Orinoco Sailfin Catfish (*Pterygoplichthys multiradiatus*)
Ecological Risk Screening Summary

Web Version – 8/28/12


Photo: Fuller

1 Native Range and Nonindigenous Occurrences

Native Range
From Nico et al. 2012:

"Tropical America. Orinoco River basin in northern South America."

Nonindigenous Occurrences
From Nico et al. 2012:

"This catfish is known from various canals and water bodies in south Florida within Dade, Palm Beach, Martin, and Broward counties (Courtenay and Stauffer 1990; Page 1994; Nico, unpublished data). It is established in Florida Panther National Wildlife Refuge (USFWS 2005). The species was first reported from Hawaii in Wahiawa Reservoir, Oahu, in January 1986; it had become one of the most abundant fish in the reservoir by 1989; it also is established in Kaukonahua Stream, Oahu (Devick 1988, 1991). The fish is widely distributed in lower elevation reservoirs and streams on northern Oahu (Devick 1988, 1989; Mundy 2005; Hoover et al. 2004)."

Means of Introductions

From Nico et al. 2012:

"This armored catfish has been collected in southeastern Florida since about 1971 (Courtenay et al. 1984). Its presence is most likely the result of escapes or releases from aquarium fish farms (Courtenay and Stauffer 1990). In Hawaii, introductions are presumably the result of aquarium releases that occurred in the 1980s, possibly as early as 1982 (Devick 1991)."

Remarks

From Nico et al. 2012:

"Established in Florida and Hawaii. Recent surveys in Florida indicate its range may be expanding (Nico, unpublished data)."

"Many early reports of Hypostomus from south Florida, and some from the Tampa area, may have been based on misidentifications of Pterygoplichthys (Loftus and Kushlan 1987; Ludlow and Walsh 1991)."

2 Biology and Ecology

Taxonomic Hierarchy

From ITIS (2012):

"Kingdom Animalia
Phylum Chordata
Subphylum Vertebrata
Superclass Osteichthyes
Class Actinopterygii
Subclass Neopterygii
Infraclass Teleostei
Superorder Ostariophysi
Order Siluriformes
Family Loricariidae
Subfamily Hypostominae
Genus Pterygoplichthys
Species Pterygoplichthys multiradiatus"

Taxonomic Status: "valid"

Size, Weight, Age

From Froese and Pauly (2010):

"Max length : 50.0 cm TL male/unsexed; (Baensch and Riehl 1991)"

Environment

From Froese and Pauly (2010):

"Demersal; freshwater; pH range: 6.5 - 7.8; dH range: 4 – 20"

Climate/Range

From Froese and Pauly (2010):

"Tropical; 23°C - 27°C (Riehl and Baensch 1991); 10°N - 1°N, 68°W - 61°W"

Distribution

From Froese and Pauly (2010):

"South America: Orinoco River basin. Reported from Argentina (Lopez et al. 1987). Introduced and have established in Taiwan, mainland USA and Hawaii (Page and Burr 1991, Yamamoto and Tagawa 2000, Page and Robins 2006)."

Biology

From Froese and Pauly (2010):

"Occurs in streams and lakes (Yamamoto and Tagawa 2000) and in weedy, mud-bottomed canals (Page and Burr 1991). Benthic (Mundy 2005). Nocturnal, feeds on algae (Riehl and Baensch 1996), but will also feed on worms, insect larvae, and other bottom-dwelling aquatic animals (Yamamoto and Tagawa 2000). Spawning period peaks once a year (Liang et al. 2005). Reproductive behavior includes digging of burrows for egg laying (Nico et al. 2009). May exhibit male parental care (Liang et al. 2005)."

Human uses

From Froese and Pauly (2010):

"Fisheries: of no interest; aquarium: commercial"

Diseases

From Froese and Pauly (2010):

"Guyanema Infection (*Guyanema* sp.), Parasitic infestations (protozoa, worms, etc.)"

Threat to humans

None reported

3 Impacts of Introductions

From Nico et al. 2012:

"Largely unknown. In Hawaii, the thousands of nesting tunnels excavated by male *Pterygoplichthys* in reservoir and stream banks have contributed to siltation problems (Devick 1989). Because of their abundance in Hawaii, *Pterygoplichthys* and other armored catfishes have the potential to affect native stream species negatively through competition for food and space (Devick 1989). In Florida, this species occupies waters adjacent to Everglades National Park and is considered a threat to the park (Courtenay 1989)."

