U.S. Fish & Wildlife Service

Rohu Labeo (*Labeo rohita*)
Ecological Risk Screening Summary

U.S. Fish & Wildlife Service, April 2011
Revised, June 2018
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1 Native Range and Status in the United States

Native Range

From Froese and Pauly (2018a):

"Asia: Pakistan, India, Bangladesh, Myanmar and Nepal."

"Found in Choto Jamuna river [*sic*] [Bangladesh] [Galib et al. 2013]."

"Known from north and central India [Talwar and Jhingran 1991]. Occurs in Chilka Lake [Rao 1995]; Maharashtra [Archarya and Iftekhar 2000]; Meenachil, Manimala & Pampa rivers, Kerala [Gopalakrishnan and Bashneer 2000], Tambraparani river system, Peechi-Vazhani WLS, Nilgiri Biosphere Reserve, southern Keral river systems and rivers of Tamil Nadu [Radhakrishnan et al. 2012]. Found throughout Tripura [Lipton 1983]. […] Present in Nainital, Bhimtal and

Naukuchiatal lakes [Pal and Kundu 2011], also in Adma and Jayanti rivers [Ray and Mishra 2011]."

"Found in Irrawaddy basin [Myanmar] [Vidthayanon et al. 2005]."

"Occurs naturally in [Nepal in] the Kosi, Bagmati, Narayani, Lumbini and Bheri zones with an altitudinal range of 76-250 m. Cultured by artificial propagation in the rivers of the Terai zone."

"Found throughout the plains of Pakistan. Known from Punjab, Sindh, and Balochistan [Mirza 2003]. Also occurs in Azad Jammu and Kashmir [Akhtar 1991]."

Status in the United States

No records of *Labeo rohita* in the United States were found. This species was not found to be in trade in the United States.

Means of Introductions in the United States

No records of *Labeo rohita* in the United States were found.

Remarks

From Froese and Pauly (2018a):

"At least six intergeneric and five interspecific hybrids employing either male or female rohu have been produced experimentally (Khan and Jhingran 1975, Tripathi 1992). Hybrids of rohu with Chinese carps are short-lived, and the male common carp female rohu hybrid is sterile. The male catla x female rohu hybrid is fertile and combines the deep body of catla and the small head of rohu: characteristics preferred by some farmers. Catla-rohu hybrids are also found in the seed produced from dry bundhs."

From Jena (2006):

"On the other hand, while the inter-generic hybridisation of mrigal, rohu, catla, grass carp and common carp has been attempted, the hybrids did not show any genetic advantage over the parent stocks."

2 Biology and Ecology

Taxonomic Hierarchy and Taxonomic Standing

According to Eschmeyer et al. (2018), *Labeo rohita* (Hamilton, 1822) is the current valid name for this species. *Labeo rohita* was originally described as *Cyprinus rohita* Hamilton 1822.

From ITIS (2018):

"Kingdom Animalia
  Subkingdom Bilateria

Infrakingdom Deuterostomia
Phylum Chordata
Subphylum Vertebrata
Infraphylum Gnathostomata
Superclass Actinopterygii
Class Teleostei
Superorder Ostariophysi
Order Cypriniformes
Superfamily Cyprinoidea
Family Cyprinidae
Genus *Labeo*
Species *Labeo rohita* (Hamilton, 1822)"

Size, Weight, and Age Range

From Froese and Pauly (2018a):

"Maturity: Lm 58.0 range ? - ? cm
Max length : 200 cm TL male/unsexed; [Frimodt 1995]; max. published weight: 45.0 kg [Frimodt 1995]; max. reported age: 10 years [Khan and Jhingran 1975]"

Environment

From Froese and Pauly (2018a):

"Freshwater; brackish; benthopelagic; potamodromous [Riede 2004]; depth range 5 - ? m [Talwar and Jhingran 1991]."

"[…] thrives well […] at [water] temperatures ranging from 16.8 - 37.0°C; minimum tolerable temperature 13.9°C; reproduces between 22-31.0°C; tolerates salinity levels of 5 ppt.."

Climate/Range

From Froese and Pauly (2018a):

"Tropical; 32°N - 21°S"

"Maximum altitude at 500 m […]"

Distribution Outside the United States

Native

From Froese and Pauly (2018a):

"Asia: Pakistan, India, Bangladesh, Myanmar and Nepal."

"Found in Choto Jamuna river [*sic*] [Bangladesh] [Galib et al. 2013]."

“Known from north and central India [Talwar and Jhingran 1991]. Occurs in Chilka Lake [Rao 1995]; Maharashtra [Archarya and Iftekhar 2000]; Meenachil, Manimala & Pampa rivers, Kerala [Gopalakrishnan and Bashneer 2000], Tambraparani river system, Peechi-Vazhani WLS, Nilgiri Biosphere Reserve, southern Keral river systems and rivers of Tamil Nadu [Radhakrishnan et al. 2012]. Found throughout Tripura [Lipton 1983]. […] Present in Nainital, Bhimtal and Naukuchiatal lakes [Pal and Kundu 2011], also in Adma and Jayanti rivers [Ray and Mishra 2011].”

