# North African Catfish (*Clarias gariepinus*)
## Ecological Risk Screening Summary

**U.S. Fish & Wildlife Service, January 2022**
**Revised, February 2022**
**Web Version, 8/25/2022**

Organism Type: Fish
Overall Risk Assessment Category: High

Image: Unknown illustrator, Illustrations of the Zoology of South Africa. Public domain. Available: https://commons.wikimedia.org/w/index.php?curid=18918273 (January 2022).

# 1 Native Range and Status in the United States

## Native Range

From Konings et al. (2019):

"This species is almost Pan-African, absent only from North Africa except Algeria, where it native to the streams in the Tolga oasis at the northern margin of the Sahara, as well as gueltas on the northern slopes of the Tassili n' Ajjer. It is also known from the Tibesti and Ennedi massives in Chad. It is in the Nile but absent from the upper and lower Guinea regions and the Cape province and probably also Nogal province. […] In the Middle East, it is native to the Asi and Jordan drainages and some coastal streams in Israel and the Azraq oasis."

"NATIVE
Extant (resident)
Algeria; Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; Congo; Congo, The Democratic Republic of the; Egypt; Eritrea; Eswatini; Ethiopia; Ghana; Guinea; Israel; Jordan; Kenya; Lebanon; Liberia; Libya; Malawi; Mozambique;

Namibia; Niger; Nigeria; Rwanda; Senegal; Somalia; South Africa; South Sudan; Sudan; Syrian Arab Republic; Tanzania, United Republic of; Togo; Turkey; Uganda; Zambia; Zimbabwe"

## Status in the United States

From Neilson (2021):

"Two specimens were collected from the Canal de Patillas in Guayama, Puerto Rico, in October 2018 (Rodriguez-Barreras and Zapata-Arroyo 2019)."

From Rodríguez-Barreras et al. (2020):

"[…] just in 2018, Rodríguez-Barreras and Zapata-Arroyo [Rodriguez-Barreras and Zapata-Arroyo 2019] recorded the occurrence of an established population of the highly invasive African catfish *Clarias gariepinus* in Puerto Rico, […]"

According to USFWS (2020), walking catfishes in the genera *Clarias* are listed as injurious wildlife under 18 U.S.C. 42(a) of the Lacey Act.

Possession or importation of *Clarias gariepinus* has been prohibited or regulated in many States. Every effort has been made to list all applicable State laws and regulations pertaining to this species, but this list may not be comprehensive.

From Alabama DCNR (2019):

"No person, firm, corporation, partnership, or association shall possess, sell, offer for sale, import, bring, release or cause to be brought or imported into the State of Alabama any of the following live fish or animals:
Any Walking Catfish or any other fish of the genus <u>*Clarias*</u>; […]"

From Arizona Secretary of State (2020):

"Fish listed below are restricted live wildlife [in Arizona] as defined in R12-4-401. […] Walking or airbreathing catfish, all species of the family Clariidae; […]"

From Arkansas GFC (2019):

"It is unlawful to import, transport, or possess any live species commonly known as snakehead (*Family channidae*), walking catfish, […]"

From California Department of Fish and Wildlife (2019):

"It shall be unlawful to import, transport, or possess live animals restricted in subsection (c) below except under permit issued by the department. […]
Family Clariidae-Labyrinth Catfishes: All species of the genera *Clarias*, *Dinotopterus*, and *Heterobranchus* (D)."

From Connecticut Secretary of State (2016):

"The importation or possession of […] and walking catfish of the family Clariidae, genera Clarias, Heteropneustes, Dinotoplerus and Heterobranchu is prohibited except that the Commissioner may at his discretion issue permits for the importation and possession, when it is in the public interest, for public display purposes, of Regulations of Connecticut State Agencies specimens of piranha and walking catfish."

From FFWCC (2021):

"Prohibited Species List […]
Family *Clariidae*, all species except *Clarias batrachus*"

From Georgia DNR (2020):

"The animals listed below are examples of the exotic species regulated under Georgia Law. […]. The exotic species listed below, except where otherwise noted, may not be held as pets in Georgia. […]
Air-breathing catfishes; all species [includes *Clarias gariepinus*]"

From Hawaii Department of Agriculture (2019):

"LIST OF PROHIBITED ANIMALS [in Hawaii] […] Clariidae (all species in catfishes family, except *Clarias fuscus*)"

From Idaho Office of the Administrative Rules Coordinator (2019):

"No person may possess, cultivate, import, ship, or transport any invasive species, into or through the state of Idaho following the effective date of this rule, unless the person possessing, importing, shipping or transporting has obtained a permit under Section 103, or unless otherwise exempt by this rule, as set forth in Section 104. […]
Walking Catfish, *Claridae* [sic]."

From Illinois Secretary of State (2015):

"Listing of Injurious Species [includes] Fish or viable eggs of the walking catfish, Clariidae family […] Injurious species shall not be possessed, propagated, bought, sold, bartered or offered to be bought, sold, bartered, transported, traded, transferred or loaned to any other person or institution unless a permit is first obtained from the Department of Natural Resources in accordance with Section 805.40 of this Part, except persons engaged in interstate transport for lawful commercial purposes who do not buy, sell, barter, trade, transfer, loan or offer to do so in Illinois may transport injurious species across Illinois without an injurious species permit from the Department."

From Indiana DNR (2005):

"Indiana Administrative Code also lists exotic catfish from the family Clariidae illegal to possess live (312 IAC 9-6- 7)."

From Kentucky General Assembly (2019):

"The live aquatic organisms established in subsections (1) through (7) of this section shall not be imported, bought, sold, or possessed in aquaria: […] (4) Genus Clarias - walking catfish;"

From Kansas Department of Wildlife and Parks (2021):

"Prohibited Species
Walking catfish [includes *Clarias gariepinus*], […] (It is illegal to possess or release any live wildlife species listed above.)"

From Louisiana State Legislature (2019):

"No person, firm, or corporation shall at any time possess, sell, or cause to be transported into this state by any other person, firm, or corporation, without first obtaining the written permission of the secretary of the Department of Wildlife and Fisheries, any of the following species of fish: […] all members of the families […] *Clariidae* (walking catfishes); […]"

From Massachusetts Division of Fisheries and Wildlife (2014):

"All aquarium trade fish may be kept without a permit except species categorically non-exempt pursuant to 321 CMR 9.01(3), and except that the following species are prohibited without a permit: […] (d) Walking Catfish (*Clarias* spp. and all members of the family Clariidae)."