"Male members of the genus *Pterygoplichthys* dig out river banks to create burrows in which an attracted female will lay and guard her eggs. In large numbers, this burrowing behavior by *Pterygoplichthys* contributes to problems with siltation. In addition, the burrows potentially destabilize the banks, leading to an increased rate of erosion (Nico et al. 2009)."

From Global Invasive Species Database (2010):

General impacts
"Potential effects of *Pterygoplichthys* spp. include alteration of bank structure and erosion, disruption of aquatic food chains, competition with native species, mortality of endangered shore birds, changes in aquatic plant communities, and damage to fishing gear and industry. "

"Environmental impacts of *Pterygoplichthys* spp. are not fully understood, but in locations where they are introduced and abundant, their feeding behaviours and burrowing activities can cause considerable disturbance. Their burrows have been reported as contributing to siltation problems and bank erosion and instability (Hoover et al. 2004; Nico et al. 2009). *Pterygoplichthys* spp. forage along the bottoms of streams and lakes, occasionally burying their heads in the substrate and lashing their tails. These behaviours can uproot or shear aquatic plants and reduce the abundance of beds of submersed aquatic vegetation, creating floating mats that shade the benthos from sunlight. By grazing on benthic algae and detritus, they may alter or reduce food availability and the physical cover available for aquatic insects eaten by other native and non-native fishes where they are introduced (Mendoza et al. 2009; Hossain et al. 2008)."

"Pterygoplichthys spp. may also compete with native fish. They are believed to displace several species of minnow in Texas including the Federally threatened and 'Vulnerable (VU)' Devils River minnow (see *Dionda diaboli*) (Cohen 2008; Mendoza et al. 2009). *Pterygoplichthys* spp. have also been found to ingest eggs of *Etheostoma fonticola*, also listed as vulnerable (Cook-Hildreth 2009)."

"*Pterygoplichthys* spp. are thought to create large, novel nutrient sinks in invaded streams of southern Mexico. They sequester the majority of nitrogen and phosphorus of systems in their body armor. These impacts on nutrient systems may also exacerbate the nutrient limitation of primary productivity in invaded streams (Capps et al. 2009). "

"Thousands of nesting tunnels excavated by *P. multiradiatus* have contributed to siltation problems in Hawaii. Because of their abundance in Hawaii, *P. multiradiatus* may compete with native stream species for food and space (Nico 2006). The burrowing behaviour and overpopulation of *P. multiradiatus* may also displace native fish in Puerto Rico where they have been reported as detrimental to reservoir fishes (Bunkley-Williams et al. 1994). In Lake Okeechobee, Florida *P. multiradiatus* feeds and burrows at the bottom and destroys submerged vegetation, essentially displacing native fishes that would otherwise use the aquatic vegetation for spawning and refuge and interfering with their reproduction (Mendoza et al. 2009). *P. multiradiatus* is known to cause economic losses to fisherman by damaging equipment such as cast and gill nets in India and displacing native fish (Krishnakumar et al. 2009).
P. multiradiatus and *P. pardalis* damage fishing gear and gill nets in various locations of Mexico (Wakida-Kusunoki et al. 2007)."

"*P. disjunctivus* and *P. pardalis* are reportedly destroying cages and nets and causing a decline in native, more desirable fish in Laguna de Bay, Philippines (Chavez et al. 2006). *P. disjunctivus* attaches to the skin of the 'Endangered (EN)' native Florida manatee (see *Trichechus manatus* ssp. *latirostris*) and feeds on their epibiota. In some instances dozens of *P. disjunctivus* and manatees appeared agitated. This interaction may be detrimental to manatee but remains unclear (Nico et al. 2009a)."

