limited home range in a coral reef fish, *Dascyllus aruanus* (Pisces: Pomacentridae). Copeia 1971: 324-327.

Sale, P. F. 1971b. Apparent effect of prior experience on a habitat preference exhibited by the reef fish, *Dascyllus aruanus* (Pisces: Pomacentridae). Animal Behaviour 19: 251-256.

Sale, P. F. 1972a. Influence of corals in the dispersion of the pomacentrid fish, *Dascyllus aruanus*. Ecology 53: 741-744.

Sale, P. F. 1972b. Effect of cover on agonistic behaviour of a reef fish: a possible spacing mechanism. Ecology 53: 733-758.

Schofield, P. J., W. T. Slack, M. S. Peterson and D. R. Gregoire. 2007. Assessment and control of an invasive aquaculture species: An update on Nile tilapia (*Oreochromis niloticus*) in coastal Mississippi after Hurricane Katrina. Southeastern Fishes Council Proceedings 49: 9-15.

Semmens, B. X., E. R. Buhle, A. K. Salomon and C. V. Pattengill-Semmens. 2004. A hotspot of non-native marine fishes: evidence for the aquarium trade as an invasion pathway. Marine Ecology Progress Series 266: 239-244.

Shafland, P. L. and J. M. Pestrak. 1982. Lower lethal temperatures for fourteen non-native fishes in Florida. Environmental Biology of Fishes 7: 149-156.

Shafland, P. L., K. B. Gestring and M. S. Stanford. 2008. Florida's exotic freshwater fishes -- 2007. Florida Scientist 71: 220-245.

Shpigel, M. and L. Fishelson. 1989. Habitat partitioning between species of the genus *Cephalopholis* (Pisces: Serranidae) across the fringing reef of the Gulf of Aqaba (Red Sea). Marine Ecology Progress Series 58: 17-22.

Shpigel, M. and L. Fishelson. 1991. Territoriality and associated behaviour in three species of the genus *Cephalopholis* (Pisces: Serranidae) in the Gulf of Aqaba (Red Sea). Journal of Fish Biology 38: 887-896.

Smith, J. L. B. 1954. Four rare serraniform fishes from East Africa. Annals and Magazine of Natural History, Ser. 12, 7: 925-933.

Smith-Vaniz, W. F. 1980. Revision of Western Atlantic species of the Blenniid fish genus *Hypsoblennius*. Proceedings of the Academy of Natural Science, Philadelphia 132: 285-305.

Smith-Vaniz, W. F., B. B. Collette and B. E. Luckhurst. 1999. Fishes of Bermuda: History, Zoogeography, Annotated Checklist, and Identification Keys. American Society of Ichthyologists and Herpetologists Special Publication No. 4.

Sommer, C., W. Schneider and J. M. Poutiers. 1996. FAO species identification field guide for fishery purposes. The living marine resources of Somalia. FAO, Rome.

Springer, V. G. and J. H. Finucane. 1963. The African cichlid, *Tilapia heudeloti Dumeril*, in the commercial catch of Florida. Transactions of the American Fisheries Society 92:317-318.

Starck, W. A. II. 1968. A list of the fishes of Alligator Reef, Florida with comments on the nature of the Florida reef fish fauna. Undersea Biology 1: 5-40.

Sweatman, H. P. A. 1983. Influence of conspecifics on choice of settlement sites by larvae of two pomacentrid fishes (*Dascyllus aruanus* and *D. reticulatus*) on coral reefs. Marine biology 75: 225-229.

Sweatman, H. 1988. Field evidence that settling coral reef fish larvae detect resident fishes using dissolved chemical cues. Journal of Experimental Marine Biology and Ecology 124: 163-174.

Taylor, J. N., D. B. Snyder and W. R. Courtenay, Jr. 1986. Hybridization between two introduced, substrate-spawning tilapias (Pisces: Cichlidae) in Florida. Copeia 1986: 903-909.

Thys van den Audenaerde, D. F. E. 1966. Les Tilapia (Pisces: Cichlidae)

de Sud-Cameroun et Gabon; étude systématique. Annals of the Museum of the Royal African Centre of Science and Zoology 153: 1-98.

Tissot, B. N., W. J. Walsh and L. E. Hallacher. 2004. Evaluating effectiveness of a marine protected area network in west Hawai`i to increase productivity of an aquarium fishery. Pacific Science 58: 175-188.

Topolski, M. F. and S. T. Szedlmayer. 2004. Vertical distribution, size structure, and habitat associations of four Blenniidae species on gas platforms in the northcentral Gulf of Mexico. Environmental Biology of Fishes 70: 193-201.

Trewavas, E. 1974. The freshwater fishes of rivers Mungo and Meme and lakes Kotto, Mboandong and Soden, West Cameroon. Bulletin of the British Museum of Natural History and Zoology 26: 331-419.

Trewavas, E. 1983. Tilapine fishes of the genera *Sarotherodon*, *Oreochromis* and *Danakilia*. Cornell University Press, Ithaca, New York.

Turner, J. S. and F. F. Snelson, Jr. 1984. Population structure, reproduction and laboratory behavior of the introduced *Belonesox belizanus* (Poeciliidae) in Florida. Environmental Biology of Fishes 10: 89-100.

Vine, P. J. 1974. Effects of algal grazing and aggressive behaviour of the fishes *Pomacentrus lividus* and *Acanthurus sohal* on coral-reef ecology. Marine Biology 24: 131-136.

Webster, M. S. 2003. Temporal density dependence and population regulation in a marine fish. Ecology 84: 632-628.

Webster, M. S. 2004. Density dependence via intercohort competition in a coral-reef fish. Ecology 85: 986-994.

Webster, M. S. and M. A. Hixon. 2000. Mechanisms and individual consequences of intraspecific competition in a coral-reef fish. Marine Ecology Progress Series 196: 187-194.

White, W. T. and I. C. Potter. 2004. Habitat partitioning among four elasmobranch species in nearshore, shallow waters of a subtropical embayment in Western Australia. Marine Biology 145: 1023-1032.

Whitfield, A. K. and S. J. M. Blaber. 1979. The distribution of the freshwater cichlid *Sarotherodon mossambicus* in estuarine systems. Environmental Biology of Fishes 4: 77-81.

Whitfield, A. K., R. H. Taylor, C. Fox and D. P. Cyrus. 2006. Fishes and salinities in the St. Lucia estuarine system -- a review. Reviews in Fish Biology and Fisheries 16: 1-20.

Williams, J. T. 2002. Blenniidae. Pages 1768 – 1772 in: Carpenter, K.

E. (Ed.). The Living Marine Resources of the Western Central Atlantic. Volume 3. Bony fishes part 2 (Opistognathidae to Molidae), sea turtles and marine mammals. FAO Species Identification Guide for Fishery Purposes. FAO, Rome.

Winterbottom, R. 1971. Movement of the caudal spine of some surgeonfishes (Acanthuridae, Perciformes). Copeia 1971: 562-566.

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