Mozambique Tilapia (*Oreochromis mossambicus*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, April 2011
Revised, August 2014, July 2015, February 2018, March 2018
Web Version, 4/9/2018


1 Native Range and Status in the United States

Native Range
From Froese and Pauly (2018):

“Africa: Lower Zambezi, Lower Shiré and coastal plains from Zambezi delta to Algoa Bay. Occurs southwards to the Brak River in the eastern Cape and in the Transvaal in the Limpopo system [de Moor and Bruton 1988].”

Froese and Pauly (2018) list *Oreochromis mossambicus* as native to Botswana, Lesotho, Malawi, Mozambique, South Africa, Swaziland, and Zimbabwe.
From Russell et al. (2012):

“The natural distribution of *O. mossambicus* in Africa is somewhat confused because of its wide translocation but is generally thought to be restricted to eastward-flowing streams extending from the lower Zambezi River and its delta and the lower Shire River southwards to Algoa Bay and the Bushmans River (Jubb 1974; Pullin and Lowe-McConnell 1980; Shelton and Popma 2006; Trewavas 1983). Populations also exist in the Hunyani and Shangani Rivers and the middle Zambezi River drainage but whether these are native or introduced is unclear (Jubb 1974; Shelton and Popma 2006).”


CABI (2018) also lists *O. mossambicus* as native in East Timor, Jordan, Kenya but these locations are thought to be errors since they are outside the native range indicated by all other sources (Cambray and Swartz 2007; Russel et al. 2012; Froese and Pauly 2018; GSID 2018).

**Status in the United States**

From Nico and Neilson (2018):

“Established or locally established in seven states including Arizona, California, Colorado, Florida, Hawai, Idaho, and Texas. Formerly considered locally established but no longer extant in Georgia, Montana, and North Carolina. Reported from Alabama, Illinois, and New York.”

“This species was stocked annually by the Alabama Department of Conservation and Auburn University in lakes and farm ponds in Alabama during the late 1950s and 1960s (Rogers 1961; Smith-Vaniz 1968), but such stockings reportedly have not been carried out for some time now (Wieland et al. 1982). Boschung (1992) reported Mozambique tilapia from Pickwick Lake in the northwestern part of the state. However, Mettee et al. (1996) did not mention the species as still occurring in Alabama. The species was introduced into several agricultural drains and mitigation ponds in Arizona near Yuma, Yuma County, and has been considered established in the state since the early 1960s (Hoover and St. Amant 1970; Hoover 1971; Minckley 1973; Courtenay et al. 1986). The species also occurs and is established in the Colorado River drainage, mainly the Gila River, from Phoenix to just north of Yuma (Minckley 1973; Lee et al. 1980 et seq.; Courtenay and McCann 1981; Barrett 1983; Grabowski et al. 1984; Courtenay et al. 1986). Populations established at Warm Springs on the San Carlos River, in Gila and Grahm counties, and in the Salt River in Tempe, Maricopa County, reportedly were destroyed by floods (Minckley 1973). Populations are established in Bill Williams National Wildlife Refuge and in springs in The Nature Conservancy's Ramsey Canyon Preserve in the Huachuca Mountains (USFWS 1997, 2005). The first record of this species in California was that of a population found in a small pond and its tributary near the Hot Mineral Spa on the east side of the Salton Sea near Niland, Imperial County, on 3 January 1964; more than 5,000 tilapia in the pond were killed with rotenone in an eradication attempt (St. Amant 1966). The species is now broadly established in the southern part of the state and has been in the Santa Ana, San Gabriel, and Los Angeles rivers since 1974 (St. Amant 1966; Hoover and St. Amant 1970; Moyle 1976; Knaggs 1977; Lee et al. 1980 et seq.; Shapovalov et al. 1981; Courtenay et al. 1984, 1991; Grabowski et al. 1984; Courtenay and Robins 1989; Swift et al. 1993). Two specimens were taken from Lake
Success in the San Joaquin Valley, Tulare County, in 1989 (Heyne et al. 1991). This species is also established in Riverside and Imperial Counties (Shapovalov et al. 1981). The species was found to be locally established in high-altitude, warmwater ponds in Colorado in the Upper Rio Grande River system in Conejos County, in 1977. These fish had escaped from a local farm where they were being cultured for food in warm artesian waters at a 7,500-ft elevation (Zuckerman and Behnke 1986). They are established in the San Luis Valley, Alamosa County (Courtenay et al. 1986). The Mozambique tilapia was first introduced into and became established in Florida in Dade County during the 1960s (Courtenay and Stauffer 1990). It is now established or has been reported in five counties including Brevard, Dade, Indian River, Palm Beach, Lee and possibly Hillsborough (Ogilvie 1969; Courtenay et al. 1974, 1984, 1986, 1991; Hogg 1976a, 1976b; Courtenay and Hensley 1979; Courtenay and McCann 1981; Dial and Wainright 1983; Loftus and Kuslanski 1987; Charlotte Harbor NEP 2004). Reports of this species from Six-Mile Creek, Hillsborough County (Courtenay et al. 1974), were probably based on misidentifications of O. aureus (Courtenay and Hensley 1979). It has also been collected in Everglades National Park (Tilmant 1999). Specimens have been reported the Everglades drainage (Hogg 1976[b][]). Individuals of this species were released into a pond in Georgia near Athens, but failed to survive (Dahlberg and Scott 1971b). It was indicated that this tilapia may be established in golf course ponds on Sea Island and St. Simons Island, Glynn County (Courtenay and Hensley 1979; Courtenay et al. 1986); however, O. mossambicus was not collected on St. Simons Island during 1980 sampling efforts and as of 1992 the Georgia Department of Natural Resources had concluded that this species was no longer present in state open waters (Gennings, personal communication). This species is established and has large populations in many streams, estuaries, low wetlands, and reservoirs or ponds of Hawaii; it is found on all the major islands including Oahu, Kauai, Maui, Hawaii, and Molokai (Brock 1960; Maciolek 1984; Randall 1987; Devick 1991a, 1991b; Bishop Museum 2000; Coles 1999). It is established in Pu’uhonua o Honaunau National Historical Park (Courtenay 1989; B. Farm, personal communication; Tilmant 1999). A reproducing population was found in Idaho in Barney Hot Springs and at the upper end of Barney Creek in Custer County, Little Lost River Valley, in September 1985 (Courtenay et al. 1987). The species was listed by Idaho Fish and Game (1990) as being introduced into and confined to geothermal waters of the Snake River below Shoshone Falls. A red hybrid of this species, possibly a cross between O. mossambicus and O. urolepis, was found in thermally heated sections of the Bruneau River near Bruneau Hot Springs, Owyhee County, after it had escaped from a local aquaculture facility (Courtenay et al. 1987; Courtenay and Stauffer 1990). This species was introduced into ponds in Illinois, probably during the early 1960s, but there was no evidence of overwintering (Smith 1965). Specimens were reported in Arrowhead [sic] Pond, Allerton Park of the University of Illinois near Monticello and were taken indoors over the winter (Courtenay et al. 1986). Four specimens were taken from a high-altitude, thermal spring fed pond of the Pend Orielle drainage in Montana in Bearmouth, Granite County, during 1962-1963 surveys (Brown and Fox 1966), but the pond habitat was later destroyed during highway construction (Brown 1971; Courtenay et al. 1986). In North Carolina, the species was introduced into and temporarily established in the Julian Reservoir (formerly Skyland Lake) in French Broad-Tennessee drainage, south of Asheville, Buncombe County, in 1965 (Courtenay and Hensley 1979), but that population reportedly did not survive beyond the early 1970s (Courtenay et al. 1986). There are unconfirmed reports that this species was introduced into Hyco Reservoir, Roanoke River drainage, in Person and Caswell counties (Menhinick 1991, but see Crutchfield 1995). In New York, a single adult fish was seized by state personnel from Hall's Pond in Hall's
Pond Park, West Hempstead, Nassau County, in the summer of 1976 (Briggs, personal communication). Probably in reference to the same collection, the species was reported as having been collected in the state by Lee et al. (1980 et seq.). This species has been found in Texas in the headwaters of the San Antonio River within the San Antonio Zoo, in Bexar County, since the late 1950s; the first specimen-based record was of a juvenile fish trapped in the San Marcos River in San Marcos, Hays County, in 1959 (Brown 1961). Populations of this species have been identified from several areas along the Balcones fault zone, including tributaries of the San Antonio River within and near the San Antonio Zoo; at the Spring Lake headwaters and in the vicinity of the state fish hatchery of the San Marcos River; and in Canyon Reservoir on the Guadalupe River (Brown 1961; Hubbs et al. 1978, 1991; Muoneke 1988; Howells 1991, 1992a, 1992b).

