U.S. Fish & Wildlife Service

Firemouth Cichlid (*Thorichthys meeki*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, February 2015
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1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2017):

"Central America: Atlantic slope, in the Usumacinta River drainage, the Belize River drainage, and near Progreso, in Mexico, Guatemala and Belize."

"Abundant in the Belize river system and to the north [Greenfield and Thomerson 1997]."

"Recorded from Rio Champoton, and Lago de Ilusiones [Mexico]."

From Nico et al. (2017):

"Tropical America. Atlantic Slope drainages in Middle America from the Ríos Grijalva and Usumacinta basins of Mexico and Guatemala, and the Yucatan Peninsula south to southern Belize (Conkel 1993; Greenfield and Thomerson 1997)."

From CABI (2017):

"*T. meeki* is native to Mexico, Belize and Guatemala. The species has a wide distribution on the Atlantic Slope from the Tonala River, Veracruz, Mexico, east and north to the upper part of the Yucatán peninsula (north latitudes 17°30' to 22°30', west longitudes 88° to 93°). […] This includes the Tonala, Pichucalco, Oxolatlan, Teapa, Chompán, Candelaria and the Champotón rivers and the lagoons around the lower Grijalva and Usumacinta basin. North of this area, *T. meeki* will be found in most sinkholes over the western and northern part of the Yucatan peninsula, including sinkholes in the Sian Káan Biosphere Reserve south of Tulum, in the eastern part of the Yucatan Peninsula, south to Belize and Guatemala (Page and Burr, 1991; Conkel, 1993; Artigas Azas, 2011; Froese and Pauly, 2014)."

Status in the United States

From Nico et al. (2017):

"A single fish was collected from a canal in Mesa, Maricopa County, Arizona, in 1973 (Minckley 1973; also see Courtenay and Stauffer 1990). The first record from Florida was a report of an established population in a rock pit in northwest Miami, Dade County (Rivas 1965). The species subsequently was found in several canals, ditches, borrow pits, and sinkhole and quarry ponds in various parts of southeastern Florida in Dade, Palm Beach, Brevard, and Broward counties during the late 1960s and 1970s (Ogilvie 1969; Courtenay et al. 1974; Courtenay and Hensley 1979; Courtenay and Stauffer 1990; Hogg 1976a, 1976b; museum specimens). Introduced into a Miami area canal system subsequent to 1972 (Hogg 1976a), it was considered established in Comfort Canal, Miami, with a range extending west to several small canals south of the Tamiami Canal in Dade County as of 1976 (Hogg 1976a, b; Courtenay and Hensley 1979). A large population was established in an isolated borrow pit adjacent to a former amusement park in Dania, Broward County; that population was eradicated by state personnel in July 1981 (Courtenay et al. 1984; Courtenay and Stauffer 1990). A small population existed in mosquito ditches on Big Pine Key, Monroe County, in the 1980s to mid-1990s but apparently no longer survives (Loftus, pers. comm.; museum specimens). First released in Hawaii in Nuuanu Reservoir in 1940 (Brock 1960), this species is now established on Oahu (Brock 1960; Maciolek 1984; Devick 1991a, b). The species was also reported as occurring in a drainage canal in the McCully District of Honolulu (Brock 1960). In Puerto Rico, the firemouth cichlid has been established in the Dos Bocas, La Plata and Loiza Reservoirs (Grana 2009)."

"Formerly established in Florida since the 1970s but no records have been taken since the late 1990s. Shafland et al. (2008) consider it to be a formerly reproducing species. Established in Hawaii since 1940, and in Puerto Rico since the late 2000s; reported from Arizona."

From Froese and Pauly (2017):

"Known from Dos Bocas Reservoir [Puerto Rico] since 2007. […] A popular species in the local [Puerto Rico] aquarium trade."

"Established in Nu'uanu Reservoirs No. 2 and 3 (reportedly stocked in 1940), and in the waterways of the Honolulu Country Club in O'ahu [Yamamoto and Tagawa 2000]."

"Populations recorded from Florida are quite abundant. An established population in an isolated borrow pit in Broward County was eradicated in July 1981."

From CABI (2017):

"A population that was recorded in Big Pine Key, Monroe County [Florida], in the 1980s to mid-1990s no longer exists (Nico et al., 2014)."

"Although populations of *T. meeki* were recorded in many counties in Florida in the 1960s to 1980s, many populations have subsequently disappeared. Loftus and Kushlan (1987) did not record *T. meeki* south of the Tamiami Canal during their 1976-1983 fish surveys of southern Florida and concluded that the species was either very localized in distribution or reduced in numbers and range since Hogg's (1976a) work. Nico et al. (2014) reports that although the species was well established in Florida in the 1970s, no populations have been recorded since the late 1990s. Shafland et al. (2008) consider it to be a formerly established species in Florida. However, Matlock (2014) considers *T. meeki* to be still established in Florida as of 2013."

"As an introduced species in Florida, *T. meeki* inhabits anthropogenically-modified mud- and sand-bottomed canals and rocky pools (Page and Burr, 1991). From the information available it appears as though *T. meeki* has only established viable populations here in highly anthropogenically-modified habitats such as drainage canals and rock quarries, and has not been successfully introduced to larger, less anthropogenically-modified river systems."