From Simonovic (2010):

"The sailfin catfish genus *Pterygoplichthys* already has the invasive history, since species *P. multiradiatus*, *P. pardalis* and *P. disjunctivus* have been so far recorded as exotic in Mesoamerica – Puerto Rico and Mexico (Bunkley-Williams et al. 1994, Guzman and Barragan 1997); in North America: southern United States – Florida, Texas, Washington and North Carolina, as well as at Hawaii islands (Edwards 2001, Fuller et al. 1999, Nico And Fuller 2010, Ludlow and Walsh 1991, Nico and Martin 2001; in Philippines and south-eastern Asia: peninsular Malaysia, Singapore, Taiwan, Java and Sumatra (Page and Robins 2006). In all those recipient areas recorded so far, the aquarists were assigned responsible for their releasing into natural ecosystems and subsequent establishment."

From Krishnakumar et al. (2009):
"Eleven species of exotic fish are known to occur in the inland waters of Kerala (Pereira et al. 2008), posing a serious threat to the native biodiversity. Of this, at least four species are popular aquarium pets: *Pterygoplichthys multiradiatus* (Ajith 1998) (algae sucker/sucker cat), Poecilia reticulate (Raghaven et al. 2008) (guppy), *Trichogaster trichopterus* (Krishnakumar 2008) (three-spot gourami) and *Xiphophorus maculatus* (Raghaven et al. 2008) (platy). *P. multiradiatus*, an armoured catfish native to the South American drainages, is a popular aquarium pet worldwide and is known commonly as 'algae eater'. *P. multiradiatus* has been

recorded from three natural freshwater ponds at Vylathur in Thrissur District (Ajith 1998), and the Chackai Canal of Thiruvananthapuram District (Baiju 2009) in Kerala. Species under the genus *Pterygoplichthys* have been introduced worldwide as a result of the ornamental fish trade. In the Philippines, where they are known as janitor fish, two species have established feral populations in Marikana River and Laguna de Bay, and are considered a threat to the native freshwater fish. *P. multiradiatus* is also known to have established in natural waters of countries as widespread as Puerto Rico, United States of America and Taiwan. They are omnivores, attaining large sizes (up to 500 mm) and exhibiting territorial behaviour. Further, they are capable of tolerating pollution because of their air-breathing ability (Fernandes et al. 1998) and are also known to create serious negative impacts on periphyton feeding and bottom spawning fishes. Similar situations may be replicated in water bodies of Kerala, where economically valuable bottom spawners such as *Etroplus suratensis* occur. Grazing on benthic algae and detritus by suckermouth catfish is also known to alter and reduce food, and physical cover available for various aquatic insects (Liang et al. 2005), thereby affecting the trophic chain. The perennial ponds from where *P. multiradiatus* were collected from Vylathur, are connected to the Canoli canal which is subjected to tidal influx from the adjacent backwaters."

"Hence, the possible escape and colonization of the sucker catfish in the backwaters and associated natural waters of the region is a cause for grave concern. *P. multiradiatus* has also established a substantial population in Chackai Canal, replacing other herbivorous fishes (Baiju 2009). Apart from biological interactions, *P. multiradiatus* is also known to cause economic losses to fishermen through damage to fishing gears, especially cast and gill nets (Wakida-Kusunaki et al. 2007)."

Location Specific Impacts

From Global Invasive Species Database (2010):

Florida

"Modification of natural benthic communities: *Pterygoplichthys* spp. are believed to be causing significant changes in food web structure and competing with native species for food and space (Nico & Martin 2001)."

Hawaii

"Competition: Because of their abundance in Hawaii, *Pterygoplichthys multiradiatus* may compete with native stream species for food and space (Nico 2006).
Habitat alteration: Thousands of nesting tunnels excavated by *Pterygoplichthys multiradiatus* have contributed to siltation problems in Hawaii (Nico 2006)."

Texas

"Competition: Gut content assessments of *Pterygoplichthys* spp. and of Guadeloupe roundnose minnow (*Dionda nigrotaeniata*) and two additional *Dionda* species suggest high dietary overlap between the *Dionda* complex and *Pterygoplichthys*."
"Threat to endangered species: *Pterygoplichthys* spp. is believed to endanger the Federally threatened and 'Vulnerable (VU)' Devils River minnow (see *Dionda diaboli*) in Texas (Mendoza

et al. 2009). *Pterygoplichthys* spp. have also been found to ingest eggs of *Etheostoma fonticola*, also listed as vulnerable (Cook-Hildreth 2009)."