From Mississippi Secretary of State (2019):

"All species of the following animals and plants have been determined to be detrimental to the State's native resources and further sales or distribution are prohibited in Mississippi. No person shall import, sell, possess, transport, release or cause to be released into the waters of the state any of the following aquatic species or hybrids thereof. However, species listed as prohibited may be allowed under a permitting process where environmental impact has been assessed. […] Airbreathing or Walking catfishes Family Clariidae"

From State of Nevada (2018):

"Except as otherwise provided in this section and NAC 504.486, the importation, transportation or possession of the following species of live wildlife or hybrids thereof, including viable embryos or gametes, is prohibited: […]
Walking catfish […] All species in the genera *Clarias*, *Heteropneustes* and *Dinotopterus*"

From Oklahoma Secretary of State (2019):

"Until such time as is necessary for the Department of Wildlife Conservation to obtain adequate information for the determination of other harmful or potentially harmful exotic species, the importation into the State and/or the possession of the following exotic fish or their eggs is prohibited: (1) Walking Catfish: The Walking Catfish, (*Clarius* [sic] *batrachus*) and other members of the exotic catfish family Claridae [sic], including but not limited to species of the genera *Clarias*, *Heteropneustes*, *Gymnallables* [sic], *Channallabes*, and *Heterobranchus* are prohibited. Any live specimens of Walking Catfish or other Claridae [sic] species within the boundaries of the State of Oklahoma are contraband and subject to seizure by the Department of Wildlife Conservation."

From Oregon Department of Fish and Wildlife (2020):

"(1) Except as otherwise provided in these rules or other rules of the commission, live wildlife listed below may not be imported, possessed, sold, purchased, exchanged or transported in the state: […]
(ii) Walking catfish (ORS 498.242) — Clariidae — All species and hybrids;"

From Rhode Island Department of State (2017):

"Possession of the following species of fish is prohibited [in Rhode Island]: […] c. Walking Catfish (*Clarias* spp. and all members of the family Clariidae) […]"

From SCDNR (2010):

"A person may not possess, sell, offer for sale, import, bring, or cause to be brought or imported into this State [of South Carolina] or release into the waters of this State the following fish or eggs of the fish: […]
(4) walking catfish or a member of the Clariidae family (*Clarias, Heteropneustea, Gymnallabes, Channallabes,* or *Heterobranchus* genera) […]"

From Texas Parks and Wildlife (2020):

"The organisms listed here are legally classified as exotic, harmful, or potentially harmful. No person may possess or place them into water of this state except as authorized by the department. Permits are required for any individual to possess, sell, import, export, transport or propagate listed species for zoological or research purposes; for aquaculture (allowed only for Blue, Nile, or Mozambique tilapia, Triploid Grass Carp, or Pacific White Shrimp); or for aquatic weed control (for example, Triploid Grass Carp in private ponds). […]
Walking Catfishes, Family Clariidae
All species"

From Utah Office of Administrative Rules (2020):

"All species of fish listed in Subsections (2) through (30) are classified [in Utah] as prohibited for collection, importation and possession […]
(3) Catfish: […]
(d) Labyrinth catfish (walking), family Clariidae (All species); […]"

From Virginia General Assembly (2021):

"A. Permit required. A special permit is required and may be issued by the department, if consistent with the department's fish and wildlife management program, to import, possess, or sell those nonnative (exotic) animals listed in the following table and in 4VAC15-20-210 that the board finds and declares to be predatory or undesirable within the meaning and intent of § 29.1-542 of the Code of Virginia, in that their introduction into the Commonwealth will be detrimental to the native fish and wildlife resources of Virginia. […]
Siluriformes [Order] Clariidae [Family] All species [Genus/Species] Air-breathing catfish [Common Name]"

From Washington State Senate (2019):

"WAC 220-640-030 Prohibited level 1 species. The following species are classified as prohibited level 1 species: […]
(b) Family Clarriidae [sic]: All members of the walking catfish family."

According to Washington State Senate (2014), Prohibited level 1 species: "pose a high invasive risk and are a priority for prevention and expedited rapid response management actions."

## Means of Introductions in the United States

From Neilson (2021):

"Unknown; potential pathways include aquarium release and escape from aquaculture ponds (Rodriguez-Barreras and Zapata-Arroyo 2019). Widely introduced around the world primarily for aquaculture (FAO 2010, Weyl et al. 2016)."

## Remarks

From Konings et al. (2019):

"Within its wide range, there are indications, that more than one species is involved and this catfish is in a need of a detailed taxonomic review. Erroneously reported from Lake Victoria under the name *C. anguillaris* by Copley (1941), a misidentification (Seegers et al. 2003)."

# 2 Biology and Ecology

## Taxonomic Hierarchy and Taxonomic Standing

According to Fricke et al. (2022), *Clarias gariepinus* is the current valid name for this species.

It was originally described as *Silurus gariepinus* and has the following historic synonyms: *Clarias capensis*, *C. depressus*, *C. guentheri*, *C. lazera*, *C. lamottei*, *C. longiceps*, *C. macracanthus*, *C. malaris*, *C. microphthalmus*, *C. moorii*, *C. mossambicus*, *C. muelleri*, *C. notozygurus*, *C. orontis*, *C. robecchii*, *C. smithii*, *C. syriacus*, *C. tsanensis*, *C. vinciguerrae*, *C. xenodon*, and *Macropteronotus charmuth*.

From ITIS (2022):

Kingdom Animalia
Subkingdom Bilateria
Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Ostariophysi
Order Siluriformes
Family Clariidae
Genus *Clarias*
Species *Clarias gariepinus* (Burchell, 1822)

## Size, Weight, and Age Range

From Froese and Pauly (2022):

"Maturity: $L_m$ 30.8, range 34 - ? cm
Max length : 170 cm TL male/unsexed; [IGFA 2001]; common length : 90.0 cm NG male/unsexed; [van Oijen 1995]; max. published weight: 60.0 kg [Robins et al. 1991]; max. reported age: 15 years [Weyl and Booth 2008]"

## Environment

From Froese and Pauly (2022):

"Freshwater; benthopelagic; pH range: 6.5 - 8.0; dH range: 5 - 28; potamodromous [Riede 2004]; depth range 0 - 80 m [Witte and de Winter 1995]."