"*T. meeki* is a popular ornamental fish worldwide, though particularly in the USA (Texas Parks and Wildlife, 2012) and Australia (Bomford and Glover, 2004)."

Schofield and Loftus (2015) lists *Thorichthys meeki* as previously established in Florida but with no recent evidence of establishment.

Means of Introductions in the United States

From Nico et al. (2017):

"The Arizona and Hawaii introductions likely represent aquarium releases. Hawaii fish were listed as a deliberate introduction by Devick (1991a, b). Some Florida introductions were likely a result of escapes or releases from former fish farms (Hogg 1976a, b; Courtenay and Hensley 1979; Lee et al. 1980 et seq.; Courtenay and Stauffer 1990)."

From Froese and Pauly (2017):

"Accidentally released from aquaria [in Florida]. Reintroduced [in Florida] in the 1970s."

From CABI (2017):

"In the USA, a single specimen collected from Maricopa County, Arizona, in 1973 was considered to be a single aquarium release (Minckley, 1973). *T. meeki* is not established in this state (Nico et al., 2014). In Hawaii, *T. meeki* was deliberately introduced to Nuuanu Reservoir in 1940 (Brock, 1960; Devick, 1991a,b)."

Remarks

From Nico et al. (2017):

"Loftus and Kushlan (1987) did not collect this species south of the Tamiami Canal during their 1976-1983 fish surveys of southern Florida and concluded that *T. meeki* was either very localized in distribution or reduced in numbers and range since Hogg's (1976a) work."

From Froese and Pauly (2017):

"Hybridizes with other cichlids."

From CABI (2017):

"The genus *Thorichthys* (Meek, 1904) was created by the US ichthyologist Seth Eugene Meek of the Field Museum of Natural History in Chicago, for a new cichlid species from Veracruz (*Thorichthys ellioti*). *Thorichthys meeki* was described as *Thorichthys helleri meeki* (Brind, 1918) by Walter L. Brind in honour of Meek who compiled the first book on Mexican freshwater fishes.

Thorichthys was later described within *Cichlasoma*, then elevated to a subgenus of *Cichlasoma*, giving *Cichlasoma* (*Thorichthys*) *meeki* (Miller et al. 1961). Hubbs (1935) also redescribed the species as *Cichlasoma hyorhynchum* which was acknowledged as a junior synonym by Hasse (1981). *Thorichthys* was elevated to generic rank by Kullander (1983, 1996).

Thorichthys is thought to represent a monophyletic species group and recent molecular and morphological analyses have supported this view (e.g. Roe et al., 1997; Chakrabarty, 2007; Rícan et al., 2008)."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

From Eschmeyer et al. (2017):

"**Current status:** Valid as *Thorichthys meeki* Brind 1918."

From ITIS (2015):

"Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Acanthopterygii
Order Perciformes
Suborder Labroidei
Family Cichlidae
Genus *Thorichthys*
Species *Thorichthys meeki* Meek, 1904"

Size, Weight, and Age Range

From Froese and Pauly (2017):

"Max length : 17.0 cm TL male/unsexed; [Page and Burr 1991]; common length : 6.1 cm TL male/unsexed; [Hugg 1996]"

From Nico et al. (2017):

"Size: to ~12 cm SL (Miller et al. 2005); average length ~4-5 cm SL (Loftus, pers. comm.)"

From CABI (2017):

"Male *T. meeki* grow to 12 cm and females 8 cm standard length (Miller et al., 2005; Artigas Azas, 2011), although in the original description of the species Brind (1918) gives a maximum length of 15 cm, and Page and Burr (1991) give 17 cm. In natural populations the species is commonly only 4-6 cm standard length (Froese and Pauly, 2014; Nico et al., 2014)."

Environment

From Froese and Pauly (2017):

"Freshwater; benthopelagic; pH range: 6.5 - 7.5; dH range: ? - 10; non-migratory."

"26°C - 30°C [Conkel 1993] [assumed to be recommended aquarium temperature range]"

From Nico et al. (2017):

"The species tolerates a wide range in salinity."

From CABI (2017):

"*T. meeki* will principally inhabit lowland rivers up to 150 m above sea level and become rarer in upland areas."

"In the natural range of *T. meeki*, the water is usually alkaline (pH 7.5 or higher) and of moderate hardness (normally over 8 GH) (Artigas Azas, 2011). Water temperature ranges from 22 to 30°C and are warmer during the late part of the dry season from December to May. In coastal habitats some lagoons may be somewhat saline. Artigas Azas (2011) reported that *T. meeki* was collected in hyper-saline springs in the upper part of the Yucatan Peninsula.

The temporary pools favoured by *T. meeki* exhibited a mean temperature 24.57-28.11°C in the wet season and 27.25-29.78°C in the dry season."

"Butler et al. (2010) found the mean dissolved oxygen threshold concentration, as per cent [*sic*] saturation, of *T. meeki* to be 13.2%."