“Found in Irrawaddy basin [Myanmar] [Vidthayanon et al. 2005].”

“Occurs naturally in [Nepal in] the Kosi, Bagmati, Narayani, Lumbini and Bheri zones with an altitudinal range of 76-250 m. Cultured by artificial propagation in the rivers of the Terai zone.”

“Found throughout the plains of Pakistan. Known from Punjab, Sindh, and Balochistan [Mirza 2003]. Also occurs in Azad Jammu and Kashmir [Akhtar 1991].”

Introduced

Froese and Pauly (2018a) list *Labeo rohita* as introduced to Madagascar, Mauritius, Zimbabwe, Bhutan, Cambodia, Philippines, Sri Lanka, Thailand, and Vietnam. It is listed as introduced but not established in China, Japan, Laos, and Malaysia.

From Froese and Pauly (2018a):

“Found in Gaylegphug ponds [Bhutan] [Petr 1999].”

“Introduced into Peninsular India [Menon 1999].”

“Established in aquaculture through assisted/artificial reproduction [in Philippines]. It has not established in the wild [Welcomme 1988]. Recorded from Candaba Swamp and Pampanga River [in Philippines] [Paz-Alberto et al. 2009]. Reported from Lake Taal [Mercene 1997], also in Laguna de Bay [in Philippines] [Palma et al. 2005].”

“Very common throughout the dry zone [of Sri Lanka].”

“Present in Da River [Vietnam] [Bui et al. 2009; Nguyen et al. 2011].”

“Has not been reported to breed in natural water bodies [in Laos] [Saphakdy and Rodger 2005].”

“Established in aquaculture through assisted/artificial reproduction [in Malaysia]. Has not established in the wild [Welcomme 1988].”

FAO (2018) lists *Labeo rohita* as introduced to Bhutan, Sri Lanka, Laos, Thailand, Former USSR, Philippines, Madagascar, Japan, Pakistan, Malaysia, Vietnam, Mauritius, China, Saudi Arabia, Nigeria, Zimbabwe, and Cambodia. FAO (2018) lists the status in the wild in Vietnam, Mauritius, China, and Cambodia as ‘established’; in Thailand and Saudi Arabia as ‘probably not

established'; and 'not established' in the former USSR, Philippines, Japan, Malaysia, Nigeria, and Zimbabwe.

Means of Introduction Outside the United States

From Froese and Pauly (2018a):

"It has been introduced to other areas of India beyond its natural range for aquaculture in ponds, and reservoirs (Jagannatham 1946; Thyagarajan and Chacko 1950) and also to the Godavari and Krishna rivers (David 1983). Because of its fast growth and high quality flesh, it has also been introduced to other countries, including the former USSR, Japan and the Philippines (Jhingran 1982)."

FAO (2018) lists the reason of introduction for *Labeo rohita* as aquaculture.

Short Description

From Jena (2006):

"Body bilaterally symmetrical, moderately elongate, its dorsal profile more arched than the ventral profile; body with cycloid scales, head without scale; snout fairly depressed, projecting beyond mouth, without lateral lobe; eyes dorsolateral in position, not visible from outside of head; mouth small and inferior; lips thick and fringed with a distinct inner fold to each lip, lobate or entire; a pair of small maxillary barbels concealed in lateral groove; no teeth on jaws; pharyngeal teeth in three rows; upper jaw not extending to front edge of eye; simple (unbranched) dorsal fin rays three or four, branched dorsal fin rays 12 to 14; dorsal fin inserted midway between snout tip and base of caudal fin; pectoral and pelvic fins laterally inserted; pectoral fin devoid of an osseous spine; caudal fin deeply forked; lower lip usually joined to isthmus by a narrow or broad bridge; predorsal scale 12-16; lateral line distinct, complete and running along median line of the caudal peduncle; lateral line scales 40 to 44; lateral transverse scale-rows six or six and a half between lateral line and pelvic fin base; snout not truncate, without any lateral lobe; colour bluish on back, silvery on flanks and belly."

Biology

From Froese and Pauly (2018a):

"Adults inhabit rivers [Talwar and Jhingran 1991]. Are diurnal species and usually solitary. They burrow occasionally. Feed on plants. Spawning season generally coincides with the southwest monsoon. Spawning occurs in flooded rivers. Fecundity varies from 226,000 to 2,794,000 depending upon the length and weight of the fish and weight of the ovary."

"Spawns in middle reaches of rivers, where flood water spreads in more or less limpid shallows over fertile flats, well above tidal reaches; also in reservoirs and bundh-type tanks."