"Widely tolerant of extreme environmental conditions [de Moor and Brunton 1988]. Water parameters appear to play only a very minor role [Seegers 2008]."

From Haylor and Mollah (1995):

"The present work investigated hatching time and the transition from endogenous to exogenous feeding at five constant temperatures over the range 15-35°C. *Clarias gariepinus* eggs can be successfully hatched in ambient water temperatures between 20 and 35°C, although at 30°C the hatching rate is significantly improved. At 15°C embryos do not survive."

## Climate

From Froese and Pauly (2022):

"Subtropical; […] 42°N - 28°S, 17°W - 51°E"

From CABI (2022):

"Average temp. of coolest month > 18°C, > 1500mm precipitation annually"

## Distribution Outside the United States

### Native

From Konings et al. (2019):

"This species is almost Pan-African, absent only from North Africa except Algeria, where it native to the streams in the Tolga oasis at the northern margin of the Sahara, as well as gueltas on the northern slopes of the Tassili n' Ajjer. It is also known from the Tibesti and Ennedi massives in Chad. It is in the Nile but absent from the upper and lower Guinea regions and the Cape province and probably also Nogal province. […] In the Middle East, it is native to the Asi and Jordan drainages and some coastal streams in Israel and the Azraq oasis."

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Extant (resident)
Algeria; Angola; Benin; Botswana; Burkina Faso; Burundi; Cameroon; Central African Republic; Chad; Congo; Congo, The Democratic Republic of the; Egypt; Eritrea; Eswatini; Ethiopia; Ghana; Guinea; Israel; Jordan; Kenya; Lebanon; Liberia; Libya; Malawi; Mozambique; Namibia; Niger; Nigeria; Rwanda; Senegal; Somalia; South Africa; South Sudan; Sudan; Syrian Arab Republic; Tanzania, United Republic of; Togo; Turkey; Uganda; Zambia; Zimbabwe"

### Introduced

From Konings et al. (2019):

"It has been introduced to other parts of Africa as well as to tropical and subtropical Asia. Occasionally, it has escaped from warm water aquaculture facilities in Europe but it has not established. […] It has been widely introduced in southern Turkey in Ceyhan, Seyhan and Göksu rivers and most likely elsewhere along the Mediterranean coast."

"Extant & Introduced (resident)
Argentina; Bangladesh; Brazil; Cambodia; China; Czechia; Côte d'Ivoire; Gabon; Greece; India; Indonesia; Iraq; Lao People's Democratic Republic; Lesotho; Mali; Myanmar; Netherlands; Philippines; Singapore; Thailand; Viet Nam"

"Extant & Origin Uncertain (resident)
Cyprus; France; Hungary; Mauritania; Poland; Russian Federation"

From Rodríguez Machado and Rodríguez-Cabrera (2015):

"One of the most recent introductions in Cuba corresponds to two catfish species genus *Clarias* in 1999-2000: *C. macrocephalus* Günther, 1864 and *C. gariepinus* (Burchell, 1822). These two predatory species were intentionally introduced for aquaculture purposes from Malaysia and Thailand (unpublished official report provided by the Centro Nacional de Seguridad Biológica, Cuba, 2015, at the request of the authors)."

Additionally, Froese and Pauly (2022) reports *Clarias gariepinus* as established or probably established in the Syrian Arab Republic, East Timor, and Malaysia. They also report introductions to the Netherlands, Côte d'Ivoire, and Zaire as probably not established, and introductions to Belgium, Germany, Greece, Slovakia, Saudi Arabia, and Mauritius as unknown regarding establishment.

## Means of Introduction Outside the United States

CABI (2022) reports aquaculture as a pathway for introductions into Vietnam and China (from the Central African Republic) in 1974 and 1981, respectively; Bangladesh, Malaysia, and the Philippines (from Thailand) between 1985 and 1989; Indonesia (from the Netherlands) in 1985; and the Netherlands (from Cote d'Ivoire) at an undetermined date. CABI (2022) reports research as an additional pathway for the introductions into Indonesia and the Netherlands.

From FAO (2022a):

"Has been imported for purposes of aquaculture and gamefish."

From Rodríguez Machado and Rodríguez-Cabrera (2015):

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## Short Description

From Froese and Pauly (2022):

"Dorsal spines (total): 0; Dorsal soft rays (total): 61-80; Anal spines: 0; Anal soft rays: 45 - 65; Vertebrae: 56 - 63. Diagnosis: body depth 6-8 times in standard length, head 3-3,5 times [van Oijen 1995]. Head somewhat between rectangular and pointed in dorsal outline; snout broadly rounded; eyes supero-lateral and relatively small [Teugels 1986]. Teeth on premaxilla and lower jaw small, fine and arranged in several rows; nasal barbels 1/5-1/2 times as long as head in fishes longer than 12 cm, and 1/2-4/5 of head length in smaller individuals; maxillary barbels rarely shorter than head, usually somewhat longer and reaching to a point midway between origin of dorsal fin and insertion of pelvic fins; outer mandibular barbel longer than inner pair [van Oijen 1995]. Postorbital bones in contact; lower part of head with 2 black, lateral bands [Teugels et al. 2007]. Contrary to other *Clarias* species, *Clarias gariepinus* has a high number of gill rakers

varying from 24-110 [Teugels 1986; van Oijen 1995; Teugels, et al. 2007; Hanssens 2009], the number increasing with size of the fish; gill rakers long, slender and closely set [Teugels 1986; van Oijen 1995]. Distance between occipital process and base of dorsal fin is short; dorsal fin almost reaches caudal fin; anal fin origin closer to caudal fin base than to snout, nearly reaching caudal fin; pelvic fin closer to snout than to caudal fin base; pectoral fin extends from operculum to below 1st dorsal fin rays [Teugels 1986]. Pectoral spine robust [Teugels 1986], serrated only on its outer face [Teugels 1986; Teugels et al. 2007], the number of serrations increasing with age [Teugels 1986]. Lateral line appears as a small, white line from posterior end of head to middle of caudal fin base; openings to secondary sensory canals clearly marked [Teugels 1986]."