*Oreochromis mossambicus* has been introduced to Puerto Rico to control algae (Erdsman 1984). It has been reported from mangrove lagoons, creeks, and bays on both eastern and western portions of the island (Burger et al. 1992), and from other non-specific locations (Lee et al. 1983). […]"

From Russell et al. (2012):

“Canonico et al. (2005) reported that a *O. mossambicus* X *O. urolepis hornorum* hybrid, a popular aquaculture species in the Americas, is established in the wild with a large self-sustaining population in the Salton Sea (Costa-Pierce and Riedel 2000). *Oreochromis mossambicus* and *O. u. hornorum* hybrids are also reported to be established in other parts of the United States (Costa-Pierce 2003).”

From Froese and Pauly (2018):

“Introduced into freshwater ponds [in the U.S. Virgin Islands] [Ogden et al. 1975].”

“Introduced and is quite abundant in the swampy areas of Aunu'u Island [American Samoa] [Wass 1984]. Also [Welcomme 1988].”

“Well established in all the major islands of Hawaii. […] Also [Frimodt 1995; Mundy 2005].”

GISD (2018) lists *Oreochromis mossambicus* as alien and established in American Samoa, Guam, Northern Mariana Islands (Pagan and Saipan islands), Puerto Rico, Hawaii, California, and Arizona,

From GISD (2018):

“Mozambique tilapia (*Oreochromis mossambicus*) aquaculture is restricted to southern California below the Tehacapi Mountains in San Bernadino, Los Angeles, Orange, Riverside, San Diego and Imperial counties [Costa-Pierce 2003].”
Means of Introductions in the United States
From Nico and Neilson (2018):

“Similar to *O. aureus*, this species has been introduced for a wide variety of reasons. Most introductions have been the result of intentional stockings for aquatic plant control by state and federal agencies and private companies, but introductions have also come about from stockings for potential use of the species as an insect control agent (e.g., to control mosquitoes and chironomids), as a sport fish, as a bait fish, and as a food or commercial fish, and through aquarium releases; the species also has been introduced through releases or escapes from fish farms, hatcheries, and zoos (Shapovalov et al. 1981; Dial and Wainright 1983; Courtenay et al. 1984, 1986; Grabowski et al. 1984; Courtenay and Stauffer 1990). This species was brought to Hawaii from Singapore in a small shipment of fish in 1951 (Brock 1960; Maciolek 1984; Randall 1987). The Mozambique tilapia was introduced with the expectation that it would be useful for aquatic plant control in irrigation systems, as a food fish, as a sport fish, and as live bait for tuna fishing (Brock 1960); results were only partially successful (Randall 1987). In California, introductions resulted from escapes or releases from fish farms and from intentional stocking by the state (Shapovalov et al. 1981). The Mozambique tilapia's initial introduction into Dade County, Florida, is believed to have been the result of escapes or releases from aquarium fish farms that cultured the species in the 1960s (Courtenay and Stauffer 1990). In some areas of Florida, this species may have been introduced by local anglers to create a commercial fishery (Dial and Wainright 1983), or intentionally stocked by aquarists (Courtenay and Stauffer 1990). In New York, introduction was probably due to aquarium release (Briggs, personal communication). In Texas, this species was introduced as a result of escapes from the San Antonio Zoo in 1956 and also from state and federal hatcheries during the late 1950s and early 1960s (Brown 1961; Courtenay and McCann 1981). Sources and reasons for many of the introductions have been reviewed by Courtenay and McCann (1981), Wieland et al. (1982), and Courtenay and Stauffer (1990).”

From GISD (2018):

“Mozambique tilapia (*Oreochromis mossambicus*) were introduced to Puerto Rico to control algae.”

Remarks
From Nico and Neilson (2018):

“Some records of this species apparently are based on incorrect identifications. For instance, recent electrophoretic evidence indicated that populations in the San Marcos River and in Canyon Reservoir were *O. mossambicus* x *O. aureus* hybrids (Howells 1991, 1992b). With the aid of W. Smith-Vaniz, we examined preserved juveniles catalogued as *O. mossambicus* from the San Marcos River (TCWC 2073.01) and determined them to be *O. aureus* based on their caudal fin patterns and scale and gill raker counts. Some California records of this species may actually be those of *O. urolepis* (= *O. hornorum*) or of hybrids between *O. mossambicus* and *O. urolepis* (Swift et al. 1993). […] *Oreochromis mossambicus* has largely replaced redbelly tilapia *Tilapia zillii* in the Salton Sea and possibly other areas in southern California (Swift et al. 1993).”
“Electrofishing was an effective way to remove adults from a population during a project in Australia, but the removal was met with questionable success because the number of juveniles greatly increased as the adult numbers decreased (Thuesen et al. 2011).

Bowen (1980) suggested that different detrital nonprotein amino acid concentrations may help to explain variable establishment success and growth of O. mossambicus.”

From Cambray and Swartz (2007):

“Threatened by hybridization with the rapidly spreading Oreochromis niloticus. […] Hybridization is already occurring throughout the northern part of the species' range, with most of the evidence coming from the Limpopo River system. […] The species is therefore assessed as Near Threatened.”

From Russell et al. (2012):

“Since tilapiine species have diverged from a relatively recent marine ancestor (Laurent and Jean-François 1995), some representatives of the group can hybridise and produce viable progeny. For example, hybridisation of O. mossambicus with O. aureus has been undertaken for aquaculture to improve cold tolerance (Cnaani et al. 2000), while crosses with genetically improved O. niloticus showed average positive heterosis for biomass gain (Kamal and Mair 2005). Hybridisation of O. mossambicus with O. hornorum can also lead to the production of all male progeny which are better suited for intensive aquaculture (Lovshin 1982). Many O. mossambicus populations established outside of their natural range are not of a ‘pure’ strain, but are rather hybrids.”

From GISD (2018):

“Outside of Asia exotic tilapia fishes were not imported directly from Africa, but arrived as transits from third or fourth party sources. Founder populations may be morphologically and meristically distinct in Africa but are still reproductively compatible due to their recent divergence (Costa-Pierce, 2003).”

“The hybrids that are commercially cultured are tetrahybrids derived from O mossambicus × O. urolepis hornorum × O. niloticus × O. aureus [Jory et al. 1999].”

From Froese and Pauly (2018):

“[…] breeds with O. andersonii [Jackson 1961; Okeyo 2003].”
2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing
From Eschmeyer et al. (2018):

Preussischen Akademie der Wissenschaften zu Berlin 1852; […]] Zambezi River, Mozambique
[East Africa]. Syntypes: BMNH [ex Peters] 1861.5.2.58-59 (2), FMNH 54267 [ex CM 2898] (2)
Mozambique; ZMB 2805-06 (2, 1), 16035 (3), 31564 (15). Type catalog: Ibarra & Stewart
1987:24 […]. •Valid as Tilapia mossambica (Peters 1852) -- (Lee et al. 1980:774 […], Uyeno &
 […], Ye in Pan et al. 1991:415 […]). •Valid as Sarotherodon mossambicus (Peters 1852) --
(Pethiyagoda 1991:236 […], Indra 1991:242 […]). •Valid as Oreochromis mossambicus (Peters
Fricke 1999:362 […], Rema Devi & Raghunathan 1999[a]:158 […], Rema Devi & Raghunathan
 […], Raju Thomas et al. 2000:444 […] as mossambica, Allen et al. 2000:159 […] as
mossambica, Arunachalam et al. 2001:129 […] as mossambica, Sakai et al. 2001:102 […],
 […], Page et al. 2013:156 […], Gurung et al. 2013:4885 […] as mossambica, Barriga S.
2014:59 […], Fricke et al. 2014:111 […], Jiménez-Prado et al. 2015:337 […] as mossambica,
Pseudocrenilabrinae.”
From ITIS (2018):

“Kingdom Animalia
  Subkingdom Bilateria
    Infrakingdom Deuterostomia
      Phylum Chordata
        Subphylum Vertebrata
          Infraphylum Gnathostomata
            Superclass Actinopterygii
              Class Teleostei
                Superorder Acanthopterygii
                  Order Perciformes
                    Suborder Labroidei
                      Family Cichlidae
                        Genus Oreochromis
                          Species Oreochromis mossambicus (Peters, 1852)”

Size, Weight, and Age Range
From Froese and Pauly (2018):

“Maturity: Lm 15.4, range 6 - 28 cm
Max length: 39.0 cm SL male/unsexed; [Wohlfarth and Hulata 1983]; common length: 35.0 cm TL male/unsexed; [Frimodt 1995]; max. published weight: 1.1 kg [IGFA 2001]; max. reported age: 11 years [Noakes and Balon 1982]”

From Nico and Neilson (2018):

“Size: 40 cm SL (Skelton 1993).”