"Inhabits rivers [Talwar and Jhingran 1991]. A diurnal species and usually solitary. Burrows occasionally. […] Feeds on detritus, plants and invertebrates [Alikunhi 1958]. Reproductive

migration during the monsoon season towards shallow waters of flood plains. Non-spawning adults usually found feeding in littoral zones."

From Jena (2006):

"In its early life stages rohu prefer zooplankton, mainly composed of rotifers and cladocerans, with phytoplankton forming the emergency food. In the fingerling stage, there is a strong positive selection for all the zooplanktonic organisms and for some smaller phytoplankters like desmids, phytoflagellates and algal spores. On the other hand, adults show a strong positive selection for most of the phytoplankton. In the juvenile and adult stages rohu is essentially an herbivorous column feeder, preferring algae and submerged vegetation. Furthermore, the occurrence of decayed organic matter and sand and mud in its gut suggests its bottom feeding habit. The nibbling type of mouth with soft fringed lips, sharp cutting edges and absence of teeth in the bucco-pharyngeal region helps the fish to feed on soft aquatic vegetation which do not require seizure and crushing. The modified thin and hair-like gill rakers also suggest that the fish feed on minute plankton through sieving water. In ponds, the fry and fingerlings exhibit schooling behaviour mainly for feeding; however, this habit is not observed in adults."

Human Uses

From Froese and Pauly (2018a):

"Fisheries: highly commercial; aquaculture: commercial; gamefish: yes"

"Extensively stocked in ponds throughout the country [Bangladesh]. Genetic research for the aquaculture sector is being done in the country [Nguyen 2004]."

"Sold for 65-70 Rs/kg at the Kathmandu market in March 1992."

"Labeo rohita is the most highly valued of all carp species farmed using traditional or newly-developed aquaculture systems in the Indian subcontinent. It has been introduced to other areas of India beyond its natural range for aquaculture in ponds, and reservoirs (Jagannatham 1946; Thyagarajan and Chacko 1950) and also to the Godavari and Krishna rivers (David 1983). Because of its fast growth and high quality flesh, it has also been introduced to other countries, including the former USSR, Japan and the Philippines (Jhingran 1982)."

"Rohu has also been exported recently to Canada, the middle East and the U.K., though on a small scale, for Bengali citizens."

From Jena (2006):

"Rohu (*Labeo rohita*) is the most important among the three Indian major carp species used in carp polyculture systems."

According to Casal (2006), 795,128 metric tons of *Labeo rohita* were produced in aquaculture in 2000.

Diseases

Infection with *Aphanomyces invadans* is an OIE-reportable disease.

From Froese and Pauly (2018a):

"Water mold Disease (l.), Fungal diseases
White spot Disease, Parasitic infestations (protozoa, worms, etc.)
Water mold Disease (e.), Fungal diseases
Fish louse Infestation 1, Parasitic infestations (protozoa, worms, etc.)
Dactylogyrus Gill Flukes Disease, Parasitic infestations (protozoa, worms, etc.)
Trichodinosis, Parasitic infestations (protozoa, worms, etc.)
Sporozoa-infection (*Myxobolus* sp.), Parasitic infestations (protozoa, worms, etc.)
Ichthyophthirius Disease, Parasitic infestations (protozoa, worms, etc.)
Neascus Disease, Parasitic infestations (protozoa, worms, etc.)
Thelohanellus Infection 2, Parasitic infestations (protozoa, worms, etc.)
Sachalinorhynchus Disease, Parasitic infestations (protozoa, worms, etc.)
Aeromonosis, Bacterial diseases"

Froese and Pauly (2018b) list *Aspidogaster piscicola*, *Cucullanus gonii*, *C. khalili*, *C. laeviconchus*, *Ectenurus papillatus*, *Fellodistomum agnotum*, *Neoergasilus kherai*, *Senga pathankotensis*, and *Thaparocleidus kheri* as parasites of *Labeo rohita*.

Jena (2006) lists *Aeromonas* spp., *A. hydrophila*, *A. sorbia*, *Pseudomonas* spp., *Flavobacterium columnaris*, *Saprolegnia parasitica*, *Branchiomyces demigrans*, *Ichthyophtirius multifilis*, *Dactylogyrus* spp., *Gyrodactylus* spp., *Trichodina reticulata*, *T. negre*, *Myxobolus bengalensis*, *M. hosadurgensis*, *M. sphericum*, *M. rohitae*, *Diplostomum pigmentata*, *Argulus* spp., and *Aphanomyces invadans* as parasites and pathogens of *Labeo rohita.*