India
"Competition: *Pterygoplichthys multiradiatus* displaces native fish in Chakai Canal (Krishnakumar et al. 2009)."
"Economic/Livelihoods: *Pterygoplichthys multiradiatus* is known to cause economic losses to fisherman by damaging equipment such as cast and gill nets in India (Krishnakumar et al. 2009)."

Mexico
"Human nuisance: *Pterygoplichthys multiradiatus* and *P. pardalis* damage fishing gear and gill nets in various locations of Mexico (Wakida-Kusunoki et al. 2007)."
"Modification of nutrient regime: *Pterygoplichthys* spp. create large, novel nutrient sinks in invaded streams of southern Mexico. They also sequester the majority of nitrogen and phosphorus of systems in their body armor. These impacts on nutrient systems may also exacerbate the nutrient limitation of primary productivity in invaded streams (Capps et al. 2009)."

Puerto Rico
"Competition: The burrowing behavior and overpopulation on *Pterygoplichthys multiradiatus* may displace native fish species and have been reported as detrimental to reservoir fishes (Bunkley-Williams et al. 1994)."

4 Global Distribution

Summary

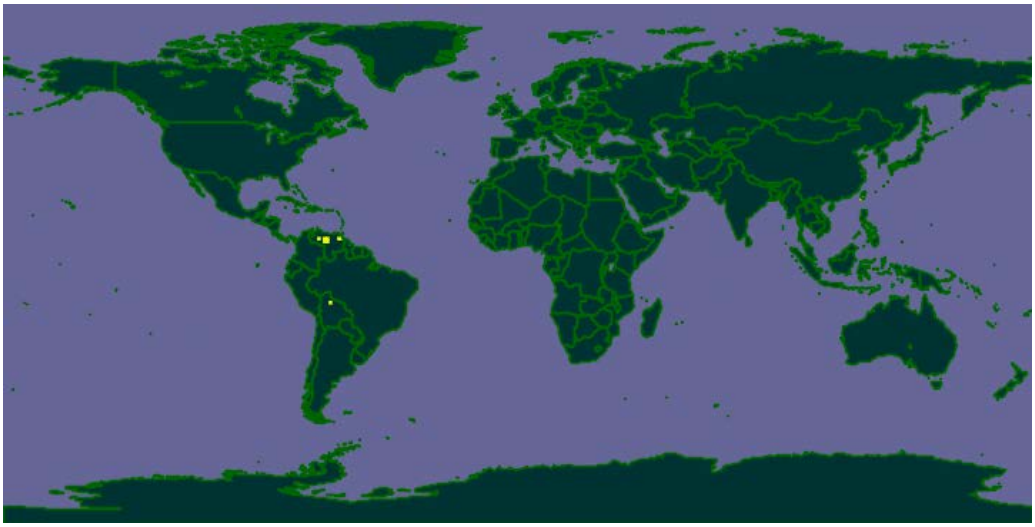

Figure 1. Global distribution of *P. multiradiatus*. Map from GBIF (2010).

5 Distribution within the United States

Figure 2. Distribution of *P. multiradiatus* in the U.S. Map from Nico et al. (2012).

6 CLIMATCH

Summary of Climate Matching Analysis

The climate match (Australian Bureau of Rural Sciences 2010; 16 climate variables; Euclidean Distance) was high in Florida. Medium matches covered much of the Southeast. Low-medium matches were present on the West Coast and through some of the interior western states. Low matches dominated the West, Midwest, and Northeast. Climate 6 match indicated that the US has a high climate match. The range for a high climate match is 0.103 and greater, climate match of *P. multiradiatus* is 0.105.