From Masterson (2007):

“The maximum size of the Oreochromis mossambicus tends to vary based on its geographical location. Collections from within the native range indicate a maximum size of around 430 mm, while animals in the Gulf of Mexico measured a maximum of 360mm (Bruton and Allanson 1974, Lee et al, 1980).”

From Tachihara and Obara (2003):

“The maximum age of males was observed as 8.5 years and females 14 years [on Okinawa Island, Japan]. […] The maximum ages in different populations of O. mossambicus varied with locality. The normal maximum age of the Genka population in both sexes (ca. 8 years) is reduced compared to that of the native South African population (11 years). It is similar to those of other introduced populations in tropical regions such as Egypt (7 years) and Lake Kariba (8 years) [Noakes and Balon 1982] and longer than populations in Australia (3 years) [Arthington and Milton 1986] and in temperate regions such as Hong Kong (4 years) [Noakes and Balon 1982].”
From Lintermans et al. (2007):

“The Mozambique mouthbrooder is a moderate-sized fish that attains a maximum total length of approximately 500 mm and 3 kg (Skelton 2001), but it is often much smaller and is known to form populations of stunted individuals with early sexual maturity (3 months, 50 mm TL).”

Environment
From Froese and Pauly (2018):

“Freshwater; brackish; benthopelagic; amphidromous [Riede 2004]; depth range 1 - 12 m [Bruton and Boltt 1975]. […] 17°C - 35°C [assumed to be recommended aquarium temperature range] [Philippart and Ruwet 1982]; […]”

From Russell et al. (2012):

“Having evolved from a marine ancestor, *O. mossambicus* are considered to be one of the most saline tolerant of all the tilapiine species, tolerating salinities between 0 and 120‰ (Costa-Pierce and Riedel 2000; Myers 1938; Philippart and Ruwet 1982; Trewavas 1983; Whitfield and Blaber 1979).”

“*Oreochromis mossambicus* tolerates wide fluctuations in salinity, however, the species does not readily exploit open estuarine and near-shore marine areas.”

“In an experimental study, Stauffer (1986) found the preferred [water] temperatures of *O. mossambicus* acclimated to freshwater was 32.2°C which was significantly lower than the final preferred temperatures of fish acclimated at either 15 or 30‰ salinity. In freshwater, *O. mossambicus* experienced osmoregulatory collapse at 15°C (Smit et al. 1981) and lapsed into a secondary chill coma at 11°C (Allanson et al. 1971). *Oreochromis mossambicus* resident in areas of higher salinity appear to be able to tolerate lower temperatures. […] In laboratory studies, Allanson et al. (1971) found that *O. mossambicus* exposed to 11°C in 5‰ seawater did not lapse into a secondary chill coma nor did they display any drops in serum ionic concentrations.”

“*Oreochromis mossambicus* are tolerant of very low dissolved oxygen levels (e.g. <1 mg L⁻¹), at least for short periods, and they can apparently supplement their oxygen requirements by ‘gulping’ air at the water surface (Maruyama 1958).”

“*Oreochromis mossambicus* show considerable tolerance to both high and low pH, with Murthy et al. (1981) reporting an upper lethal alkaline limit of pH 10.3 and a lower lethal acidic limit of pH 3.7. Sampath et al. (1991) reported that *O. mossambicus* could withstand ammonia concentrations of 3 mg L⁻¹ without any significant adverse impact on food uptake or growth. The 96 h LC₅₀ for ammonia was 32 mg L⁻¹ and at concentrations below 14 mg L⁻¹ they found 100% survival (Sampath et al. 1991).”
From Masterson (2007):

“Mozambique tilapia was found to have a lower lethal limit of 9.5°C under laboratory conditions (Shafland and Pestrak 1982). Trewavas (1983) similarly reported that *Oreochromis mossambicus* does not tolerate temperatures below 10°C. This temperature limits its distributional range, although some studies suggest the species may exploit thermal refuges similar to other cichlids such as the blue tilapia, *O. aureus*, to move somewhat further north (Hubbs et al. 1978).”

From Lintermans et al. (2007):


**Climate/Range**

From Froese and Pauly (2018):

“Tropical; […]: 13°S - 35°S, 180°W - 180°E”

**Distribution Outside the United States**

Native

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Froese and Pauly (2018) list *Oreochromis mossambicus* as introduced to Algeria, Angola, Benin, Congo, Democratic Republic of Congo, Egypt, Kenya, Madagascar, Namibia, Réunion, Seychelles, Tanzania, Tunisia, Uganda, Andaman Island, Bangladesh, Cambodia, China, Hong Kong, India, Indonesia, Japan, Jordan, Laos, Malaysia, Maldives, Myanmar, Nepal, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Taiwan, Thailand, Timor-Leste, Turkey, Vietnam, Yemen, Russia, Antigua Barbuda, Bahamas, Barbados, Costa Rica, Cuba, Dominican Republic, El Salvador, Grenada, Guadeloupe, Guatemala, Haiti, Honduras, Jamaica, Martinique, Mexico, Netherland Antilles, Nicaragua, Panama, St. Lucia, Trinidad Tobago, Australia, Caroline Island, Cook Islands, Fiji, French Polynesia, Kiribati, Micronesia, Nauru, New Caledonia, Niue, Papua New Guinea, Samoa, Solomon Islands, Tahiti, Tonga, Vanuatu, Wallis Futuna, Bolivia, Brazil, Colombia, Guyana, Peru, Suriname, and Venezuela.

Froese and Pauly (2018) list *Oreochromis mossambicus* as introduced but not established in Cote d’Ivoire, Israel, South Korea, France, Malta, Argentina, and Ecuador.

From Froese and Pauly (2018):

“Introduction to north Egypt considered a complete failure [Philippart and Ruwet 1982].”

“Known from the lower course of the Ramisi River [Kenya] [Seeger et al. 2003]. Also reported from the lower Athi [Thys van den Audenaerde 1988] and the Tana River [Whitehead 1959], although this is probably at least part *O. spilurus spilurus* [Trewavas 1966].”


“Introduced to Lake Otjikoto, near Tsumeb [Namibia], where its population is still increasing [Agenbag 1998]. Known from Lower Orange, Interior [Hay et al. 1999] and Fish River [Hay 1991]. Present in all major state dams: Hardap, Naute, Omatako, Otjiwerero, Swakoppoort and Von Bach [Hay et al. 1999; Okeyo 2003], and the Cuvelai system (Omuramba Omatako and Owamboland); also collected from Goreangab Reservoir (Windhoek) [Okeyo 2003]. […] First introduced into Namibia from the Cape in 1947 for angling/sport [Schrader 1985; Okeyo 2003]. Distribution in Namibian ephemeral rivers sporadic and depends on good rains [Okeyo 2003]. Also [Trewavas 1983; Skelton 1993; Okeyo 2000, 2005].”

“Successfully introduced to Mwadingusha, Koni and Nzilo [Tanzania].”

“Widely cultured in ponds and rice paddies [in Bangladesh] [Haroon 1998]. Due to overcrowding of stunted tilapia in ponds, few reach marketable size and hence culture was

“Known from the Mekong basin [Cambodia] [FAO 1996]. Also [FAO 1993, 1997[a]].”

“Established in brackish and marine coastal waters and in the rivers of the central and southern provinces [China] [Philippart and Ruwet 1982]. Recorded from the Yili river [sic] [Walker and Yang 1999]. Also [Bardach et al. 1972; FAO 1983; Welcombe 1988].”

“Well established in Plover Cove Reservoir [Hong Kong] [Hodgkiss and Man 1977; Man and Hodgkiss 1981; Lowe-McConnell 1982; Philippart and Ruwet 1982].”


“Found in virtually every body of water [in Indonesia], including ditches and stagnant pits where few other fish of value can be grown [Bardach et al. 1972]. Also [Fish 1955; Philippart and Ruwet 1982; Trewavas 1983; Welcombe 1988; FAO 1993, 1997[a]; Frimodt 1995; Costa-Pierce 2003].”

“Found in hot springs, from Hokkaido to Kyushu and Okinawa [Japan] [Masuda et al. 1984]. Also Philippart and Ruwet 1982; Japan Ministry of Environment 2005].”


“Introduced in 1985 to ponds in Janakpur [Nepal] but have not been introduced elsewhere to prevent competition with indigenous species [Shrestha 1994]. Also [Shrestha 1999]).”

“Occurs in North West Frontier Province, Punjab, Sindh and Balochistan [Pakistan] (introduced for fish culture in saline waters) [Mizra 2003]. Also [Welcombe 1988; Talwar and Jhingran 1991].”

“Well-established populations throughout the country [Singapore] [Tan and Tan 2003]. […] Also [Trewavas 1983; Welcomme 1988; Lever 1996; Tang 2004; Ng and Tan 2010; NSS Vertebrate Study Group 2014].”