Climate/Range

From Froese and Pauly (2017):

"Tropical; […]; 22°N - 14°N, 95°W - 87°W"

Distribution Outside the United States

Native

From Froese and Pauly (2017):

"Central America: Atlantic slope, in the Usumacinta River drainage, the Belize River drainage, and near Progreso, in Mexico, Guatemala and Belize."

"Abundant in the Belize river system and to the north [Greenfield and Thomerson 1997]."

"Recorded from Rio Champoton, and Lago de Ilusiones [Mexico]."

From Nico et al. (2017):

"Tropical America. Atlantic Slope drainages in Middle America from the Ríos Grijalva and Usumacinta basins of Mexico and Guatemala, and the Yucatan Peninsula south to southern Belize (Conkel 1993; Greenfield and Thomerson 1997)."

Introduced

Froese and Pauly (2017) list *Thorichthys meeki* as introduced to and established in Colombia and Singapore; introduced but not established in Israel; introduced with an unknown status in the Philippines.

From Froese and Pauly (2017):

"Established in the Magdalena watershed [Colombia]. Widespread in fish rearing facilities […]."

From Corfield et al. (2007):

"11. Firemouth cichlid *Thorichthys meeki*, location: Ross River (northern Qld [Queensland, Australia])"

From CABI (2017):

"*T. meeki* has established in the Magdalena watershed, Colombia (Welcomme, 1988). It is also recorded in the Philippines, Singapore, Israel and Queensland, Australia."

Xiong et al. (2015) list *Thorichthys meeki* as a non-native species in China but its status is uncertain.

Thorichthys meeki is present in the aquarium trade in Greece (Papavlasopoulou et al. 2014).

Thorichthys meeki is present in the aquarium trade in Tamilnadu, India (Premdass et al. 2016).

Means of Introduction Outside the United States

FAO (2015) listed ornamental and aquaculture as reasons of introductions outside the United States.

From Webb (2003):

"For the Ross catchment, three cichlid species, the Convict cichlid, Firemouth cichlid and Burton's haplochromis, were also fist found in ornamental ponds and then in a nearby creek."

From Froese and Pauly (2017):

"Widespread in fish rearing facilities [in Colombia] and has presumably escaped into local waters."

Short Description

From CABI (2017):

"*T. meeki* has a grey to yellow-olive head and body. There is a large black mark on lower half of operculum. The ventral surface and particularly the underside of the head is bright red or orange; this is most noticeable in adults and particularly breeding males. There are 5 or 6 black vertical bars of varying intensity along the flanks; the third bar is usually more pronounced and often extends over both upper and lower lateral lines. All fins, except pectoral, have red edge and rows of iridescent blue spots or blotches. Large males have extended ray filaments at the rear of the dorsal and anal fins and to a lesser degree the upper and lower edges of the caudal fin. There are

15-17 dorsal spines, 10-13 dorsal rays, 8-10 anal spines, 7-9 anal rays (Miller and Taylor, 1984; Page and Burr, 1991).

T. meeki is sexually dimorphic, with males growing somewhat larger than female fish, exhibiting extended fin rays and being more intensely coloured (particularly the red ventral colouration). Adult female fish may have rounder bodies with larger bellies (Artigas Azas, 2011; Seriously Fish, 2014).

According to Artigas Azas (2011), *T. meeki* is highly variable throughout its natural range, both morphologically and in colouration. The most intensely-coloured individuals are found in the lower Grijalva in the state of Tabasco, Mexico."

Biology

From Froese and Pauly (2017):

"Prefers lower and middle sections of rivers in slow moving waters [Conkel 1993]. Lives in mud-bottomed and sand-bottomed canals and rocky ponds [Page and Burr 1991]. Stays close to the shoreline vegetation for protection [Yamamoto and Tagawa 2000]. Omnivorous, but feeds mainly on algae [Lee et al. 1980]."

"Deposits eggs on open substrate such as stones [Lee et al. 1980], a piece of submerged wood, or a shallow depression excavated in the substrate; from 100 to 500 eggs are deposited and guarded by both parents; newly hatched young are transferred to shallow pits and the parents continue guarding them [Yamamoto and Tagawa 2000]."

"Showed quantitative diel, ontogenetic and seasonal diet changes [Valtierra-Vega and Schmitter 2000]."

From Nico et al. (2017):

"Primarily a benthic omnivore, consuming detritus, molluscs, copepods, cladocerans, and insects by sifting through the bottom substrate (Chávez-Lomelí et al. 1988; Valtierra-Vega and Schmitter-Soto 2000; Cochran-Biederman and Winemiller 2010). Generally found in shallow, slow moving water (e.g., cenotes, lagoons, wetlands, roadside ditches, streams) over soft sediments (Miller et al. 2005; Soria-Barreto and Rodiles-Hernández 2008)."

"The dominant habitat in Hawaii was listed as reservoirs by Maciolek (1984), but as streams by Devick (1991a, 1991b)."