Poelen et al. (2014) list *Acinetobacter ursingii*, *Methylobacterium gregans*, *Serratia marcescens*, *Haplorchis taichui*, *Pseudochauhanea elongatus*, *Dactylogyrus speciosus*, *Neodactylogyrus raipurensis*, *Mazocraes mamaevi*, *Rhabdochona nemacheli*, *Opisthorchis bilabiata*, *Opisthorchis caninus*, *Opisthorchis gurdaspurensis*, *Neoechinorhynchus formosanus*, *Acanthogyrus acanthogyrus*, *Acanthogyrus guptai*, *Dispiron heteroacanthus*, *Neoechinorhynchus gibsoni*, *Acanthosentis antspinis*, *Pallisentis kalriai*, *Bothriocephalus teleostei*, *Senga ophiocephalina*, *Gangesia bengalensis*, *Gangesia rohitae*, *Gyrodactylus elegans*, *Gyrodactylus medius*, *Dactylogyrus labei*, *Pseudochauhanea elongata*, *Procamallanus rohitai*, *Rhabdochona alii*, *Rhabdochona labeonis*, *Rhabdochona sarana*, *Cucullanus jalnaensis*, *Pseudocryptogonimus pakisanensis*, *Lasiotocus rohitai*, *Prosogonotrema nickoli*, *Proctoeces maculatus*, and *Ligula intesinalis* as parasites and pathogens of *Labeo rohita.*

Threat to Humans

From Froese and Pauly (2018a):

"Harmless"

3 Impacts of Introductions

Many records of introduction were found, some of which resulted in established wild populations. No information on impacts of those populations was found.

4 Global Distribution

Figure 1. Known global distribution of *Labeo rohita*. Locations are in India, Pakistan, Nepal, Bangladesh, Myanmar, Thailand, China, and Vietnam. Map from GBIF Secretariat (2018).

According to FAO (2018), *Labeo rohita* is listed as probably not established in the wild in Thailand. The location in Thailand was not used as a source point for the climate match.

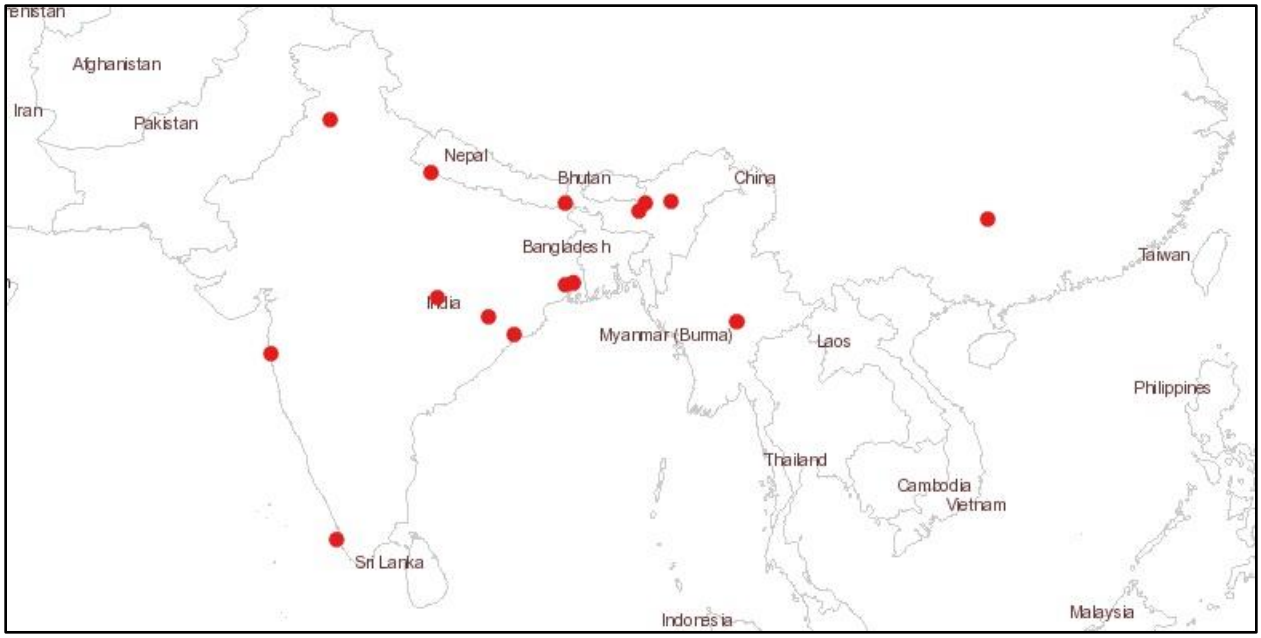

Figure 2. Additional known global distribution of *Labeo rohita*. Locations are in India, Nepal, Myanmar, and China. Map adapted from Froese and Pauly (2018a).

Figure 3. Additional known global distribution of *Labeo rohita*. Locations are in India, Pakistan, Nepal, Bangladesh, Myanmar, and Thailand. Map from VertNet (2018).

According to FAO (2018), *Labeo rohita* is listed as probably not established in the wild in Thailand. The location in Thailand was not used as a source point for the climate match.

5 Distribution Within the United States

No records of *Labeo rohita* in the United States were found.