“Widespread throughout the country [Sri Lanka] up to an elevation of about 1,000m. Occurs also in lagoons, where it has been found to breed in occasion. […] Recorded from a large number of reservoirs [De Silva and Chandrasoma 1980; Pet and Piet 1993; Nathaniel and Silva 1996; Wijeyaratne and Perera 2001; Amarasinghe 2002; Welianage and Amarasinghe 2003a, b]. Also [Philippart and Ruwet 1982; De Silva et al. 1984; De Silva 1985, 1988; Maitipe and De Silva 1985; Welcomme 1988; Talwar and Jhingran 1991; Shaji et al. 2000].”

“Collected from the Tsengwen estuary [Taiwan] [Kuo and Shao 1999] and from mangrove creeks in southwestern Taiwan (Pu-Tai, Pei-Men, and Syh-Tsao) [Kuo et al. 1999]. Also known from the Penghu Islands [Chen 2004]. […] First successful larviculture in Taiwan occurred in 1946 [Liao et al. 2001]. Also [Bardach et al. 1972; Philippart and Ruwet 1982; Trewavas 1983; Shaji et al. 2000].”

“Introduced [to Turkey] in the 1970s for research in aquaculture. Introduced into southern Anatolia [Çiçek et al. 2015]. Found in Koycegiz Lake [İnnal and Erk’akan 2006].”

“Present in Da River [Vietnam] [Bui et al. 2009; Nguyen et al. 2011] Also [Philippart and Ruwet 1982].”

“Known from Wadi Hajr [Yemen] [Attaala and Rubaia 2005].”

“Known from Western and Southern Australia, Victoria, New South Wales and Queensland [Native Fish Australia 2003]. Feral populations recorded from reservoirs in Brisbane area (Qld) [Appleyard and Mather 2000; Allen et al. 2002] and from freshwater and tidal creeks around Townsville [Appleyard and Mather 2000; Allen et al. 2002] and Cairns (Qld) [Allen et al. 2002], in the latter possibly an interspecific cross with O. niloticus [Appleyard and Mather 2000]. Established on the Atherton Tablelands (Qld) in the Barron (including Lake Tinaroo) and North Johnstone rivers and Western Australia in the Gascoyne-Lyons river system [Allen et al. 2002]. Also [Trewavas 1983; Welcomme 1988; Blühdorn and Arthington 1990b; Fulton and Hall 2014].”

“Well established in freshwater habitats on Yap [Nelson and Eldredge 1991].”

“Well established in freshwater habitats [in the Cook Islands] [Nelson and Eldredge 1991].”

“Known from Western and Southern Australia, Victoria, New South Wales and Queensland [Native Fish Australia 2003]. Feral populations known from the rivers Rewa, Navua, Sigatoka and Ba [Macaranas et al. 1997]. Known from Viti Levu and Vanua Levu [Andrews 1985]. Also [Lewis and Pring 1986; Welcomme 1988; Seeto and Baldwin 2010].”
“Found in rivers of Tubuaï, Mangareva, Moorea and Tahiti [Marquet 1993]. Also [Hureau 1991; Bacchet et al. 2006].”


“Well established in freshwater habitats [in Nauru] [Nelson and Eldredge 1991].”


“Well established in freshwater habitats; impressive harvests taken from Lake Tenaggano on the island of Rennell [Solomon Islands] [Nelson and Eldredge 1991].”

“Found in rivers [in Tahiti]. Also [Welcomme 1988; Marquet et al. 1997].”

“Well established in freshwater habitats; important fisheries in Lake Vaihali (Niuafo'ou Island) and the islands of Vava'u and Nomuka [Nelson and Eldredge 1991].”

“Known from Funafuti, Namumanga and Niutao [Eldredge 2000].”

“Known from Efate Island and Tanna Island [Eldredge 2000].”

“Well established in freshwater habitats on Wallis Island [Nelson and Eldredge 1991] (also [Keith and Marquet 2011]).”

“Reportedly used for aquaculture [in Suriname] [Chakalall 1993]. Known from brackish lagoons in the Bigi Pan area [Mol et al. 2000].”

“Known from the Manzanares River and its estuary [Venezuela] [Ruiz et al. 2005].”

“Introduced to open waters at Ain Skhouna [Algeria], […]. Total sites of introduction 2 and total number of introduction events 2 [Kara 2011].”
“Reportedly introduced [to Israel] in 1975 from South Africa […]. Reportedly introduced from Thailand in 1966 [Welcomme 1988]. No specimens have been reported from the local natural environment [Golani and Mires 2000].”

“Established in aquaculture [in South Korea] through unassisted reproduction. Has not established in the wild [Welcomme 1988]. Collected but not known to have established [Jang et al. 2002]. Also [FAO 1997a].”

“Introduction considered a complete failure [in Malta] [Philippart and Ruwet 1982].”

“Cultivated in several fish farms and reported in 2000 in the in-take channel of the Krasnodar electric power station [Russia]. Recorded in Kuban River [Vasil’eva 2003]. Also [Ivoilov 1992].”


“Established in fishponds and small streams in Huila Province [Costa Rica] [Lever 1996]. Also [Bardach et al. 1972].”

“Probably established in nature [in El Salvador] [Philippart and Ruwet 1982]. Also [Bowman 1975].”

“Established in natural waters [in Grenada] [Philippart and Ruwet 1982].”

“Widespread, cultivated in ponds and established in natural waters [Guatemala] [Welcomme 1981].”

“Established in natural waters [in Haiti] [Pullin and Lowe-McConnell 1982].”

“Known from Tegucigalpa and Lago de Yojoa [Honduras] [Welcomme 1981].”

“Unpopular, relegated to rivers and smaller ponds [in Jamaica] [Aiken et al. 2002]. Also [Philippart and Ruwet 1982; Trewavas 1983].”

“Introduced and established in the Lerma River basin [Mexico] [Lyons et al. 1998]. Also know from Laguna Chichancanab (Yucatan peninsula), where it was introduced in the 1980's [Fuselier 2001]. Also [Philippart and Ruwet 1982].”

“One of the most frequently encountered species in natural or semi-natural freshwater habitats in Curaçao; abundant in water basins built around the natural spring of Fontein in Aruba; reported from brackish water bays in Curaçao and Aruba [Debrot 2003]. […]”

“Established in a few impoundments [in Panama] [Welcomme 1981].”

“Established in natural waters [in St. Lucia] [Pullin and Lowe-McConnell 1982].”

“Occurs in lakes and ponds, but occasionally found in rivers such as below Hollis Reservoir and in brackish waters such as the Caroni Swamp and Fullerton Swamp [Trinidad and Tobago]. […]”

GISD (2018) lists *Oreochromis mossambicus* as alien and established in Algeria, Antigua and Barbuda, Australia, Bahamas, Bangladesh, Barbados, Benin, Bolivia, Brazil, Colombia, Congo, Cook Islands, Costa Rica, Cuba, Dominican Republic, Egypt, El Salvador, Fiji, Viti Levu Island, French Polynesia, Guadeloupe, Guatemala, Guyana, Honduras, Hong Kong, India, Indonesia, Israel, Jamaica, Japan, Gilbert Island, Kiribati, Madagascar, Malaysia, Maldives, Martinique, Mexico, Micronesia, Namibia, Nauru, New Caledonia, Nicaragua, Niue, Pakistan, Panama, Papua New Guinea, Philippines, Saint Lucia, Samoa, Saudi Arabia, Seychelles, Singapore, Solomon Islands (Malaita and Santa Ana islands), South Africa, Sri Lanka, Taiwan, Thailand, Tonga (Tongatapu Island), Tuvalu, Uganda, Vanuatu (Efate and Tana islands), Venezuela, Vietnam, and Wallis and Futuna.

GISD (2018) lists *O. mossambicus* as alien and not established in the wild in Argentina, Ecuador, Malta, Russian Federation (Kuban River), and Suriname.

GISD (2018) lists *O. mossambicus* as alien and probably not established in the wild in China, Czech Republic, Nepal, Tunisia, and the United Kingdom.

GISD (2018) lists *O. mossambicus* as alien but unknown if established in the wild in Burundi, Cambodia, Dominica, Grenada, Haiti, Kenya, South Korea, Palau, Peru, and Trinidad and Tobago.

GISD (2018) lists *O. mossambicus* as alien but only present in containment facilities in Reunion.

From GISD (2018):

“In Victoria [Australia] tilapia are only found in Hazelwood Pondage, which is a waterway heated by the effluent cooling water from a power station [Wager and Jackson 1993].”

“Mozambique tilapia (*Oreochromis mossambicus*) were introduced [to Jordan] for aquaculture and weed control purposes, now established in the wild through continuous restocking [FAO 2004].”