From CABI (2017):

"*T. meeki* has a wide distribution and is found in different aquatic biotopes across Mexico, Belize and Guatemala. It occupies lowland aquatic habitats including permanent and seasonal lagoons and pools, slow-flowing backwaters of larger river systems and smaller streams. These habitats are typically lentic or slow-flowing, relatively shallow (depth <1.5 metres), turbid, and with a soft or mud substrate covered with leaf litter and submerged branches. Emergent vegetation commonly edges these pools and lagoons. *T. meeki* does occur in upland areas (150 m above sea level and higher) of these river systems, though it is much rarer and confined to backwater areas (Artigas Azas, 2011). The paucity of *T. meeki* in these upland aquatic habitats may be influenced by the clearer water and higher water velocities. In the northern areas of the Yucatan peninsula particularly, *T. meeki* occurs in sinkholes. The habitats exhibit clear water and sandy or limestone substrates (Miller et al., 2005; Soria-Barreto and Rodiles-Hernández, 2008; Artigas Azas, 2011; Vega-Cendejas et al., 2013; Nico et al., 2014). Artigas Azas (2011) observed *T. meeki* in a hyper-saline spring at Celestum in the upper Yucatan Peninsula."

"*T. meeki* is a biparental, monogamous substrate spawner with advanced parental care of offspring. Reproduction is generally seasonal with pairs forming during the wet season (March to May), although in stable environments the reproductive period may be protracted. Pairs usually form when a male selects a territory and courts passing females. Less frequently pairs may form in feeding territories with pairs then selecting a territory.

Males or pairs defend their territories from intruders or neighbouring pairs by extending their gular pouches forward and making small runs in the intruder's direction. The black spots present at the bottom of the operculum displays as larger, more separated eyes when the gills are flared, presenting the appearance of a larger fish. Preferred breeding sites tend to become highly populated with pairs competing strongly with neighbouring pairs for territories. Pairs incur frequent conflicts with neighbours though fish are rarely injured in these encounters.

Eggs are normally laid on a solid substrate such as a flat rock or driftwood. After they have vigorously cleaned the spawning surface using their mouths, males and females extend their genital tubes some hours prior to the spawning act. Females lay one or more rows of eggs before the male fertilises them, the process being repeated numerous times until between one and five hundred eggs 1.7 mm in length have been deposited. The eggs are guarded closely by the female during the incubation period while the male is responsible for defence of the surrounding territory.

The eggs are fanned by the pectoral fins of the female and take around 48 hours to hatch. The pair excavate several small pits around the spawning area and the wrigglers are transported to one of these pits. The wrigglers are frequently moved to different pits to reduce predation. In the aquarium environment it takes five days for the wrigglers to consume their yolk sac and become free-swimming.

Once free-swimming, fry are guarded closely by parents who guide them with spasmodic body movements and rapid fin movement. The female directly guards the wrigglers while the male guides the groups movements and confronts intruders. *T. meeki* may guard offspring for up to three months until the fry grow to approximately 15-20 mm. Young *T. meeki* inhabit structure in shallow water, such as grass or vegetation, and join larger feeding groups when around 40 mm (Radesater and Ferro, 1979; Lee et al., 1980; Neil 1983a,b; 1984a,b; Coleman and Galvani, 1998; Yamamoto and Tagawa, 2000; Artigas Azas, 2011; Seriously Fish, 2014).

Escalera-Vázquez and Zambrano (2010) collected *T. meeki* in temporary pools in a tropical wetland of the Sian Káan Biosphere Reserve, Mexico. These researchers concluded that fishes, including *T. meeki*, that showed a clear preference for temporary pools and exhibited a 'seasonal' life history strategy. Fishes with a seasonal strategy exhibit synchronised reproduction with high fecundity during the early wet season and inhabit seasonal ecosystems (Winemiller, 1989)."

"*T. meeki* is a benthic omnivore and substrate sifter that feeds on soft substrate. Mouthfuls of substrate are consumed and sifted for edible items with the remaining material expelled via the gill openings and mouth. Using this method, detritus, molluscs, copepods, cladocerans, and insects are consumed (Chávez-Lomelí et al., 1988; Valtierra-Vega and Schmitter-Soto, 2000; Cochran-Biederman and Winemiller, 2010; Hinojosa-Garro et al., 2013). *T. meeki* will opportunistically consume small fishes, and some dietary studies have reported the predominant consumption of algae (Lee et al., 1980). *T. meeki* feeds in large groups and the feeding behaviour apparently consumes most of its time in the natural habitat (Artigas Azas, 2011). Dominant fish forage in the most profitable areas of substrate, while sub-dominant fish forage in less productive areas to avoid confrontation (Hodapp and Frey, 1982)."

Human Uses

From Froese and Pauly (2017):

"Used in behavioral studies [Robins et al. 1991]. Aquarium keeping: minimum aquarium size 100 cm [BMELF 1999]."

"Fisheries: of no interest; aquarium: highly commercial"

"A popular species in the local [Puerto Rico] aquarium trade."

From CABI (2017):

"While *T. meeki* is widely available and kept within the ornamental fish community worldwide, it is not as popular as other ornamental species such as the guppy *Poecilia reticulata* (Poeciliidae)."