From CABI (2022):

"*Clarias gariepinus* are readily recognized by their cylindrical body with scaleless skin, flattened bony head, small eyes, elongated spineless dorsal fin and four pairs of barbels around a broad mouth. The upper surface of the head is coarsely granulated in adult fishes but smooth in young fish (Van Oijen, 1995). The anal, caudal and dorsal fins are not united. The males can be easily recognized by a distinct sexual papilla located immediately behind the anal opening. This sexual papilla is not present in female fish."

"The body is greyish-black with the underside of the head and body a creamy-white colour (Van Oijen, 1995), with a distinct black longitudinal band on each side of the ventral surface of the head (which is absent in young fish of less than 9 cm long). Larger fish (more than 9 cm) are mottled with an overall grey-khaki colour. Skin coloration is known to change slightly according to substrate and light intensity in culture systems."

## Biology

From Froese and Pauly (2022):

"Adults occur mainly in quiet waters, lakes and pools [Teugels 1986] and prefer rather shallow and swampy areas with a soft muddy substrate and calmer water [Seegers 2008]. They may also occur in fast flowing rivers and in rapids [Teugels 1986; Seegers 2008]. Recorded as having been or being farmed in rice fields [Halwart and Gupta 2004]. The two known colour types appear to correlate with water turbidity and substrate type [Teugels et al. 2007]. […] The presence of an accessory breathing organ enables this species to breath air when very active or under very dry conditions. They remain in the muddy substrates of ponds and occasionally gulp air through the mouth [de Moor and Brunton 1988]. Can leave the water at night using its strong pectoral fins and spines in search of land-based food or can move into the breeding areas through very shallow pathways [Burgess 1989]. Omnivorous bottom feeders which occasionally feed at the surface [Teugels 1986]. Feed at night on a wide variety of prey [Burgess 1989] like insects, plankton, invertebrates and fish but also take in young birds, rotting flesh and plants [de Moor and Brunton 1988]. Migrate to rivers and temporary streams to spawn [Witte and de Winter 1995]. […] During intra-specific aggressive interactions, this species was noted to generate electric organ discharges that were monophasic, head-positive and lasting from 5-260 ms [Baron et al. 1994]."

“Oviparous. Spawning takes place during the rainy season in flooded deltas. The fishes make a lateral migration towards the inundated plains to breed and return to the river or lake soon afterwards while the juveniles remain in the inundated area. Juveniles return to the lake or river when they are between 1.5 and 2.5 cm long [Witte and de Winter 1995]. First sexual maturity occurs when females are between 40-45 cm and males between 35-40 cm. Eggs are greenish. Incubations lasts little (about 33 hours at 25°C).”

From FAO (2022b):

“Under stable environmental conditions, adult *C. gariepinus* have mature gonads year-round. Under ideal conditions, a ripe female may lay about 60 000 eggs/kg. […] Larvae feed and grow rapidly in the warm (usually >24 °C) nutrient rich floodplains, reaching 3-7 g within 30 days. […] In areas with two rainy seasons, there are usually two reproductive peaks during the year, corresponding in intensity to the magnitude of the rains.”

“Stomach contents of *Clarias* species typically include insects (adults and larvae), worms, gastropods, crustaceans, small fish, aquatic plants and debris, but terrestrial seeds and berries, and even birds and small mammals, have also been observed. Larvae are almost exclusively dependent on zooplankton for the first week of exogenous feeding. Large *C. gariepinus*, because of their high number of gillrakers, also target zooplankton as a primary food source.”

## Human Uses

From FAO (2022a):

“One of the commercially most important freshwater fishes in Africa. Caught with drawnets. The total catch reported for this species to FAO for 1999 was 27 220 t. The countries with the largest catches were Mali (15 091 t) and Nigeria (9 994 t). Has been imported for purposes of aquaculture and gamefish. Marketed live, fresh and frozen; eaten broiled, fried and baked.”

From FAO (2022b):

“African catfish are mentioned within traditional capture-based aquaculture (known as *wheddos* in Benin and Ghana and *barochois* in Mauritius) for centuries. Their culture in modern times follows a similar trend to that of tilapias: first domestication trials by the year 1950 and adoption of the North African catfish *Clarias gariepinus* as the most desirable catfish for aquaculture in the mid 1970s.”

“Generally, *Clarias gariepinus* have mostly been used as ‘police-fish’ to control over-breeding in mixed-sex tilapia culture in earthen ponds. In Uganda, the development of *Clarias* culture is more related to its use as baits for fishing in Lake Victoria.”

“China has adopted it within its rice-fields and is currently among the main producing countries, […]”

According to FAO (2022b), global aquaculture production of *C. gariepinus* exceeded 250,000 tonnes in 2014.

From Froese and Pauly (2022):

"Known as sharptooth catfish in aquaculture, a highly recommended food fish in Africa [Okeyo 2003]."

## Diseases

**Epizootic ulcerative syndrome is an OIE-reportable disease (OIE 2021).**

From Songe et al. (2012):

"A field investigation was conducted in the Sesheke District of Zambia along the Zambezi River to determine the fish species susceptible to epizootic ulcerative syndrome (EUS), a newly confirmed disease in Southern Africa. […] The following 16 species of fish were examined and found with EUS lesions; *Clarias ngamensis*, *Clarias gariepinus*, […]. *T. sparrmanii* did not show any lesions, while the *Clarias* species were found to be the most afflicted with EUS."

From FAO (2022b):

"African catfish are subject to a wide variety of diseases including bacteria, fungi and miscellaneous parasites. […] many of the observed diseases are yet to be fully diagnosed. […] Most of the diseases […] are principally observed within intensive culture. […] So far, virus related diseases have not been reported in African catfish."

FAO (2022b) report the following diseases for *C. gariepinus*: broken head (unknown agent), ruptured intestine syndrome (unknown agent), ulcerative disease (unknown agent), white spot (Myxobacteria), *Aeromonas* septicaemia (*Aeromonas hydrophila*), motile Aeromonad septicaemia (*Aeromonas* sp.), and water mould (*Saprolegnia* spp.).