“Mozambique tilapia (*Oreochromis mossambicus*) are reported near the intake channel of Krasnodar electric power station and are cultivated in several fish farms [in the Russian Federation] [Vasileva 2003].”

CABI (2018) lists *Oreochromis mossambicus* as present and introduced in Bangladesh, Cambodia, China (Fujian, Guangdong, Guangxi, Hainan, Hong Kong, Macau, and Shandong), India, Indonesia, Israel, Japan, Republic of Korea, Kuwait, Laos, Lebanon, Malaysia (including Peninsular Malaysia), Myanmar, Nepal, Pakistan, Philippines, Saudi Arabia, Singapore, Sri Lanka, Syria, Taiwan, Thailand, Turkey, United Arab Emirates, Vietnam, Yemen, Algeria, Angola, Benin, Cameroon, Cape Verde, Congo, Democratic Republic of the Congo, Côte d’Ivoire, Egypt, Eritrea, Ethiopia, Madagascar, Namibia, Nigeria, Réunion, Rwanda, Seychelles,
Canary Islands, Sudan, Tunisia, Uganda, Canada (Alberta, British Columbia, Manitoba, Ontario), Mexico, Antigua and Barbuda, Bahamas, Barbados, Costa Rica, Cuba, Dominica, Dominican Republic, El Salvador, Grenada, Guatemala, Haiti, Honduras, Jamaica, Martinique, Netherlands Antilles, Nicaragua, Panama, Saint Lucia, Trinidad and Tobago, Argentina, Bolivia, Brazil, Colombia, Ecuador, Guyana, Paraguay, Peru, Suriname, Uruguay, Venezuela, Belgium, France, Germany, Hungary, Italy, Malta, Netherlands, Russian Federation, Spain, UK, Australia, Caroline Islands, Cook Islands, Fiji, French Polynesia, Guam, Kiribati, Micronesia, Nauru, New Caledonia, Niue, Papua New Guinea, Samoa, Solomon Islands, Tonga, Tuvalu, Vanuatu, and Wallis and Futuna Islands.

CABI (2018) lists *O. mossambicus* as present but does not give an indication of its native or introduced status in Mayotte and Senegal.

From Russell et al. (2012):

“[…] One of the first places they became established was in the Indonesian province of West Java where they acquired the common name ‘Java’ tilapia (Blaxter 2000). […]. Invasive populations of *O. mossambicus* are now widely distributed on five continents and recent records suggest that they have been successfully introduced into 94 countries, territories or regions throughout the world (Fishbase 2010). Philippart and Ruwet (1982) noted that this species was found in 13 countries in south east Asia and in 11 countries in North and South America. *Oreochromis mossambicus* are now also widespread in the South Pacific after being introduced into eight locations in Micronesia, 13 locations in Polynesia and 10 locations in Melanesia (Nelson and Eldredge 1991). They have also been introduced outside their native range in Africa including to Madagascar where they are now widespread (Canonico et al. 2005; Reinthal and Stiassny 1991). Invasive populations have also become established in Papua New Guinea (Glucksman et al. 1976) and in Australia (Bluhdorn and Arthington 1989, 1990a, b; McKay 1978).”

From Tachihara and Obara (2003):

“Fortunately, in mainland Japan, the distribution of *O. mossambicus* is restricted around hot springs in temperate areas as a result of low temperatures in the winter season [Imai 1980]. In the case of Okinawa Island, *O. mossambicus* can be found in 110 rivers (41.2% of the main water bodies investigated) [Tachihara et al. 2002] as a result of relatively higher water temperatures in winter.”

**Means of Introduction Outside the United States**

From CABI (2018):

“The Mozambique tilapia was the first tilapia to be widely distributed as a farmed fish.”

“Dispersal of the Mozambique tilapia accelerated in the 1940s and 1950s with Japanese occupiers and later post-war reconstruction efforts spreading the fish to several countries in Asia. Sixty individuals were sent from Singapore to Hawaii in 1951. Progeny of these fish were later sent to public aquariums in California and New York, who later shared further progeny with universities and resource agencies in Alabama, Arizona and California. […]”
From GISD (2018):

“The mouthbrooding habit of this species allows it to nurture and carry its young long distances to invade habitats far from the original site of introduction (Costa-Pierce, 2003).”

“Mozambique tilapia (*Oreochromis mossambicus*) were introduced to Fiji to culture for pig feed.”

From Froese and Pauly (2018):

“Translocated and introduced for aquaculture, sport fishing, stocking man-made lakes and biological control of nuisance plants and animals [de Moor and Bruton 1988].”

“Introduced [to Madagascar] in 1956 by the Forestry Service for rizipisciculture [Stiassny and Harrison 2000].”

**Short Description**

From Froese and Pauly (2018):

“Dorsal spines (total): 15 - 18; Dorsal soft rays (total): 10-13; Anal spines: 3; Anal soft rays: 7 - 12; Vertebrae: 28 - 31. Diagnosis: snout long; forehead with relatively large scales, starting with 2 scales between the eyes followed by 9 scales up to the dorsal fin [Pfeffer 1893, 1894]. Adult males develop a pointed, duckbill-like snout [Lamboj 2004] due to enlarged jaws, often causing the upper profile to become concave [Bell-Cross 1976; Trewavas 1983; Bell-Cross and Minshull 1988; Skelton 1993; Lamboj 2004], but upper profile convex in smaller specimens [Boulenger 1899; Weber 1897]. Pharyngeal teeth very fine, the dentigerous area with narrow lobes, the blade in adults longer than dentigerous area; 28-31 vertebrae; 3 anal spines; 14-20 lower gill-rakers; genital papilla of males simple or with a shallow distal notch; caudal fin not densely scaled; female and non-breeding male silvery with 2-5 mid-lateral blotches and some of a more dorsal series; breeding male black with white lower parts of head and red margins to dorsal and caudal fins [Trewavas 1983].”

“Coloration: basic melanin pattern of 2 horizontal and 6-7 vertical bars never fully realized; more commonly, at least in preserved specimens, females and sexually inactive males have no bands, but may have the intersection points of the facultative bands represented by 3-4 upper and 2-5 mid-lateral blotches, or some or all of these may be present [Trewavas 1983]. Basic body coloration silvery grey [Trewavas 1983; Lamboj 2004] to greenish grey, sometimes a more bluish colored head [Lamboj 2004]. Belly greyish [Gilchrist and Thompson 1917; Copley 1952; Bruton et al. 1982]. Spiny part of dorsal fin light with dark mottling [Pfeffer 1893]. Soft dorsal and anal, and caudal and pelvic fins blackish [Pfeffer 1893, 1894; Boulenger 1915; Gilchrist and Thompson 1917]. Pectoral fins colorless [Pfeffer 1893, 1894]. Indistinct, dark opercular spot present [Steindachner 1864; Pfeffer 1893, 1894; Boulenger 1899, 1915; Pellegrin 1904; Gilchrist and Thompson 1917]. Vertical fins uniform [Gilchrist and Thompson 1917], blackish with more or less distinct whitish spots [Günther 1862] or with large or small, fused or non-fused, dark spots on a pale background [Weber 1897; Gilchrist and Thompson 1917], given a darker aspect.
to these fins [Weber 1897]. 3 black blotches present in juveniles but possibly obscured in adults due to the dark body coloration of breeding males or old adults [Bell-Cross 1976; Bell-Cross and Minshull 1988].

Female and non-breeding male: dirty yellowish-olive [Pienaar 1978] or silvery-gray, with 2-5 mid-lateral blotches and some of a more dorsal series [Trewavas 1983; Lamboj 2004]. Sometimes a series of more or less distinct spots along the side of the body above and below the upper lateral line [Gilchrist and Thompson 1917].


From Masterson (2007):

“The blue tilapia, *Oreochromis aureus*, and the blackchin tilapia *Sarotherodon melanotheron* also occur as exotic species in Florida. They are superficially quite similar to *Oreochromis mossambicus*, but species-specific markings (e.g., the black chin of *S. melanotheron* which *O. aureus* lacks) as well as differing spine/ray counts are sufficient to differentiate the species from one another.”