Diseases

White spot disease is on the 2017 list of OIE reportable diseases (OIE 2017).

From Froese and Pauly (2017):

"White spot Disease, Parasitic infestations (protozoa, worms, etc.)
False Fungal Infection (*Apiosoma* sp.), Parasitic infestations (protozoa, worms, etc.)
False Fungal Infection (*Epistylis* sp.), Parasitic infestations (protozoa, worms, etc.)
Serpinema Infestation, Parasitic infestations (protozoa, worms, etc.)
Skin Flukes, Parasitic infestations (protozoa, worms, etc.)
Yellow Grub, Parasitic infestations (protozoa, worms, etc.)
Bothriocephalus Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Posthodiplostomum Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Spiroxys Infestation, Parasitic infestations (protozoa, worms, etc.)
Procamallanus Infection 13, Parasitic infestations (protozoa, worms, etc.)

Serpinema Infestation, Parasitic infestations (protozoa, worms, etc.)
Crassicutis Infection, Parasitic infestations (protozoa, worms, etc.)
Genarchella Infection, Parasitic infestations (protozoa, worms, etc.)
Oligogonotylus Infection, Parasitic infestations (protozoa, worms, etc.)
Oligogonotylus Infection, Parasitic infestations (protozoa, worms, etc.)
Contracaecum Disease (larvae), Parasitic infestations (protozoa, worms, etc.)
Apharyngostrigea Disease, Parasitic infestations (protozoa, worms, etc.)
Ascocotyle Infestation 1, Parasitic infestations (protozoa, worms, etc.)
Cladocystis Infection, Parasitic infestations (protozoa, worms, etc.)
Ascocotyle Infestation 3, Parasitic infestations (protozoa, worms, etc.)
Cotylurus Infection, Parasitic infestations (protozoa, worms, etc.)
Diplostomum Infection, Parasitic infestations (protozoa, worms, etc.)
Pelaezia Infection, Parasitic infestations (protozoa, worms, etc.)
Perezitrema Infection, Parasitic infestations (protozoa, worms, etc.)
Stunkardiella Infection, Parasitic infestations (protozoa, worms, etc.)
Uvulifer Infection, Parasitic infestations (protozoa, worms, etc.)
Sciadicleithrum Infection 2, Parasitic infestations (protozoa, worms, etc.)
Valipora Infestation, Parasitic infestations (protozoa, worms, etc.)
Falcaustra Infection (*Falcaustra* sp.), Parasitic infestations (protozoa, worms, etc.)
Pseudoterranova Infection, Parasitic infestations (protozoa, worms, etc.)
Neoechinorhynchus Infestation 6, Parasitic infestations (protozoa, worms, etc.)
Procamallanus Infection 13, Parasitic infestations (protozoa, worms, etc.)"

Poelen et al. (2014) list *Ascocotyle nana*, *A. nunezae*, *Atrophecaecum astroguii*, *Bothriochephalus acheilognathi*, *Cladocystis trifolium*, *Crassicutis cichlasomae*, *Diplostomum compactum*, *Genarchella isabellae*, *Neoechinorhynchus golvani*, *Olmeca laurae*, *Pelaezia loossi*, *Posthodiplostomum minimum*, *Procamallanus rebecae*, *Sciadicleithrum meekii*, *Sperinema trispinosum*, *Valipora mutabilis* as parasites of *Thorichthys meeki*.

Threat to Humans

From Froese and Pauly (2017):

"Harmless"

3 Impacts of Introductions

No details on actual impacts of *Thorichthys meeki* introductions were found. The following concerns potential impacts or broad generalizations of impacts.

From Froese and Pauly (2017):

"Significant ecological interactions: some – adverse"

From Nico et al. (2017):

"Unknown. As with other cichlids, there is the potential that *T. meeki* will compete with native centrarchids."

From CABI (2017):

"Limited data are available on the impacts of introduced populations of *T. meeki*, though generalisations can be made regarding the diet and behaviour of the species, and consequently its potential impacts on sympatric native fishes and aquatic ecosystems. *T. meeki* may compete with indigenous fishes for food and will opportunistically consume smaller fishes. While breeding, *T. meeki* may become aggressive and territorial and this behaviour may lead to the displacement of indigenous fishes.

Nico et al. (2017) identified native North American sunfishes (Centrarchidae) as potentially competing with introduced populations of *T. meeki*. The introduced cichlid occupies a similar ecological niche as sunfishes with regards to reproduction (sunfishes are substrate spawners and nest builders with the male guarding the nest), trophic position (adults eat insects, larvae, small fish) and habitat (occupy slower waters, muddy bottoms, high vegetation cover).

Froese and Pauly (2017) state that ecological impacts, including hybridization with local conspecifics, have been observed in Puerto Rico after the establishment of *T. meeki*, though no further information is available."

4 Global Distribution

Figure 1. Known global distribution of *Thorichthys meeki*. Locations are in the United States, Mexico, and Puerto Rico. Map from GBIF Secretariat (2017). The northernmost point in Mexico was an outlier and was not used to select source points in the climate match.