FAO (2022b) report the following parasites for *C. gariepinus*: *Costia* sp., *Chilodonella*, *Trichodina*, *Gactylogyrus* sp., *Gyrodactilus* sp., *Henneguya* sp., *Cysticerca* sp., and *Trichodina maritinkae*.

Poelen et al. (2014) lists the following parasites, diseases, and pathogens of *C. gariepinus*: *Aeromonas sobria*, *Allocreadium mazoensis*, *Astiotrema reniferum*, *Barsonella lafoni*, *Bothriocephalus acheilognathi*, *Clinostomoides brieni*, *Dolops ranarum*, *Edwardsiella tarda*, *Euclinostomum dollfusi*, *Euclinostomum heterostomum*, *Eumasenia ghanensis*, *Glossidium pedatum*, *Gyrodactylus alberti*, *Gyrodactylus rysavyi*, *Macrogyrodactylus clarii*, *Macrogyrodactylus congolensis*, *Macrogyrodactylus karibae*, *Macrogyrodactylus polypteri*, *Monobothrioides chalmersius*, *Orientocreadium bactrachoides*, *Orientocreadium batrachoides*, *Panamphistomum benoiti*, *Paracamallanus cyathopharynx*, *Paraquadriacanthus nasalis*, *Procamallanus laeviconchus*, *Proteocephalus glanduliger*, *Quadriacanthus ashuri*, *Quadriacanthus bagrae*, *Quadriacanthus clariadis*, *Quadriacanthus numidus*, *Quadriacanthus papernai*, *Rhabdochona congolensis*, *Spinitectus petterae*, *Stenotrophomonas maltophilia*, *Tetracampos ciliotheca*, and *Tylodelphys mashonensis*.

### Threat to Humans

From Froese and Pauly (2022):

"Potential pest [Robins et al. 1991]"

# 3 Impacts of Introductions

From CABI (2022):

"*Clarias gariepinus* has all the qualities of an aggressive and successful invasive species. Its high fecundity, flexible phenotype, rapid growth, wide habitat preferences, tolerance to extreme water conditions and the ability to subsist on a wide variety of prey can devastate indigenous fish and aquatic invertebrate populations (Bruton, 1986). It is because of these characteristics that countries such as India have imposed a ban on the introduction and culture of *C. gariepinus* (Dhawan and Kaur, 2001). Nevertheless, the effects of the illegal and indiscriminate introduction of this fish into India, as in other countries, have brought about potential ecological problems such as the loss of biodiversity in natural inland waters (Singh, 2000). Genetic introgression of native wild clariid catfish by escapees of hybrid catfish (*C. gariepinus* x *C. macrocephalus*) from fish farms have been reported in Thailand (Senanan et al., 2004)."

"The introduction of *C. gariepinus* into Asia has resulted in the rapid expansion of the hybrid catfish culture when the exotic male *C. gariepinus* is hybridized with local female clariid species. The resultant hybrid with high growth rates and disease resistance (from paternal genes), and high flesh quality and taste (from maternal genes), is very popular with fish farmers and has almost completely replaced the native clariid catfish aquaculture in countries such as Thailand (Poompuang and Na-Nakorn, 2004)."

From Senanan et al. (2004):

"Escaped hybrid catfish (female Thai walking catfish, *Clarias macrocephalus* x male African catfish, *C. gariepinus*) from farms in central Thailand may interbreed with *C. macrocephalus* individuals in the wild. We assessed genetic introgression of *C. gariepinus* genes into four wild and two broodstock populations of *C. macrocephalus* based on diagnostic alleles at six allozyme loci and one microsatellite locus. A total of 22 out of 515 *C. microcephalus* individuals examined had *C. gariepinus* alleles. One individual had *C. gariepinus* alleles at all six loci while the 21 remaining individuals had *C. gariepinus* alleles at one to two loci. In each population, the diagnostic markers detected between one and five individuals (1% to 11% of the sample) bearing hybrid genotypes. Farmers' inadvertent use of introgressed *C. macrocephalus* individuals as broodstock in producing hybrid catfish could result in loss of hybrid vigor for growth or disease resistance."

From Kadye and Booth (2012):

"This study examined invasion disturbances by determining the relationship between non-native sharptooth catfish *Clarias gariepinus* and aquatic macroinvertebrates in the Eastern Cape, South Africa. A Multiple Before–After Control–Impact (MBACI) experimental design was used to

examine macroinvertebrate communities within two rivers: one with catfish and another one without catfish. […] within the uninvaded river, catfish introduction into the Impact treatment plots indicated negative effects on macroinvertebrate community that was reflected by decrease in diversity, richness and biomass. A community-level impact was also reflected in the multivariate analysis that indicated more variation in macroinvertebrate composition within the Impact treatment relative to the Control in the uninvaded river. Catfish impact within the uninvaded river suggests the dominance of vulnerable taxa, such as odonates that were less abundant in the Impact treatment plots after catfish introduction. […] Within the invaded Koonap River, high macroinvertebrate diversity and richness were observed in the Control treatment that excluded catfish relative to the Impact treatment that had catfish where macroinvertebrate community structure varied less between sampling periods. This demonstrated that, within invaded habitats, excluding the non-native catfish increased community structure, whereas catfish presence was associated with less temporal variation in macroinvertebrate composition. In contrast, biomass and abundance were uninfluenced by either treatment, indicating that the macroinvertebrate community within the invaded river was dominated by taxa that were less responsive or adapted to the impact."

From Sarkar et al. (2017):

"The mass balance modelling study [Feroz Khan and Panikkar 2009] was conducted in Karapuzha reservoir, Kerala where species diversity includes indigenous Cauvery carps, Indian Major Carps, Cichlids, Murrells, Catfishes and exotics such as *O. mossambicus* and *C. gariepinus*. The study showed that the *O. mossambicus* did not have a significant negative influence on any of the fish groups in the reservoir but African catfish, *C. gariepinus* negatively impacted many fish groups, especially the barbs."

From Weyl et al. (2016):

"There are few direct studies on competitive or predatory the impacts of *C. gariepinus* on invaded ecosystems. Weir (1972) demonstrated that *C. gariepinus* were able to alter invertebrate density and community composition in experimental ponds in Zimbabwe. In South Africa, Alexander et al. (2014) demonstrated that, in comparison to size matched native predatory fishes, juvenile *C. gariepinus* displayed higher type II functional responses resulting from significantly lower prey handling times and higher maximum feeding rates."