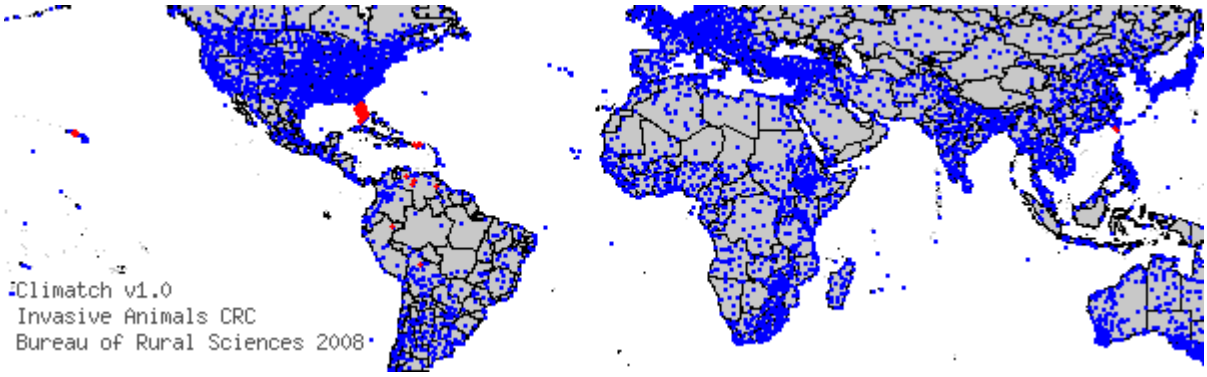

Figure 3. CLIMATCH (Australian Bureau of Rural Sciences 2010) source map showing weather stations selected as source locations (red) and non-source locations (blue) for *P. multiradiatus* climate matching. Source locations from GBIF (2010) and Nico et al. (2012).

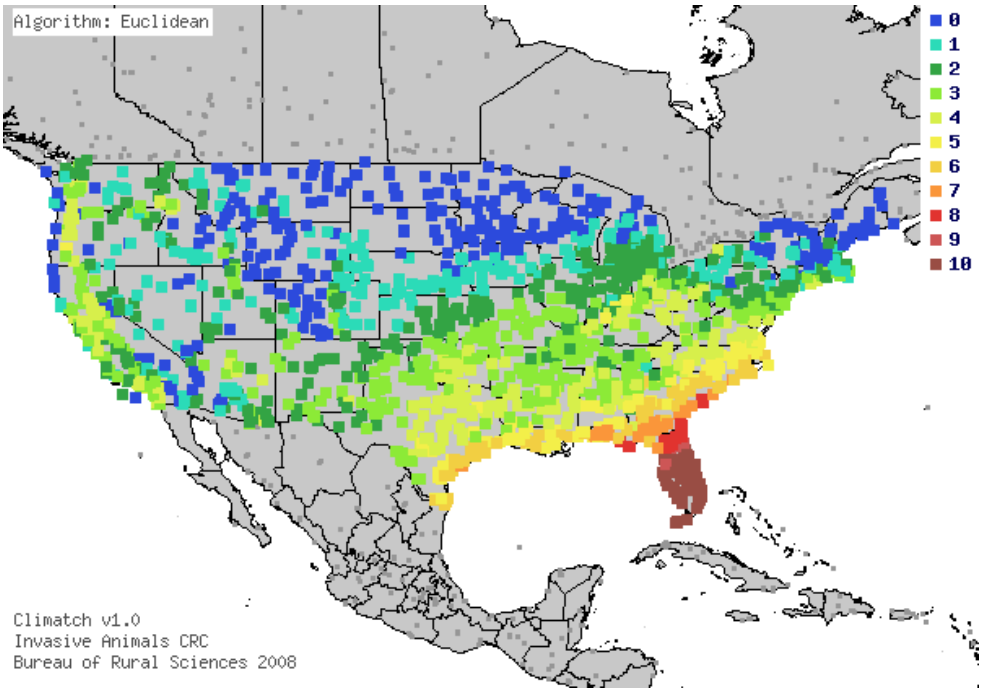

Figure 4. Map of CLIMATCH (Australian Bureau of Rural Sciences 2010) climate matches for *P. multiradiatus* in the continental United States based on source locations reported by GBIF (2010) and Nico et al. (2012). 0= Lowest match, 10=Highest match.

Table 1. CLIMATCH climate match scores

CLIMATCH Score	0	1	2	3	4	5	6	7	8	9	10
Count	320	268	406	409	269	100	73	39	22	4	69
Climate 6 Proportion = 0.105 (High)											

7 Certainty of Assessment

Information on this species is abundant, both on its biology and on the impacts caused by introduction of this species. Certainty of this assessment is high.