Figure 2.10: Distribution of firemouth cichlid *(Thorichthys meeki)*.

Figure 2. Distribution of *Thorichthys meeki* in Australia. From Corfield et al. (2007).

While no georeferenced observations are available for the established population in Singapore, the small size of the country allows for source locations to be chosen to represent this population in the climate match. No georeferenced observations were available in Colombia and there was not enough information given by the source to be able to choose source points to represent this population in the climate match.

5 Distribution Within the United States

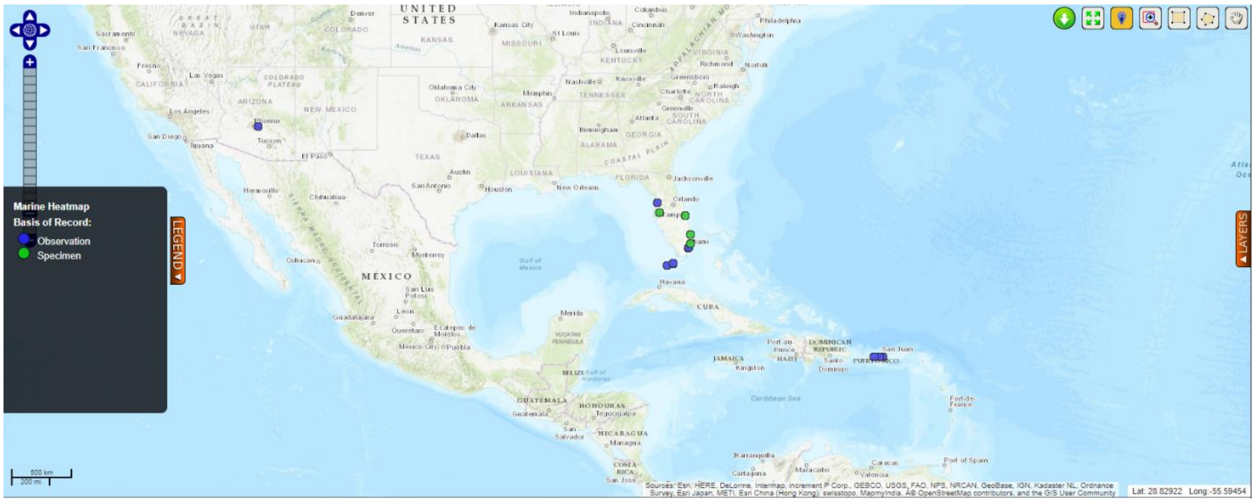

Figure 3. Known distribution of *Thorichthys meeki* in the contiguous United States and Puerto Rico. Map from BISON (2017). The location in Arizona failed to establish a population and was excluded as a source point in the climate match. *Thorichthys meeki* was once established in Florida and may still be established, therefore those populations were used as source point for the climate match.

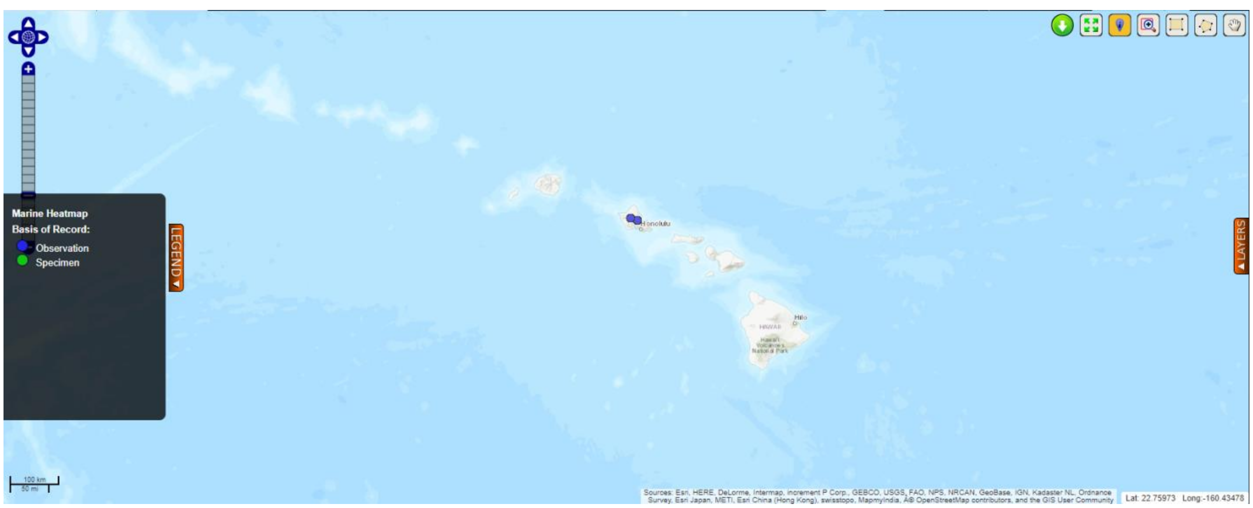

Figure 4. Known distribution of *Thorichthys meeki* in Hawaii. Map from BISON (2017).