"Although predation on native fishes by *C. gariepinus* in invaded ecosystems is fairly well documented (e.g. Mili & Teixeira, 2006; Potts et al., 2008; Kadye & Booth, 2013) there are currently no peer-reviewed assessments demonstrating impacts on native fish communities. Cambray (2003), however, provides two anecdotal accounts which infer impacts on two endangered fishes in South Africa: (1) the drastic reduction in abundance of *Pseudobarbus asper* (Boulenger 1911) from invaded pools in the Gamtoos River and (2) the exclusion of *Sandelia bainsii* Castelnau 1861 from habitats occupied by *C. gariepinus*. Other impacts have only been inferred from the presence of native fishes in the diet of *C. gariepinus* (Vitule et al., 2006; Kadye & Booth, 2013). This may be due to the introduction of *C. gariepinus* into river systems that were already invaded by other alien predators such as *Micropterus salmoides* (Lacépède 1802) (Ellender & Weyl, 2014). Anglers, however, report that the introduction of *C. gariepinus* has

resulted in the decline of *Micropterus* spp. populations in several South African impoundments (Cambray, 2003)."

From Neilson (2022):

"The impacts of this species [in Puerto Rico] are currently unknown, as no studies have been done to determine how it has affected ecosystems in the invaded range in the US and associated territories. The absence of data does not equate to lack of effects. It does, however, mean that research is required to evaluate effects before conclusions can be made."

"Worldwide, there has been limited direct research on impacts to ecosystems invaded by *C. gariepinus*. Most impacts to native communities have been inferred from presence of native species (e.g., fishes) in diet studies, although there is limited experimental evidence that *C. gariepinus* can alter invertebrate community composition (reviewed by Weyl et al. 2016)."

The importation, possession, and/or trade of *Clarias gariepinus* is regulated federally by the Lacey Act (USFWS 2020), and in at least the following States (see Section 1 for detailed information): Alabama (Alabama DCNR 2019), Arizona (Arizona Secretary of State 2020), Arkansas (Arkansas GFC 2019), California (California Department of Fish and Wildlife 2019), Connecticut (Connecticut Secretary of State 2016), Florida (FFWCC 2021), Georgia (Georgia DNR 2020), Hawaii (Hawaii Department of Agriculture 2019), Idaho (Idaho Office of the Administrative Rules Coordinator 2019), Illinois (Illinois Secretary of State 2015), Indiana (Indiana DNR 2005), Kansas (Kansas Department of Wildlife and Parks 2021), Kentucky (Kentucky General Assembly 2019), Louisiana (Louisiana State Legislature 2019), Massachusetts (Massachusetts Division of Fisheries and Wildlife 2014), Mississippi (Mississippi Secretary of State 2019), Nevada (State of Nevada 2018), Oklahoma (Oklahoma Secretary of State 2019), Oregon (Oregon Department of Fish and Wildlife 2020), Rhode Island (Rhode Island Department of State 2017), South Carolina (SCDNR 2010), Texas (Texas Parks and Wildlife 2020), Utah (Utah Office of Administrative Rules 2020), Virginia (Virginia General Assembly 2021), and Washington (Washington State Senate 2019).

# 4 History of Invasiveness

*Clarias gariepinus* is one of the most commonly utilized catfish species in commercial aquaculture production globally. It has subsequently been introduced to five continents and become established in numerous countries around the world outside of its native range. *Clarias* species are listed as injurious wildlife under 18 U.S.C. 42(a) of the Lacey Act, and possession or importation of *C. gariepinus* has been regulated by numerous States. Although additional peer reviewed studies on the impacts of introduced populations of *C. gariepinus* are warranted, there is evidence that *C. gariepinus* has negatively impacted invaded ecosystems by altering invertebrate communities, preying on native fishes, and hybridizing with native congeners. Such impacts and numerous established nonnative populations globally warrant classification of the history of invasiveness as High.

# 5 Global Distribution

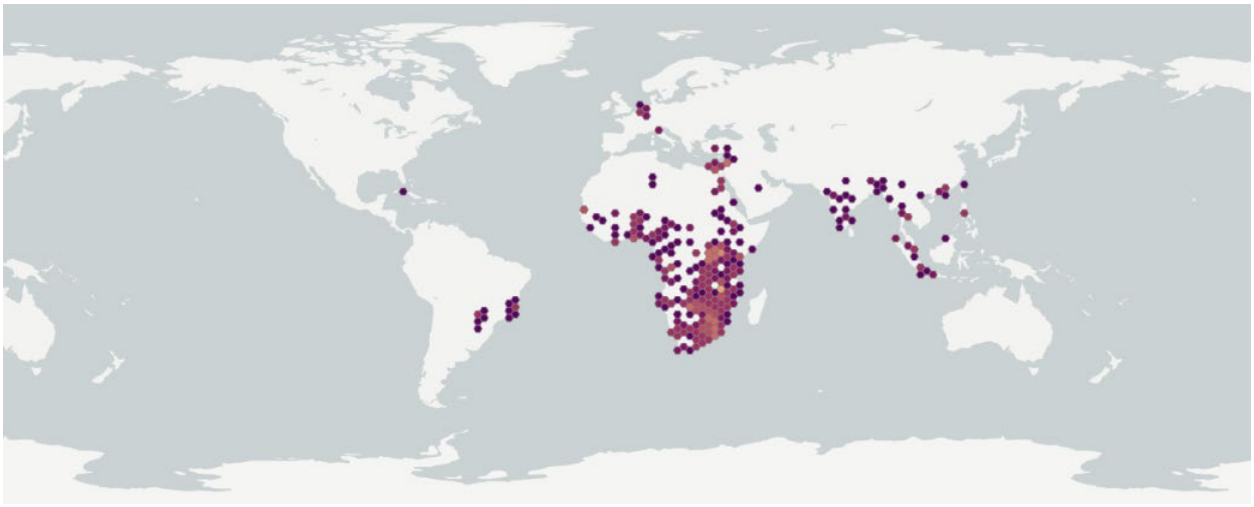

**Figure 1**. Known global distribution of *Clarias gariepinus*. Observations are primarily reported from Africa and southern Asia, but also from Cuba, Brazil, the Netherlands, Belgium, and Italy. Map from GBIF Secretariat (2022). Points in the Netherlands, Belgium, and Italy were excluded from the climate matching analysis because they are not known to represent establish populations of *C. gariepinus*.