6 Climate Matching

Summary of Climate Matching Analysis

The climate match for *Labeo rohita* was low for most of the contiguous United States. The coastal southeast had a medium match from North Carolina to Florida and there was a moderate area of medium to high match in the southwest centered on southern Arizona. The Climate 6 score (Sanders et al. 2014; 16 climate variables; Euclidean distance) for the contiguous United States was 0.008, medium. The range for a medium climate match is between 0.005 and 0.103. Only Arizona had a high individual climate score.

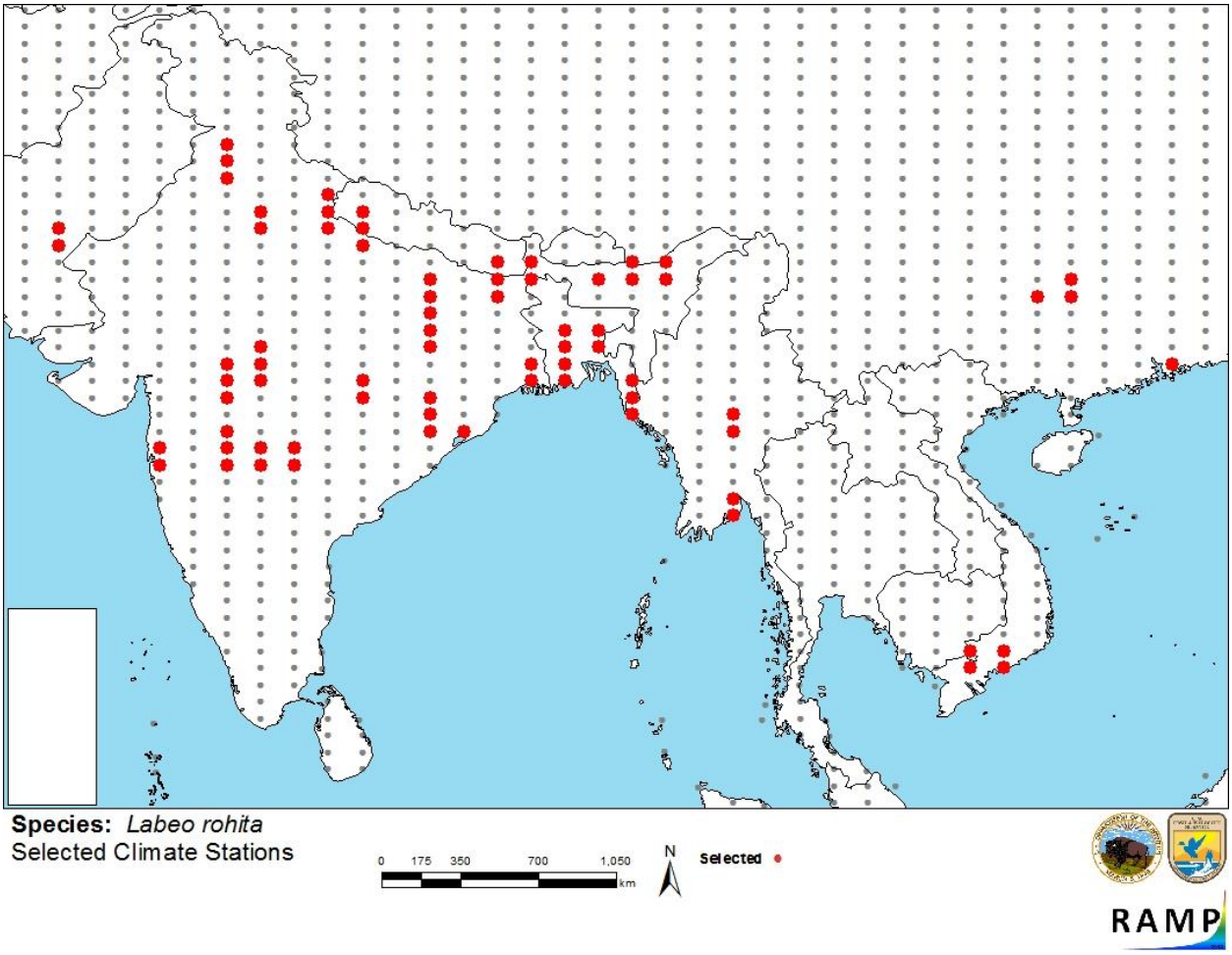

Figure 4. RAMP (Sanders et al. 2014) source map showing weather stations selected as source locations (red; Pakistan, India, Nepal, Bangladesh, Myanmar, China, Vietnam) and non-source locations (gray) for *Labeo rohita* climate matching. Source locations from FAO (2018), Froese and Pauly (2018), GBIF Secretariat (2018), and VertNet (2018).