8 Risk Assessment

Summary of Risk to the Continental United States

P. multiradiatus is established in several U.S. locations. While ecological impacts in these locations are largely unknown, other types of negative impacts have occurred, including siltation and erosion due to tunneling by males (Nico et al. 2012). Furthermore, negative ecological impacts have been described in other invasive locations like India and the Philippines (Krishnakumar et al. 2009).

Assessment Elements

- **History of Invasiveness (Sec. 3):** High
- **Climate Match (Sec. 6) :** High
- **Certainty of Assessment (Sec. 7):** High
- **Overall Risk Assessment Category: High**

9 References

Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 10.

Australian Bureau of Rural Sciences. 2010. CLIMATCH. (http://adl.brs.gov.au:8080/Climatch/; accessed on Jan. 6, 2011).

Froese, R., and D. Pauly. Editors. 2010. FishBase. World Wide Web electronic publication. www.fishbase.org, version (03/2010). (http://www.fishbase.org/Summary/speciesSummary.php?ID=4793&genusname=Pterygoplichthys&speciesname=multiradiatus&AT=Pterygoplichthys+multiradiatus&lang=English; accessed on Jan. 6, 2011).

GBIF (Global Biodiversity Information Facility). 2010. (http://data.gbif.org/species/13538603; accessed on Jan. 6, 2011).

Global Invasive Species Database (GISD). 2010. *Pterygoplichthys multiradiatus.* Invasive Species Specialist Group (ISSG). (http://www.issg.org/database/species/ecology.asp?si=1656&fr=1&sts=sss&lang=EN; accessed on Jan. 7, 2011).

ITIS. 2012. Integrated taxonomic information system. *Pterygoplichthys multiradiatus.* (http://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=164375 (Accessed August 28, 2012).

Krishnakumar, K.; R. Raghavan, G. Prasad, A. Bijukumar, M. Sekharan, B. Pereira and A. Ali, 2009. When pets become pests – exotic aquarium fishes and biological invasions in Kerala, India. Commentary Current Science, v97, n4 (25).

Nico, L., M. Cannister, and M. Neilson. 2012. *Pterygoplichthys pardalis*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. http://nas.er.usgs.gov/queries/FactSheet.aspx?SpeciesID=769 Revision Date: 10/3/2011

Simonovic, P., V. Nikolic and S. Grujic. 2010. Amazon sailfin catfish *Pterygoplichthys pardalis* (Castellnnau, 1855) (Loricariidae, Siluriformes), a new fish species recorded in the

Serbian section of the Danube River. Biotechnol. & Biotechnol. Eq. Second Balkan Conference on Biology. Special Edition/On-line May 2010. pp. 655-660.

10 References Quoted But Not Accessed

Note: The following references are cited within quoted text within this ERSS, but were not accessed for its preparation. They are included here to provide the reader with more information.

Ajith K., C.R. Biju, C.R. and R. Thomas. 1998. LAK News. pp. 1–2.19.

Baensch, H.A. and R. Riehl. 1991. Aquarien atlas. Bd. 3. Melle: Mergus, Verlag für Natur-und Heimtierkunde, Germany. 1104 p.

Baiju, P.T. 2009. Population status of exotic catfish (*Peterygoplichthys multiradiatus*) in the feeder canals of Akku-lam Lake, Thiruvananthapuram, Kerala. M Phil dissertation, University of Kerala, p. 103.22.

Bunkley-Williams, L., E.H. Williams Jr., C.G. Lilystrom, I. Corujo-Flores, A.J. Zerbi and C. Aliaume. 1994. The South American Sailfin Armored Catfish, *Liposarcus multiradiatus* (Hancock), a New Exotic Established in Puerto Rican Fresh Waters. Caribbean Journal of Science, Vol. 30, No. 1 -2, 90-94, 1994 (Summary: Available from: http://academic.uprm.edu/publications/cjs/VOL30/P090-094.PDF [Accessed November 23, 2009])

Capps, K.A., A.S. Flecker, and R.Rodiles-Hernández. 2009. COS 45-8: Exotic fishes alter nutrient dynamics in tropical streams. 93rd ESA Annual Meeting Summary: Available from: http://eco.confex.com/eco/2009/techprogram/P16502.HTM [Accessed November 23, 2009]

Chavez, J.M., R.M. De La Paz, S. K. Manohar, R.C. Pagulayan, J.R. Carandang VI. 2006. New Philippine record of South American sailfin catfishes (Pisces: Loricariidae). Zootaxa (1109), pp. 57-68.