**Biology**

From Froese and Pauly (2018):


“Spawns at the edge of the littoral terrace of lakes [Lowe-McConnell 1982; Trewavas 1982, 1983; de Moor and Bruton 1988], in sandy or muddy bottoms [Oliveira et al. 2005]. Displays a lek mating system; territorial males establish breeding territories where they dig spawning pits, assume a dark coloration, defend a breeding territory and actively court females; sneaking males
intrude into nests during a spawning episode, exhibiting quivering behavior which is usually an indicator of sperm release; sneaking is predominantly performed by subordinate males, which may adopt pseudo-female behavior [Oliveira et al. 2005]. Only territorial males produce sounds, during all phases of courtship but especially during the late stages, including spawning [Amorim et al. 2003]. Territorial male excavates and defends a basin-shaped pit in the center of his territory, where female deposits 100-1700(1800) eggs [Allen et al. 2002; Lamboj 2004]. Eggs and milt are sucked up by the female [Trewavas 1983; Allen et al. 2002]. Fertilization is reported to sometimes occur in the mouth of the female [Pethiyagoda 1991]. Females incubate eggs alone [Crass 1964; Lamboj 2004]. It is possible, albeit rare, that males take up some eggs after spawning [Bruton and Boltt 1975; Trewavas 1983; Arthington and Milton 1986; Lamboj 2004], but they almost always eat them soon after [Lamboj 2004]. Females school together while mouthbrooding [Holden and Bruton 1994], they cease to feed and subsist on food reserves stored in their body [Trewavas 1982]. Females may spawn a full clutch with just one male, or may spawn with several different males in a series [Lamboj 2004]. Water is circulated over the eggs by chewing movements of the jaws [Crass 1964; Pienaar 1978]. Fry hatch in the female's mouth after 3-5 days [Crass 1964; Pienaar 1978; Trewavas 1983; Allen et al. 2002; Lamboj 2004], depending on the temperature [Lamboj 2004]. The young are released from the mouth in 10-14 days, but remain near the female and enter the mouth if threatened until about 3 weeks old [Trewavas 1983; Allen et al. 2002; Lamboj 2004]. Fry and juveniles shoal in shallow water [Bruton and Boltt 1975; de Moor and Bruton 1988; Skelton 1993] where they feed during the day, and retreat to deep water at night [Lowe-McConnell 1982; de Moor and Bruton 1988]. Females raise multiple broods during a season [Bruton and Boltt 1975; Skelton 1993].”

From Russell et al. (2012):

“In Africa, Gaigher (1973) and de Pienaar (1968) demonstrated that O. mossambicus preferred quiet open pools in both perennial and annual streams and avoided rapids and other areas of swiftly flowing water. This is supported by the experimental evidence of Whitfield and Blaber (1979) who found that O. mossambicus avoid flows exceeding 370 m h$^{-1}$. The aversion of O. mossambicus for higher water velocities may in part, be due to their nest building activities which require calm, sandy areas (Jubb 1967). The growth of aquatic macrophytes and inundation of marginal terrestrial vegetation during elevated flows can provide additional shelter for O. mossambicus juveniles (Ward 1976). In African lakes where predatory tigerfish, Hydrocynus vittatus were present, young O. mossambicus utilised the vegetated littoral zones until they reached maturity and were too large to be consumed (Donnelly 1969). Donnelly (1969) noted that juvenile O. mossambicus showed a preference for shallow waters of up to 30 cm deep on gently sloping shorelines.”

“[…] In Sri Lankan reservoirs, de Silva and Sirisena (1988) noted that nests of similar sizes were usually clustered together. Males actively advertise their dominant status through urinary odorants which act as a ‘dominance’ pheromone to modulate aggression in rivals, thereby contributing to social stability within the lek (Barata et al. 2008; Frade et al. 2002; Miranda et al. 2005). A male uses the nest to attract a female in spawning condition to deposit eggs prior to external fertilisation (Fryer and Iles 1972). […] Females defend their brood aggressively against predators and conspecifics. Agonistic behaviour peaks when fry are mobile and capable of
exogenous feeding, thus ensuring that fry may forage more safely without being consumed by other larger fish (Oliveira and Almada 1998a; Oliveira and Canario 2000).

“Females usually choose males that build larger leks, display conspicuous dark black-purple colouration, produce higher levels of hormones and pheromones and have a higher gonadosomatic index (Oliveira and Almada 1996). Turner (1986) suggested that one of the costs of reproductive and territorial activity was reduced growth and that this will eventually lead to a loss of status. Oliveira and Almada (1998b) discussed evidence which showed that male territoriality was associated with an energetic cost that eventually forces males to leave their territories. Further, males can morphologically resemble females or immature fish (Oliveira and Canario 2000), allowing them to ‘sneak’ into nests during spawning episodes and fertilise the eggs of a spawning female (Oliveira and Almada 1998b). […] Oliveira and Almada (1998b) observed that even territorial males intruded into the territories of their neighbours when spawning was occurring to engage in ‘sneaking’ attempts. The presence of both ‘sneakers’ and ‘floaters’ that wander around a spawning area trying to occupy recently vacated territories was likely to result in the frequent disruption of spawning acts. […]”

“In South Africa, James and Bruton (1992) estimated that O. mossambicus in ponds can spawn up to five broods per female during a 133 day period. Riedel (1965) observed that spawning takes place every 2 months or at even shorter intervals under favourable conditions. In Sri Lanka, De Silva and Chandrasoma (1980) found that O. mossambicus in a man-made lake spawned throughout the year with four possible peak periods. In contrast, the breeding season for O. mossambicus in the Brisbane area of south-eastern Queensland only spans 6–7 months of the year, when water temperatures exceed 23°C (Arthington and Milton 1986). In the Townsville area of north-eastern Queensland, Webb (1994) found that O. mossambicus spawned for 9–10 months. Further north in the Cairns region, populations of O. mossambicus can, depending on local conditions, spawn for much, or all of the year (Russell et al. 2010, in press).”

From GISD (2018):

“Thought to be ideal pond fish, they readily produce stunted stocks when overcrowded, as has been observed on Pagan in the Northern Mariana Islands (Eldredge, 2000).”

From Lintermans et al. (2007):

“Growth of populations and individuals is often rapid. For example, from 6–8 fish released into an ornamental pond in Cairns 18 months prior to rotenone treatment, 12.5 ton of fish were removed!”

**Human Uses**

From Froese and Pauly (2018):

“Used extensively in biological, physiological and behavioural research [Skelton 1993].”

“Highly preferred food fish [in Laos] [Saphakdy and Rodger 2005].”
“Reared in fish culture with satisfactory results up to altitudes of 2400m [in Ecuador] [Philippart and Ruwet 1982].”

“By 1998 production had surpassed 2000 mt and made up more than 20% of total aquacultural production [in Venezuela].”

From GISD (2018):

“Mozambique tilapia (*Oreochromis mossambicus*) is a declared noxious pest in Queensland. It is illegal to possess, rear, sell or buy tilapia. It is also an offence to release tilapia into Queensland waterways or to use them as bait, live or dead. Penalties up to $AUS 150 000 apply.”

From Canonico et al. (2005):

“The most important tilapias in aquaculture are species in the mouthbrooding genus *Oreochromis (O. niloticus, O. mossambicus, and O. aureus)* and certain hybrids, which account for 99.5% of global tilapia production (FAO, 1997[b]).”

**Diseases**

No records of OIE reportable diseases were found for *Oreochromis mossambicus*.

From Froese and Pauly (2018):

“Fish louse Infestation 1, Parasitic infestations (protozoa, worms, etc.)
White spot Disease, Parasitic infestations (protozoa, worms, etc.)
Ichthyobodo Infection, Parasitic infestations (protozoa, worms, etc.)
Dactylogyrus Gill Flukes Disease, Parasitic infestations (protozoa, worms, etc.)
Trichodinosis, Parasitic infestations (protozoa, worms, etc.)
False Fungal Infection (*Epistyli* sp.), Parasitic infestations (protozoa, worms, etc.)
Transversotrema Infestation, Parasitic infestations (protozoa, worms, etc.)
Trichodinella Infection 1, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 1, Parasitic infestations (protozoa, worms, etc.)
Trichodina Infection 5, Parasitic infestations (protozoa, worms, etc.)
Orientocreadium Disease, Parasitic infestations (protozoa, worms, etc.)
Ichthyophthirius Disease, Parasitic infestations (protozoa, worms, etc.)
Fish Louse Infestation 3, Parasitic infestations (protozoa, worms, etc.)
Fish louse Infestation 1, Parasitic infestations (protozoa, worms, etc.)
HTRLO Disease, Parasitic infestations (protozoa, worms, etc.)
Lernaea Infestation, Parasitic infestations (protozoa, worms, etc.)
Cryptobia Infestation, Parasitic infestations (protozoa, worms, etc.)
Amyloodinium Infestation, Parasitic infestations (protozoa, worms, etc.)
Ambiphyra Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Turbidity of the Skin (Freshwater fish), Parasitic infestations (protozoa, worms, etc.)
Euclinostomum Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Fish Tuberculosis 2, Parasitic infestations (protozoa, worms, etc.)
Dolops Infestation, Parasitic infestations (protozoa, worms, etc.)
Edwardsiellosis, Bacterial diseases
Epitheliocystis, Bacterial diseases
Saccoccelioides Infection, Parasitic infestations (protozoa, worms, etc.)
Goezia Disease 2, Parasitic infestations (protozoa, worms, etc.)
Gnathostoma Disease (larvae), Parasitic infestations (protozoa, worms, etc.)
Diplodistomum Infection, Parasitic infestations (protozoa, worms, etc.)
Goezia Disease 2, Parasitic infestations (protozoa, worms, etc.)
Rhabdophona Infestation 6, Parasitic infestations (protozoa, worms, etc.)
Contracaecum Disease (larvae), Parasitic infestations (protozoa, worms, etc.)
Gnathostoma Infestation 2, Parasitic infestations (protozoa, worms, etc.)
Gnathostoma Disease (larvae), Parasitic infestations (protozoa, worms, etc.)
Spinning Tilapia Syndrome, Viral diseases
Cichlidogyrus Infestation 4, Parasitic infestations (protozoa, worms, etc.)
Cichlidogyrus Infestation, Parasitic infestations (protozoa, worms, etc.)
Cichlidogyrus Infestation 4, Parasitic infestations (protozoa, worms, etc.)
Pentastoma Infection 2, Parasitic infestations (protozoa, worms, etc.)
Velvet Disease 2 (Piscinoodinium sp.), Parasitic infestations (protozoa, worms, etc.)”