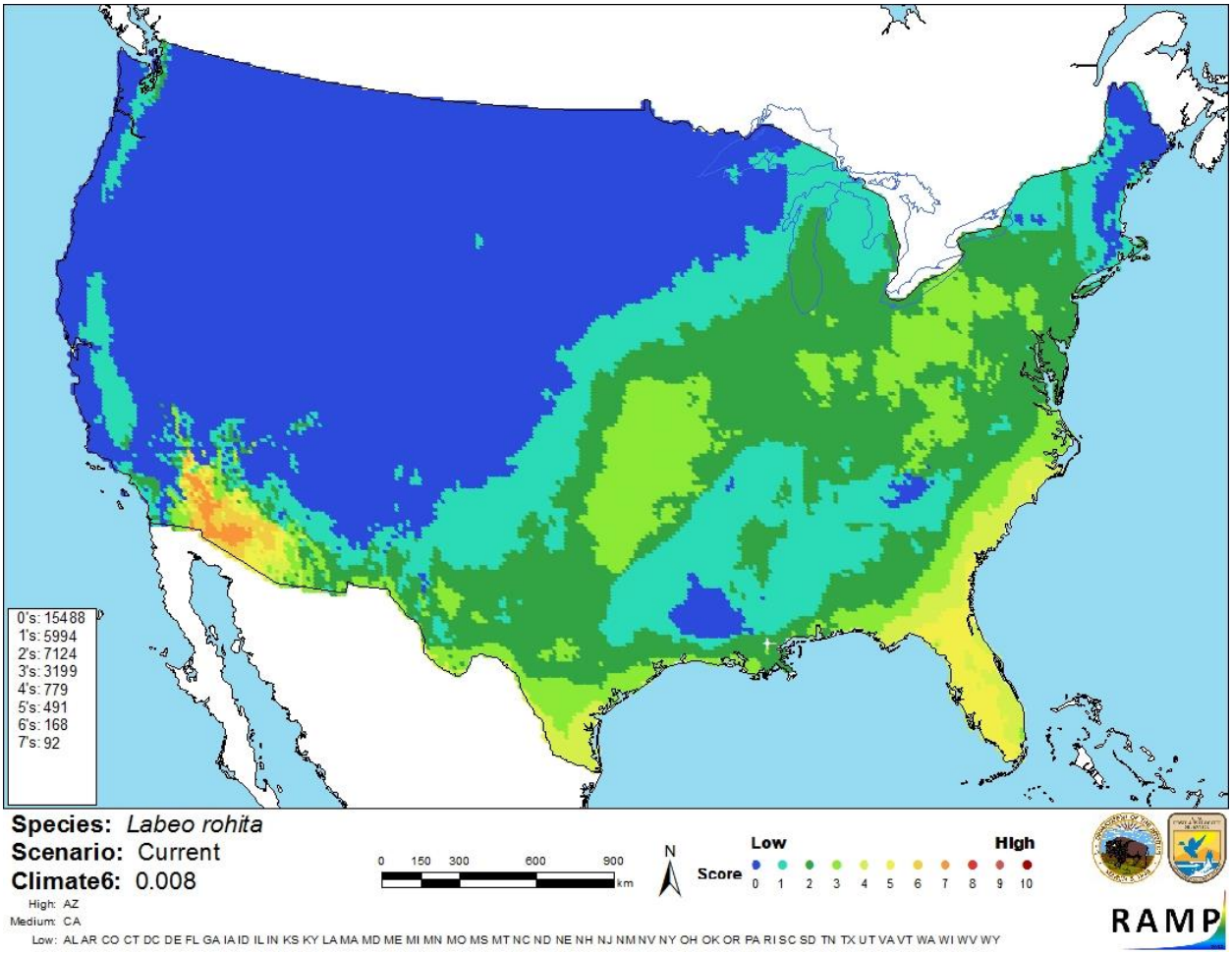

Figure 5. Map of RAMP (Sanders et al. 2014) climate matches for *Labeo rohita* in the contiguous United States based on source locations reported by FAO (2018), Froese and Pauly (2018), GBIF Secretariat (2018), and VertNet (2018). 0 = Lowest match, 10 = Highest match.

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

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

7 Certainty of Assessment

The certainty of assessment for *Labeo rohita* is low. There is quality information about the biology and ecology of *L. rohita*. There is also information on the volume of *L. rohita* in aquaculture. Although *L. rohita* has established beyond its native range, no information on impacts of introduction were available.

8 Risk Assessment

Summary of Risk to the Contiguous United States

Rohu Labeo *(Labeo rohita*) is native to Southern Asia, but has been widely introduced throughout Asia and parts of Africa for aquaculture purposes. This species is considered an important food source and is one of the primary species in aquaculture worldwide. There is no history of invasiveness documented. Though widely introduced with some populations established in the wild, there have been no reports or studies of adverse impacts from their introductions. *L. rohita* has been heavily in use in aquaculture since at least the middle of the 20th century. Many parasites, fungi, and pathogens are known to infect *L. rohita*. The climate match for *L. rohita* is medium and Arizona had a high individual climate score. The certainty of assessment is low. The overall risk assessment category is uncertain.