Cohen, K. 2008. Gut content and stable isotope analysis of exotic suckermouth catfishes in the San Marcos River, TX: A concern for spring endemics? Masters Thesis, Texas State University – San Marcos.

Cook-Hildreth, S.L. 2009. Exotic Armored Catfishes in Texas: Reproductive Biology, and Effects of Foraging on Egg Survival of Native Fishes (*Etheostoma fonticola*, Endangered and *Dionda diabolic*, Threatened). Masters in Science Dissertation. Texas State University – San Marcos. 63 pp.

Courtenay, W. R., Jr. 1989. Exotic fishes in the National Park System. Pages 237-252 in L. K. Thomas, editor. Proceedings of the 1986 conference on science in the national parks, volume 5. Management of exotic species in natural communities. U.S. National Park Service and George Wright Society, Washington, D.C.

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(3):145-159.

Courtenay, W.R., Jr., D.A. Hensley, J.N. Taylor, and J.A. McCann. 1984. Distribution of exotic fishes in the continental United States. Pages 41-77 in W. R. Courtenay, Jr., and J. R. Stauffer, Jr., editors. Distribution, biology and management of exotic fishes. Johns Hopkins University Press, Baltimore, MD.

Devick, W.S. 1988. Disturbances and fluctuations in the Wahiawa Reservoir ecosystem. Project F-14-R-12, Job 4, Study I. Division of Aquatic Resources, Hawaii Department of Land and Natural Resources. 48 pp.

Devick, W.S. 1989. Disturbances and fluctuations in the Wahiawa Reservoir ecosystem. Project F-14-R-13, Job 4, Study I. Division of Aquatic Resources, Hawaii Department of Land and Natural Resources. 30 pp.

Devick, W.S. 1991. Patterns of introductions of aquatic organisms to Hawaiian freshwater habitats. Pages 189-213 in new directions in research, management and conservation of Hawaiian freshwater stream ecosystems. Proceedings of the 1990 symposium on freshwater stream biology and fisheries management, Division of Aquatic Resources, Hawaii Department of Land and Natural Resources.

Edwards, R.J. 2001. New additions and persistence of the introduced fishes of the upper San Antonio River, Bexar County, Texas. Texas Journal of Science, 53, 3-12.

Fernandes, M.N., Perna, S.A. and S.E. Moron. 1998. Chloride cell apical surface changes in gill epithelia of the armoured catfish *Hypostomus plecostomus* during exposure to distilled water. J. Fish. Biol. , 52,844–849.23.

Fuller, P.L., Nico, L.G. and J.D. Williams. 1999. Nonindigenous fishes introduced into inland waters of the United States. American Fisheries Society, Bethesda, MD.

Guzman, A.F. and S. Barragan. 1997. Presencia de bagre Sudamericano (Osteichthyes: Loricariidae) en El Río Mezcala, Guerrero, México. Vertebrata Mexicana, 3, 1-4.

Hoover, J.J., K.J. Killgore, and A.F. Cofrancesco. 2004. Suckermouth catfishes: Threats to aquatic ecosystems of the United States? Aquatic Nuisance Species Research Program Bulletin, 4 (1).

Hossain, M.Y., M.M. Rahman, Z.F. A.J. Ohtomi, A.B.M.S. Islam. 2008. First record of the South American sailfin catfish *Pterygoplichthys multiradiatus* in Bangladesh. Journal of Applied Ichthyology. 24(6). DEC 2008. 718-720.

Krishnakumar, K., 2008. Masters of Science thesis, Mahatma Gandhi University, Kottayam, p.56.21.

Liang, S.H., H.P. Wu and B.S. Shieh. 2005. Size structure, reproductive phenology, and sex ratio of an exotic armored catfish (*Liposarcus multiradiatus*) in the Kaoping River of southern Taiwan. Zool. Stud. 44(2):252-259.