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Thorichthys meeki* was high in Florida, small parts of the Gulf Coast, and the very southern Atlantic Coast. It was medium in the rest of the Gulf Coast and the Mid-Atlantic Coast; it was low almost everywhere else. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.034, medium (scores greater than 0.005, but less than 0.103, are classified as medium). Florida, Georgia, and South Carolina had high individual Climate 6 scores, and Alabama, Louisiana, North Carolina, and Texas has medium individual Climate 6 scores. All other States had low individual scores.

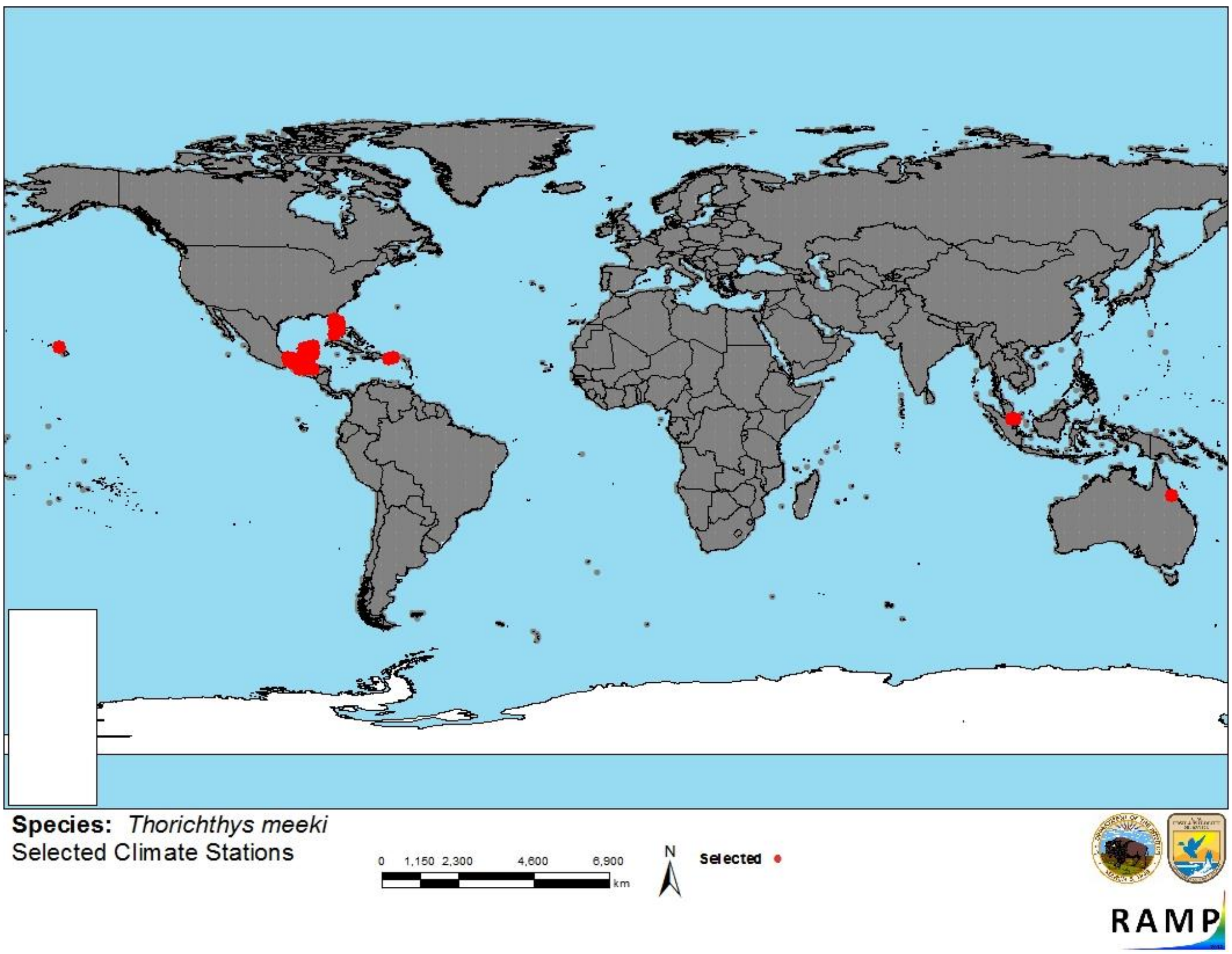

Figure 5. RAMP (Sanders et al. 2014) source map showing source locations (red; United States (Hawaii, Florida, Puerto Rico), Mexico, Singapore, Australia) and non-source locations (grey) for *Thorichthys meeki* climate matching. Source locations from Corfield et al. (2007), Schofield and Loftus (2015), BISON (2017), Froese and Pauly (2017), and GBIF Secretariat (2017). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