Assessment Elements

- **History of Invasiveness (Sec. 3): None documented**
- **Climate Match (Sec. 6): Medium**
- **Certainty of Assessment (Sec. 7): Low**
- **Remarks/Important additional information:** No additional information.
- **Overall Risk Assessment Category: Uncertain**

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.

Casal, C. M. V. 2006. Global documentation of fish introductions: the growing crisis and recommendations for action. Biological Invasions 8:3–11.

Eschmeyer, W. N., R. Fricke, and R. van der Laan, editors. 2018. Catalog of fishes: genera, species, references. Available: http://researcharchive.calacademy.org/research/ichthyology/catalog/fishcatmain.asp. (June 2018).

FAO (Fisheries and Agriculture Organization of the United Nations). 2018. Database on introductions of aquatic species. FAO, Rome. Available: http://www.fao.org/fishery/introsp/search/en. (June 2018).

Froese, R., and D. Pauly, editors. 2018a. *Labeo rohita* (Hamilton, 1822). FishBase. Available: https://www.fishbase.de/summary/Labeo-rohita.html. (June 2018).

Froese, R., and D. Pauly, editors. 2018b. *Labeo rohita*. *In* World Register of Marine Species. Available: http://www.marinespecies.org/aphia.php?p=taxdetails&id=281240. (June 2018).

GBIF Secretariat. 2018. GBIF backbone taxonomy: *Labeo rohita* (Hamilton, 1822). Global Biodiversity Information Facility, Copenhagen. Available: https://www.gbif.org/species/5206083. (June 2018).

ITIS (Integrated Taxonomic Information System). 2018. *Labeo rohita* (Hamilton, 1822). Integrated Taxonomic Information System, Reston, Virginia. Available: https://www.itis.gov/servlet/SingleRpt/SingleRpt?search_topic=TSN&search_value=163681. (June 2018).

Jena, J. K. 2006. *Labeo rohita* (Hamilton, 1822). Cultured Aquatic Species Information Programme. FAO Fisheries and Aquaculture Department, Rome.

Poelen, J. H., J. D. Simons, and C. J. Mungall. 2014. Global Biotic Interactions: an open infrastructure to share and analyze species-interaction datasets. Ecological Informatics 24:148–159.

Sanders, S., C. Castiglione, and M. Hoff. 2014. Risk assessment mapping program: RAMP. U.S. Fish and Wildlife Service.

VertNet. 2018. VertNet. Available: http://portal.vertnet.org/search?q=Labeo+rohita. (June 2018).

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.

Akhtar, N. 1991. Azad Jammu and Kashmir. Cold water fisheries development interim report. Report for Project PAK/88/048. FAO, Rome.

Alikunhi, K. H. 1958. Observations on the feeding habits of young carp fry. Indian Journal of Fisheries 5(1):95–106.

Archarya, P., and M. B. Iftekhar. 2000. Freshwater ichthyofauna of Maharashtra State. Pages 136–144 *in* A. G. Ponniah, and A. Gopalakrishnan, editors. Endemic fish diversity of Western Ghats. National Bureau of Fish Genetic Resources, Lucknow, India.

Bui, T. A., N. T. L. Anh, N. Q. Thai, and N. H. Son. 2009. Assessment for domestic fisheries in Son La. Ministry of Agriculture and Rural Development. Technical report.

David, A. 1983. Studies on the fish and fisheries of the Godavari and Krishna river system. Part I. Proceedings of the National Academy of Science of India (B) 33:263–286.

Frimodt, C. 1995. Multilingual illustrated guide to the world's commercial warmwater fish. Fishing News Books, Osney Mead, Oxford, England.

Galib, S. M., S. M. Abu Naser, A. B. M. Mohsin, N. Chaki, and F. H. Fahad. 2013. Fish diversity of the River Choto Jamuna, Bangladesh: present status and conservation needs. International Journal of Biodiversity and Conservation 5(6):389–395.

Gopalakrishnan, A., and V.S . Bashneer. 2000. Occurrence of *Labeo rohita* and *Cirrhinus mrigala* in Meenachil, Manimala and Pampa Rivers, Kerala. Pages 167–168 *in* A. G. Ponniah, and A. Gopalakrishnan, editors. Endemic fish diversity of Western Ghats. National Bureau of Fish Genetic Resources, Lucknow, India.

Jagannatham, N. 1946. A note on the introduction of rohu and mrigal into Madras waters. Indian Farming 7:292–296.

Jhingran, V. G. 1982. Fish and fisheries of India. Hindustan Publishing, Delhi, India.

Khan, H. A., and V. G. Jhingran. 1975. Synopsis of biological data on rohu *Labeo rohita* (Hamilton, 1822). FAO Fish Synopsis 111.