Loftus, W.F., and J.A. Kushlan. 1987. Freshwater fishes of southern Florida. Bulletin of the Florida State Museum of Biological Science 31(4):255.

Lopez, H.L., R.C. Menni and A.M. Miguelarena. 1987. Lista de los peces de agua dulce de la Argentina. Biologia Acuatica No. 12, 50 p. (Instituto de Limnologia "Dr. Raul A. Ringuelet").

Ludlow, M.E., and S.J. Walsh. 1991. Occurrence of a South American armored catfish in the Hillsborough River, Florida. Florida Scientist 54(1):48-5.

Mendoza, R.E., B. Cudmore, R. Orr, S.C. Balderas, W.R. Courtenay. P.K. Osorio. N. Mandrak, P.A. Torres, M.A. Damian, C.E. Gallardo, A.G. Sanguines, G. Greene, D. Lee, A. Orbe-Mendoza, C.R. Martinez, and O.S. Arana. 2009. Trinational Risk Assessment Guidelines for Aquatic Alien Invasive Species. Commission for Environmental Cooperation. 393, rue St-Jacques Ouest, Bureau 200, Montréal (Québec), Canada. ISBN 978-2-923358-48-1.

Mundy, B.C. 2005. Checklist of the fishes of the Hawaiian Archipelago. Bishop Museum Bulletins in Zoology. Bishop Mus. Bull. Zool. (6):1-704.

Nico, L. 2006. ***[Note: Original reference has been updated online; new reference is Nico et al. 2012 below.]***

Nico, L.G., H.L. Jelks, and T. Tuten. 2009. Non-Native Suckermouth Armored Catfishes in Florida: Description of Nest Burrows and Burrow Colonies with Assessment of Shoreline Conditions. Aquatic Nuisance Species Research Program Bulletin 9(1): 1-30.

Nico, L. and Fuller, P. 2010. *Pterygoplichthys disjunctivus*. USGS Nonindigenous Aquatic Species Database, Gainesville, FL. (http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=767)

Nico, L.G. and Martin R.L. 2001. The South American suckermouth armored catfish ... fish introductions in the American Southwest The Southwestern Naturalist, 46, 98-104.

Page, L.M. 1994. Identification of sailfin catfishes introduced to Florida. Florida Scientist 57(4):171-172.

Page, L.M. and B.M. Burr, 1991. A field guide to freshwater fishes of North America north of Mexico. Houghton Mifflin Company, Boston. 432 p.

Page, L.M. and Robins, R.H. 2006. Identification of Sailfin Catfishes (Teleostei: Loricariidae) in Southeastern Asia. The Raffles Bulletin of Zoology, 54, 455-457.

Pereira, B., G. Prasad. K. Krishnakumar, A. Ali, and R. Raghavan. 2008. BIOCAM 2008: International Conference on Bio-diversity Conservation and Management. Cochin University of Science and Techno-logy, Kochi, 2008, Abstract No. CMB 30.

Raghavan, R., G. Prasad, A. Ali, and B. Pereira. 2008. Exotic fish species in a global biodiversity hotspot: observations from River Chalakudy, part of Western Ghats, Kerala, India. Biol. Inv. v10, n1, 37–40.20.

Riehl, R. and H.A. Baensch, 1991. Aquarien Atlas. Band. 1. Melle: Mergus, Verlag für Natur- und Heimtierkunde, Germany. 992 p.

Riehl, R. and H.A. Baensch, 1996. Aquarien Atlas, Band 1. 10th edition. Mergus Verlag GmBH, Melle, Germany. 992 p.

USFWS. 2005. ***[Source material did not give full citation for this reference.]***

Wakida-Kusunoki, A.T.; R. Ruiz-Carus; E. Amador-del-Angel. 2007. Amazon sailfin catfish, *Pterygoplichthys pardalis* (Castelnau, 1855) (Loricariidae), another exotic species established in southeastern Mexico. Southwestern Naturalist. 52(1). MAR 2007. 141-144.

Yamamoto, M.N. and A.W. Tagawa, 2000. Hawai'i's native and exotic freshwater animals. Mutual Publishing, Honolulu, Hawaii. 200 p.