# 6 Distribution Within the United States


**Figure 2**. Known distribution of *Clarias gariepinus* in the United States. Map from Neilson (2021).

# 7 Climate Matching

## Summary of Climate Matching Analysis

The climate match for *Clarias gariepinus* was high in peninsular Florida and along the Atlantic Coast from North Carolina to Florida; in the Southwest and southern Great Plains regions; much of California; and in portions of Washington, Oregon, and Idaho. Medium matches covered much of the remaining contiguous United States, except for inland areas of New England and the Olympic Peninsula, and portions of the Rocky and Cascade mountain ranges which had low matches. The overall Climate 6 score (Sanders et al. 2021; 16 climate variables; Euclidean distance) for the contiguous United States was 0.489, High (scores greater than or equal to 0.103, are classified as high). The following States had high individual Climate 6 scores: Alabama, Arizona, California, Colorado, Florida, Georgia, Idaho, Iowa, Kansas, Louisiana, Mississippi, Missouri, Montana, Nebraska, Nevada, New Mexico, North Carolina, Oklahoma, Oregon, South Carolina, South Dakota, Texas, Utah, Washington, Wisconsin, and Wyoming. Illinois, Massachusetts, Michigan, Minnesota, North Dakota, New York, Virginia, and West Virginia had medium scores. All other States had low individual Climate 6 scores.

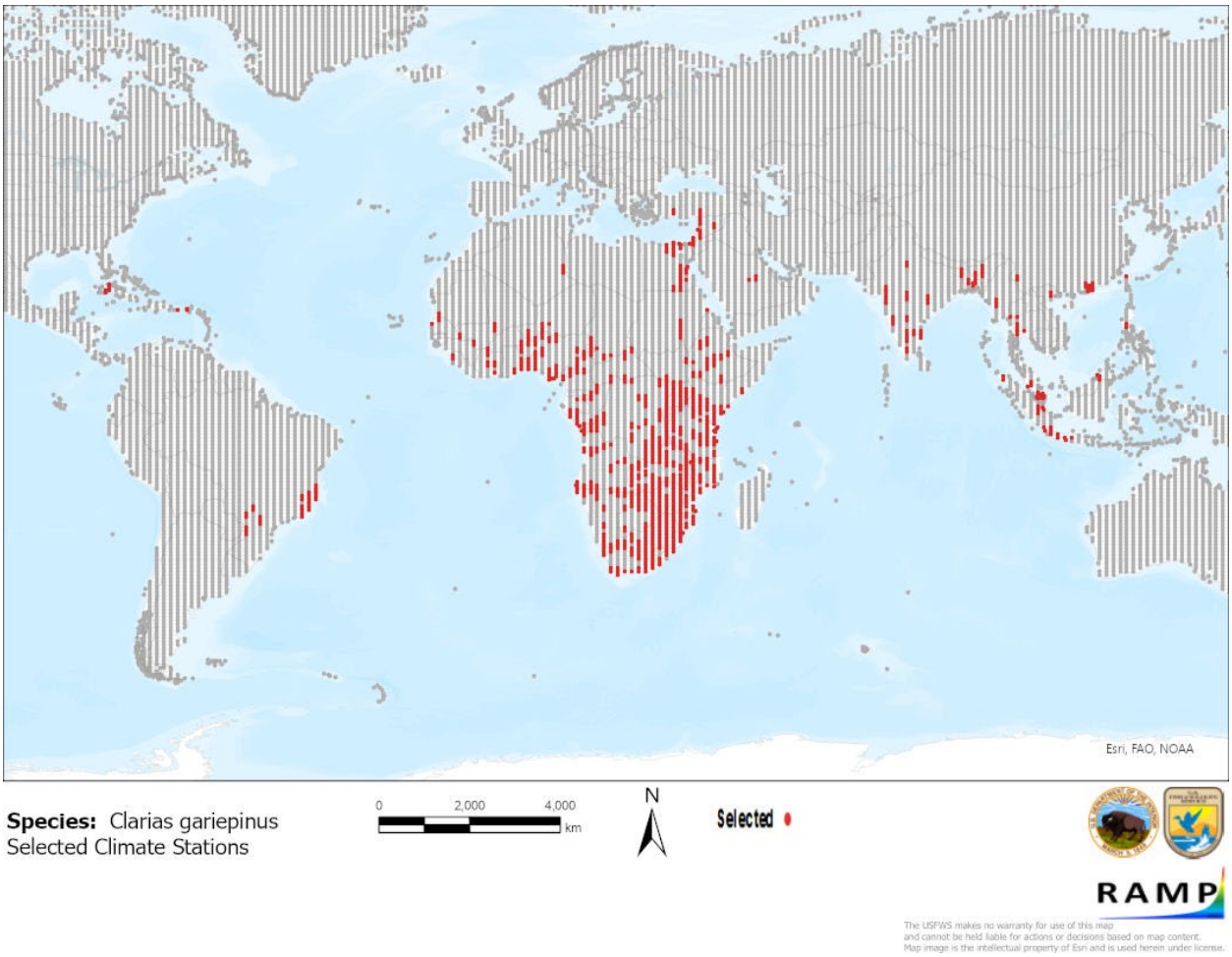


**Figure 3**. RAMP (Sanders et al. 2021) source map showing weather stations in Cuba, Puerto Rico, Brazil, southern Asia, and throughout Africa selected as source locations (red) and non-source locations (gray) for *Clarias gariepinus* climate matching. Source locations from GBIF Secretariat (2022) and Neilson (2021). Selected source locations are within 100 km of one or more species occurrences, and do not necessarily represent the locations of occurrences themselves.