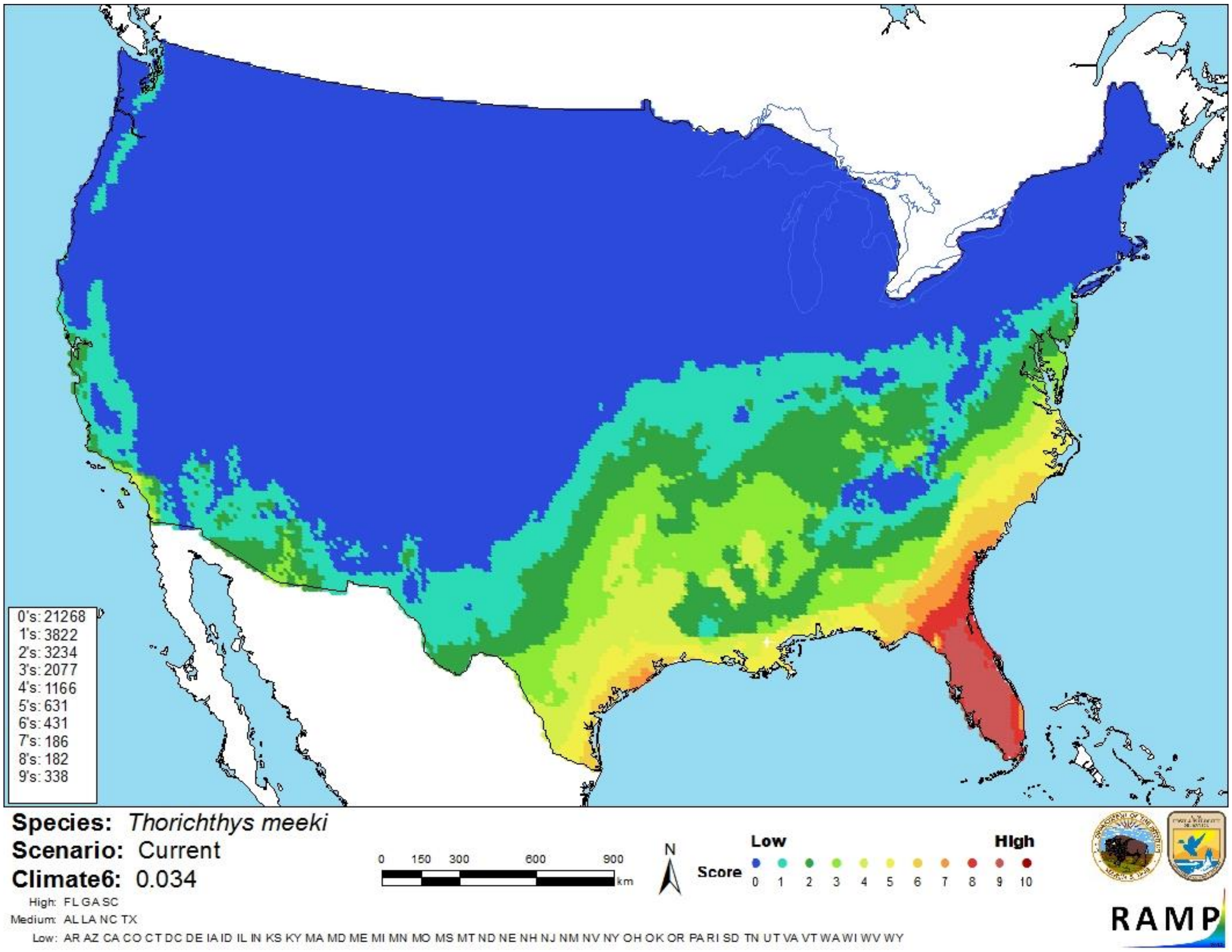

Figure 6. Map from RAMP (Sanders et al. 2014) of a current climate match for *Thorichthys meeki* in the contiguous United States based on source locations reported by Corfield et al. (2007), Schofield and Loftus (2015), BISON (2017), Froese and Pauly (2017), and GBIF Secretariat (2017). 0 = Lowest match, 10 = Highest match.

The High, Medium, and Low Climate match Categories are based on the following table:

Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)	Climate Match Category
$0.000 \leq X \leq 0.005$	Low
$0.005 < X < 0.103$	Medium
≥ 0.103	High

7 Certainty of Assessment

The certainty of assessment is low. There was adequate biological and ecological information available about *Thorichthys meeki*. Records of introductions were found. The records were not always clear on if the population was established. There were no records of actual impacts of those introductions.

8 Risk Assessment

Summary of Risk to the Contiguous United States

The Firemouth Cichlid (*Thorichthys meeki*), is fish native to Central America. It is popular in the aquarium trade and for behavioral studies. History of invasiveness is None Documented. It has been introduced to Israel, the Philippines, and China, and established in Colombia, Singapore, and Australia. A few broad, general statements of 'adverse impacts' were found but no details were available. Some information on potential impacts was found. The climate match with the contiguous United States is medium. The southeast from the mid-Atlantic coastal area to southern Texas had medium to high matches and low matches were found almost everywhere else. Established populations have been reported in Florida historically, but the current status of those populations is in question. The certainty of assessment is low. The overall risk assessment category is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None Documented**
- **Climate Match (Sec. 6): Medium**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information** *Thorichthys meeki* can be infected with white spot disease, an OIE reportable disease.
- **Overall Risk Assessment Category: Uncertain**

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