From Russell et al. (2012):

“[…] *Trichodina heterodentata*, which is known to use *O. mossambicus* as a host (Dove and O’Donoghue 2005).”

“Webb (2003) recorded 11 parasites on *O. mossambicus* in north Queensland waters, including the non-indigenous cestode *Bothriocephalus acheilognathi* and the non-indigenous monogenean *Cichlidogyrus tilapiae*.”

Poelen et al. (2014) lists *Aeromonas veronii* and *Gyrodactylus ulinganisus* as parasites of *Oreochromis mossambicus*.

**Threat to Humans**
From Froese and Pauly (2018):

“Potential pest”

**3 Impacts of Introductions**
From Russell et al. (2012):

“[…] *Oreochromis mossambicus* was directly or indirectly responsible for the disappearance of native species in Venezuela (Pérez et al. 2006a). In Central America, *O. mossambicus* and other tilapia species have been implicated in the decline of native cichlid populations in Lake Nicaragua, probably as a result of competitive displacement (McKay et al. 1995) and their presence has been related to damage to indigenous fauna in Florida and Columbia (Philippart and
The introduction of *O. mossambicus* into Laguna Chichancanab in Mexico negatively impacted on a species flock of endemic pupfish (*Cyprinodon* spp.) (Fuselier 2001) by competitively excluding them from optimal habitats, resulting in declines in the abundance in four out of the five flock members. These results were supported by both field and laboratory experiments that suggested agonistic behaviour of *O. mossambicus* towards pupfish had caused major microhabitat shifts. Fuselier (2001) also cautioned that the introduction of *O. mossambicus* may have disrupted the evolutionary mechanisms that led to the sympatric speciation of the pupfish flocks. This potentially could result in the breakdown of reproductive barriers between the recently diverged species, resulting in introgression and loss of rare phenotypes. On the Pacific island of Nauru, milkfish (*Chanos chanos*) aquaculture collapsed following the introduction of *O. mossambicus* to the island’s mangrove lined lagoons and ponds to provide a food source and to control mosquitoes (Fortes 2005). Similar observations were made where *O. mossambicus* were introduced into milkfish ponds in the Philippines thereby resulting in predation and competition for food (Philippart and Ruwet 1982). In Fiji, stream networks with populations of *Oreochromis* spp. (*O. mossambicus* and/or *O. niloticus*) that were affected by loss of forest cover had, on average, 11 fewer species of native fish than did intact systems (Jenkins et al. 2009).

“More recently Morgan et al. (2004) observed that since their introduction, *O. mossambicus* have spread rapidly throughout the Gascoyne River in Western Australia and are now the largest and most abundant fish in the system. *Oreochromis mossambicus* were observed during this study to be aggressive towards native fish when guarding their nests which, in places, covered up to 80% of the shallow, sandy river channels. Further, these authors suggested that because of this aggressive behaviour and reduced available habitat to endemic fishes through nest building, *O. mossambicus* must be impacting significantly on native fish populations especially during the dry season when the river contracts to isolated, small pools. They did not, however, quantify these impacts.

In a laboratory study investigating the impact of *O. mossambicus* on the spawning success of the native eastern rainbow-fish (*Melanotaenia splendida splendida*), the presence of breeding groups of *O. mossambicus* resulted in a decrease in both egg production and proportion of eggs fertilised by 70 and 30%, respectively (Doupé et al. 2009b). These authors observed no agonistic interactions and suggested that the results were possibly a combination of behavioural and chemical factors. Interestingly, when in the presence of a single *O. mossambicus* male, there was no negative impact on the spawning success of eastern rainbow-fish, with egg production actually increasing.”

“Doupé et al. (2010) reported that herbivory from *O. mossambicus* significantly reduced macrophyte biomass of three native Australian species (*Hydrilla verticillata*, *Ceratophyllum demersum* and *Vallisneria nana*) in controlled microcosm experiments. However, within Australia, the impact of *O. mossambicus* on macrophytes at a community scale has not been assessed. […] In an aquarium experiment Wager and Rowe-Rowe (1972) found that out of 15 aquatic plants tested, *Spirogyra* sp. was the only one eaten by *O. mossambicus*. As a result they suggested that *O. mossambicus* was not as harmful to freshwater habitat as other tilapia species (e.g. *Tilapia rendalli*).”
“There are no confirmed cases in the literature of *O. mossambicus* being responsible for outbreaks of new diseases or parasite infestations in Australian native fishes. However, a recent study of Trichodinids of freshwater fish in Australia revealed new records of the exotic species *Trichodina heterodentata*, which is known to use *O. mossambicus* as a host (Dove and O’Donoghue 2005). Some specimens of *T. heterodentata* were collected more than a 1,000 km away and on the other side of the Great Dividing Range from the nearest wild *O. mossambicus* population, suggesting the parasite may be endemic or was introduced via another source (Dove and O’Donoghue 2005). Trichodinids can result in mass mortality of fish, particularly when the fish are stressed or in high densities (Barker et al. 2002). Webb (2003) recorded 11 parasites on *O. mossambicus* in north Queensland waters, including the non-indigenous cestode *Bothriocephalus acheilognathi* and the non-indigenous monogenean *Cichlidogyrus tilapiae.*”

From GISD (2018):

“Juveniles [of *Oreochromis mossambicus*] have been documented to feed on other fish (de Moor et al. 1986).”

“In Hawai‘i, this species is suspected to be a threat to native species such as striped mullet (*Mugil cephalus*) (Randall 1987; Devick 1991). Tilapia also have been considered a major factor in the decline of the desert pupfish (*Cyprinodon macularius*) in the Salton Sea area (Courtenay and Robins, 1989; Swift et al. 1993).”

“Mozambique tilapia (*Oreochromis mossambicus*) compete with the threatened native Bahama pupfish (*Cyprinodon laciniatus*) resulting in declining abundance of these fish (Barton, 1999).”

“Mozambique tilapia (*Oreochromis mossambicus*) in the Amaravathy [India] have resulted in chages [sic] in the fish assemblage.”

“Mozambique tilapia (*Oreochromis mossambicus*) compete with the vulnerable silverside fish charal de la caldera (see *Chirostoma bartoni* in IUCN Red List of Threatened Species) that is endemic to La Alberca crater-lake [Alcocer et al. 2000].”

“Mozambique tilapia (*Oreochromis mossambicus*) compete with the native *Cyprinodon* species for habitat, resulting in declining abundance of these fish [Fuselier 2001].”

“Stocking of Mozambique tilapia (*Oreochromis mossambicus*) in ponds has resulted in a net decrease in fisheries production, due to competition with other fish species [Contreras-MacBeath et al. 1998].”

“Mozambique tilapia (*Oreochromis mossambicus*) have caused the collapse of milkfish aquaculture [in Nauru] [Adams et al. 2000].”

“The introduction of two tilapia species (*Oreochromis mossambicus* and *Sarotherodon occidentalis*) in 1955, followed by that of the largemouth bass (*Micropterus salmoides*) in 1960, has led to a decrease in numbers of galaxias (*Galaxias neocaledonicus*). These introduced species preyed on the different stages of *G. neocaledonicus* (Keith 2002).”
From Froese and Pauly (2018):

“Enhanced food security and rural development [in Myanmar] [Thame 2003].”

“Has competed aggressively for food with Mugil cephalus leading to its decrease in population [Randall 1987].”

“Poses a serious threat of genetic pollution in Kunene and Okavango rivers: breeds with O. andersonii [Jackson 1961; Okeyo 2003].”

“Compete with small indigenous fish and gradually occupy their habitats [in Bangladesh] [Barua et al. 2001; Islam et al. 2003].”