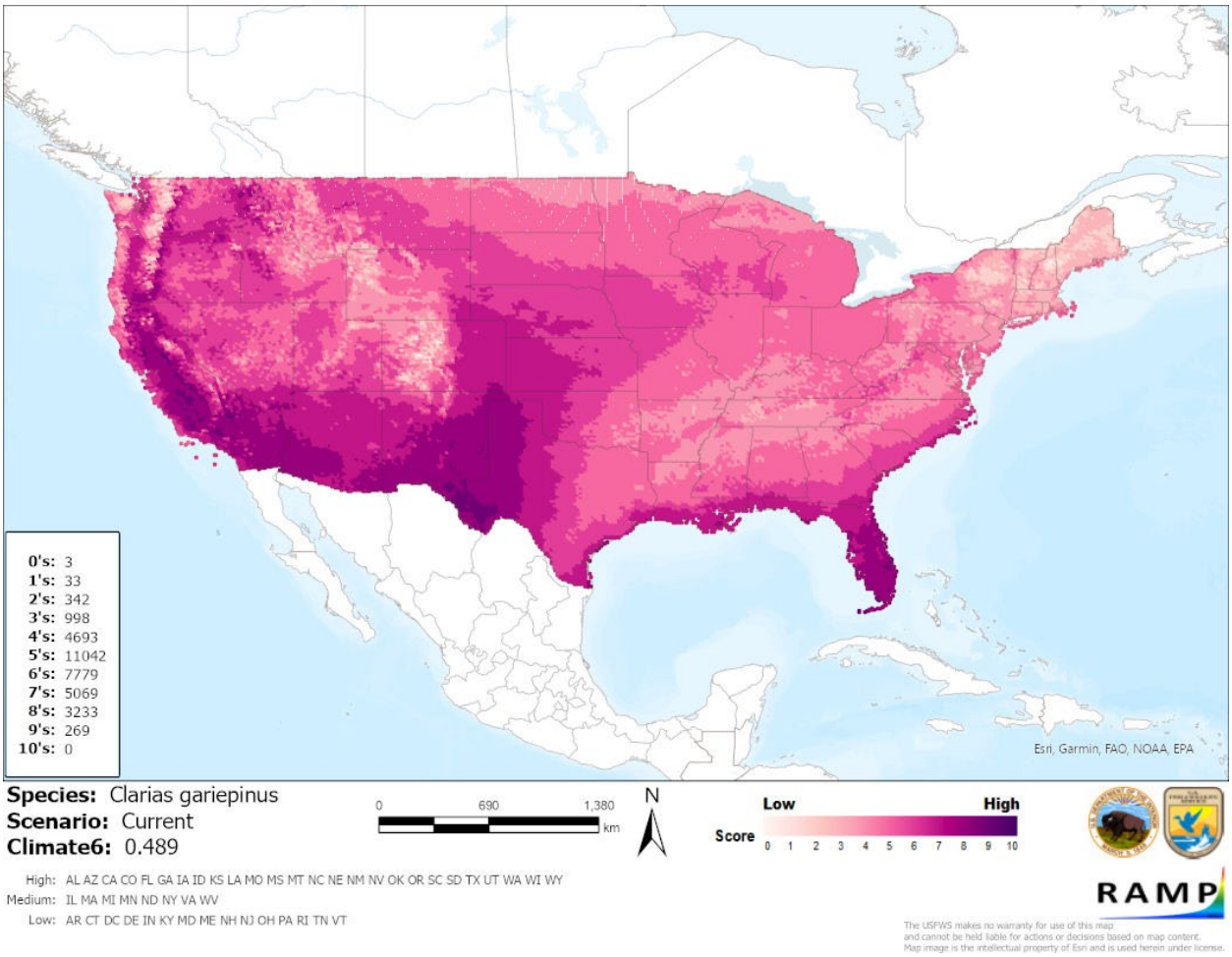


**Figure 4**. Map of RAMP (Sanders et al. 2021) climate matches for *Clarias gariepinus* in the contiguous United States based on source locations reported by GBIF Secretariat (2022) and Neilson (2021). Counts of climate match scores are tabulated on the left. 0/Pale Pink = Lowest match, 10/Dark Purple = Highest match.

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

| Climate 6:<br>(Count of target points with climate scores 6-10)/<br>(Count of all target points) | Overall Climate Match Category |
|---|---|
| 0.000≤X≤0.005 | Low |
| 0.005<X<0.103 | Medium |
| ≥0.103 | High |

# 8 Certainty of Assessment

There is substantial information and literature addressing the biology, distribution, and impacts of *Clarias gariepinus* on native fauna following the species' introduction outside of its native range. However, a recent review of *C. gariepinus* impacts called for more direct study of potential population-level impacts on native fish communities. Despite the remaining knowledge

gaps, no further information is needed to identify that the species is having negative impacts where introduced. The certainty of this assessment is High.

# 9 Risk Assessment

## Summary of Risk to the Contiguous United States

The North African catfish (*Clarias gariepinus*) has a current distribution spanning from East Timor to Brazil and Puerto Rico. Indigenous to much of Africa's inland waters and endemic in Israel, Syria, and parts of Turkey, the species has also been introduced–primarily for aquaculture–into numerous Asian and European countries, two countries in South America, Cuba, Puerto Rico, and several African countries where it did not originally occur. It is a hardy fish that is tolerant of extreme water conditions, has a high resistance to disease, grows rapidly, is an omnivorous and opportunistic feeder, exhibits high fecundity, and is attractive both for aquaculture and as a game fish. The history of invasiveness of *C. gariepinus* is High. There have been extensive introductions to other continents, subsequent reports of competition with and predation upon native species across multiple taxa, and hybridization with native congeners in invaded ecosystems. *Clarias* species are listed as injurious wildlife under 18 U.S.C. 42(a) of the Lacey Act, and possession or importation of *C. gariepinus* has been regulated by numerous States. The Climate match with the contiguous United States was High, particularly in Florida, the Southwest, California, and parts of the Northwest. The certainty of assessment is High. Given the documented impacts to native species and high overall climate match, the overall risk category for *C. gariepinus* for the contiguous United States is High.

## Assessment Elements

- **History of Invasiveness (Sec. 4): High**
- **Overall Climate Match Category (Sec. 7): High**
- **Certainty of Assessment (Sec. 8): High**
- **Remarks, Important additional information:** Epizootic ulcerative syndrome is reported from *Clarias gariepinus*; an OIE-reportable disease.
- **Overall Risk Assessment Category: High**

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**Note: The following references were accessed for this ERSS. References cited within quoted text but not accessed are included below in Section 11.**

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