“Considered invasive [in Malaysia], their numbers growing rapidly and often displacing native species particularly in rivers and lakes [Chong et al. 2010].”

“Competes with Chanos chanos for food in brackish water farms [in the Philippines] [Juliano et al. 1989]. Caused the near extinction of the local endemic fish Mistichthys luzonensis in Lake Buhi [Kottelat and Whitten 1996].”

From Nico and Neilson (2018):

“In Hawaii, this species is suspected as a threat to native species such as striped mullet Mugil cephalus (Randall 1987; Devick 1991b). […]”

From Canonico et al. (2005):

“In Lake Alaotra [Madagascar], the progressive introductions of different species of carp first, followed by several species of tilapias in 1954 (T. rendalli), 1958 (O. macrochir), and 1961 (O. niloticus and O. mossambicus) have also induced a drastic decline of native fish (Leveque, 1997).”

“By 1990, three species of introduced tilapias (O. aureus, O. mossambicus, and O. niloticus) were being caught throughout the coastal region, including in Lake Nicaragua’s outlet on the San Juan River, the southern islands of Solentiname, and the northern shore (including isletas). In comparison with standing crop levels in the lake before tilapia introduction, and in locations where tilapias had not yet migrated, there was approximately 80% reduction of native cichlids and a 50% reduction in total cichlid biomass (including tilapias) wherever introduced tilapias were found in Lake Nicaragua (McKay et al., 1995, 1998b).”

“In Lake Chichincanab, introduced O. mossambicus competed strongly for habitat with an endemic cyprinodontid, threatening extinction (Fuselier, 2001), and was the dominant species (Schmitter-Soto and Caro, 1997).”
From Pallewatta et al. (2003:95):

“Thus, this IAS [Oreochromis mossambicus, reported under the name Sarotherodon mossambicus] has replaced some of the native inhabitant fish such as Labeo porcellus and L. dussumieri [in Sri Lanka] (Bambaradeniya et al., 2001).”

From Lintermans et al. (2007):

“The species [Oreochromis mossambicus] has been reported elsewhere to kill aquatic macrophytes while feeding on periphyton, and they may eliminate submerged and emergent macrophytes by grazing or by uprooting plants (Lahser 1967). There is little data available on competition for food between Mozambique mouthbrooder and Australian native fish species, however the diet of juvenile O. mossambicus in the Chapman River (WA) and mature fish in the Gascoyne River was dominated by detritus, while some aquatic insects are also taken (Maddern 2003; Morgan et al. 2004).”

4 Global Distribution

**Figure 1.** Known global distribution of Oreochromis mossambicus. Map from GBIF Secretariat (2018).

The location in Idaho is from a population established in hot springs (GBIF Secretariat 2018; Nico and Neilson 2018), the influence of the geothermal waters on the establishment and persistence of the population cannot be controlled for in the climate matching program (Sanders et al. 2014) so this point was not used as a source point for the climate match.
Figure 2. Known global distribution of *Oreochromis mossambicus*. Map from VertNet (2018).

Figure 3. Known distribution of *Oreochromis mossambicus* in Japan. Map from NIES (2018).

The main islands of Japan were not used as source points for the climate match as *Oreochromis mossambicus* only persists overwinter in thermal refuges (Tachihara and Obara 2003).
Figure 4. Known distribution of *Oreochromis mossambicus* in India. Map adapted from India Biodiversity Portal (No date).
5 Distribution Within the United States

Figure 5. Known distribution of *Oreochromis mossambicus* in the contiguous United States and Caribbean U.S. territories. Map from Nico and Neilson (2018).

The location in New York is from an introduction that did not result in an established population (Nico and Neilson 2018) and was not used as a source point in the climate match. The locations in Idaho and western Montana are from populations established in geothermal waters and hot springs (Nico and Neilson 2018), the influence of the geothermal waters on the establishment and persistence of the population cannot be controlled for in the climate matching program (Sanders et al. 2014) so these points were not used as source points for the climate match. The location in the middle of Montana is the result of a record with no specific location (Nico and Neilson 2018) and was not used as a source point for the climate match. The northernmost point in California is the result of a biocontrol stocking that did not result in an established population (Nico and Neilson 2018); this location was not used as a source point for the climate match. The records from Illinois are either non-specific location records or from a research population that was moved indoors in the winter (Nico and Neilson 2018). The research population does not reflect the ability of the species to establish wild populations under the full climate conditions at that location and was not used as a source point for the climate match. The locations in Alabama, Georgia, and North Carolina are all from failed introductions (Nico and Neilson 2018) and were not used as source points for the climate match. The location in northeast Texas is also the result of a failed introduction (Nico and Neilson 2018) and was not used as a source point for the climate match.

The locations in Colorado were used as source points for the climate match as the records indicated that they were established without mention of a thermal refuge (Nico and Neilson 2018).
**Figure 6.** Known distribution of *Oreochromis mossambicus* in the contiguous United States. Map from BISON (2018).

**Figure 7.** Known distribution of *Oreochromis mossambicus* in Hawaii. Map from Nico and Neilson (2018).
Figure 8. Known distribution of *Oreochromis mossambicus* in Hawaii. Map from BISON (2018).

Figure 9. Known distribution of *Oreochromis mossambicus* in Puerto Rico and the U.S Virgin Islands. Map from BISON (2018).
Figure 10. Known distribution of *Oreochromis mossambicus* in Guam and the Northern Mariana Islands. Map from BISON (2018).
6 Climate Matching

Summary of Climate Matching Analysis
The climate match for *Oreochromis mossambicus* was high in Florida and the southern Atlantic Coast, along the border with Mexico extending north into most of Texas and the southwest, most of California, and a strip from Colorado to North Dakota. The climate match was low in the Pacific Northwest, and in the east from New England down through the Appalachian Mountains and small areas of Louisiana, Mississippi, and Alabama. Everywhere else had a medium match. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous U.S. was 0.486, high. The following states had individually high climate scores: Arizona, California, Colorado, Florida, Georgia, Idaho, Michigan, Minnesota, Montana, Nebraska, Nevada, New Mexico, North Carolina, North Dakota, Oklahoma, South Carolina, South Dakota, Texas, Utah, Washington, West Virginia, Wisconsin, and Wyoming.

Figure 11. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red) and non-source locations (gray) for *Oreochromis mossambicus* climate matching. Source locations from Tachihara and Obara (2003), BISON (2018), GBIF Secretariat (2018), Nico and Neilson (2018), NIES (2018), VertNet (2018), and India Biodiversity Portal (no date).
Figure 12. Map of RAMP (Sanders et al. 2014) climate matches for *Oreochromis mossambicus* in the contiguous United States based on source locations reported by Tachihara and Obara (2003), BISON (2018), GBIF Secretariat (2018), Nico and Neilson (2018), NIES (2018), VertNet (2018), and India Biodiversity Portal (no date). 0 = Lowest match, 10 = Highest match.

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

<table>
<thead>
<tr>
<th>Climate 6: Proportion of (Sum of Climate Scores 6-10) / (Sum of total Climate Scores)</th>
<th>Climate Match Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.000 ≤ X &lt; 0.005</td>
<td>Low</td>
</tr>
<tr>
<td>0.005 ≤ X &lt; 0.103</td>
<td>Medium</td>
</tr>
<tr>
<td>≥ 0.103</td>
<td>High</td>
</tr>
</tbody>
</table>

7 Certainty of Assessment

The certainty of assessment for *Oreochromis mossambicus* is high. Information on the biology, distribution, and impacts of this species is readily available. Negative impacts from introductions of this species are adequately documented in the scientific literature. No further information is needed to evaluate the negative impacts the species is having where introduced.
8 Risk Assessment

Summary of Risk to the Contiguous United States

The history of invasiveness for *Oreochromis mossambicus* is high. *O. mossambicus* has a truly circumglobal distribution currently owing to its high value to humans for commercial and recreational fishing, aquaculture, the aquarium trade, mosquito and macrophyte control, and biological research. Where *O. mossambicus* has been introduced outside its native range in southeastern Africa, numerous impacts have been documented on native fish and macrophytes including potential extirpation of native species. In addition to impacts of herbivory, competition, and predation, *O. mossambicus* is susceptible to numerous parasitic, bacterial, and viral diseases that could be transmitted to native fish populations. Climate match to the contiguous U.S. is high. There are already established populations in some states. The species has established in thermal springs, even in colder climates, such as Idaho and Japan. The certainty of assessment is high. Overall risk assessment category is high.

Assessment Elements

- **History of Invasiveness (Sec. 3): High**
- **Climate Match (Sec. 6): High**
- **Certainty of Assessment (Sec. 7): High**
- **Remarks/Important additional information** This species is very popular in the worldwide aquaculture industry and easily hybridizes with other species of *Oreochromis*. Known to establish in thermal springs around the world.

- **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.*


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.


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