Lipton, A. P. 1983. Fish fauna of Tripura. Matsya 9–10:110–118.

Menon, A. G. K. 1999. Check list - fresh water fishes of India. Records of the Zoological Survey of India, Miscellaneous Publication, Occasional Paper 175.

Mercene, E. C. 1997. Freshwater fishes of the Philippines. Pages 81–105 *in* R. Guerrero III, A. Calpe, and L. Darvin, editors. Aquatic biology research and development in the Philippines. Proceedings of the First National Symposium, 1995, Los Baños, Laguna. PCAMRD Book Series 20.

Mirza, M. R. 2003. Checklist of freshwater fishes of Pakistan. Pakistan Journal of Zoology Supplemental Series (3):1–30.

Nguyen, T. T. T. 2004. Genetic considerations in fisheries and aquaculture with regard to impacts upon biodiversity. Aquaculture 9(3):5–9.

Nguyen, T. D. P., T. H. T. Nguyen, V. T. Do, T. T. Nguyen, and H. D. Nguyen. 2011. Freshwater ecosystem services and biodiversity values of Phu Yen District, Son La, Viet Nam. Pages 313–363 *in* Report on highland aquatic ecosystem services and biodiversity values, including livelihoods, trade, policy and conservation oriented inputs to two global online databases. Highland Aquatic Resources Conservation and Sustainable Development Project. Project 213015, Work Package 3 Report. Research Institute for Aquaculture, Viet Nam.

Pal, M., and N. Kundu. 2011. Freshwater ecosystem services and biodiversity values at Nainital, Uttrakhand. Pages 191–250 *in* Report on highland aquatic ecosystem services and biodiversity values, including livelihoods, trade, policy and conservation oriented inputs to two global online databases. Highland Aquatic Resources Conservation and Sustainable Development Project. Project 213015, Work Package 3 Report. Centre For

Environmental Management And Participatory Development, and Institute Of Environmental Studies And Wetland Management, Kolkata, India.

Palma, A. L., E. C. Mercene, and M. R. Goss. 2005. Fish. Pages 115–132 *in* R. D. Lasco, and M. V. O. Espaldon, editors. Ecosystems and people: The Philippine millennium ecosystem assessment sub-global assessment. College of Forestry and Natural Resources, University of the Philippines, Los Baños.

Paz-Alberto, A. N., E. S. Castro, V. L. Flores, and M. A. V. Romero. 2009. Endemic, indigenous and introduced species in the freshwater ecosystems of Nureva Ecija and Pampanga: Status, diversity and impacts. Silliman Journal 50(2):43–60.

Petr, T. 1999. Coldwater fish and fisheries in Bhutan. Pages 6–12 *in* T. Petr, editor. Fish and fisheries at higher altitudes: Asia. FAO, Fisheries Technical Paper 385, Rome.

Radhakrishnan, K. V., B. M. Kurup, B. R. Murphy, and S.-G. Xie. 2012. Status of alien fish species in the Western Ghats (India) as revealed from 2000-2004 surveys and literature analyses. Journal of Applied Ichthyology 28:778–784.

Rao, K. V. R. 1995. Pisces. Pages 483–506 *in* Fauna of Chilka Lake. Wetland Ecosystem Series 1. Zoological Survey of India.

Ray, D., and R. Mishra. 2011. Freshwater ecosystem services and biodiversity values at Buxa, West Bengal. Pages 123–189 *in* Report on highland aquatic ecosystem services and biodiversity values, including livelihoods, trade, policy and conservation oriented inputs to two global online databases. Highland Aquatic Resources Conservation and Sustainable Development Project. Project 213015, Work Package 3 Report. Centre for the Development of Human Initiatives, Jalpaiguri, India.

Riede, K. 2004. Global register of migratory species - from global to regional scales. Final Report of the R&D-Projekt 808 05 081. Federal Agency for Nature Conservation, Bonn.

Saphakdy, B., and K. Rodger. 2005. Alien aquatic species in Lao People's Democratic Republic. *In* D. M. Bartley, R. C. Bhujel, S. Funge-Smith, P. G. Olin, and M. J. Phillips, editors. International mechanisms for the control and responsible use of alien species in aquatic ecosystems. Report of an Ad Hoc Expert Consultation. Xishuangbanna, People's Republic of China, 2003. Rome, FAO.

Talwar, P. K., and A. G. Jhingran. 1991. Inland fishes of India and adjacent countries, volume 1. A.A. Balkema, Rotterdam, Netherlands.

Thyagarajan, S., and P. I. Chacko. 1950. Introduction of rohu and mrigal from Orissa State to Madras State. Indian Com. J.:1–4.

Tripathi, S. D. 1992. Three decades of research on carp hybridisation in India. Pages 00–00 [*sic*] *in* Symposium on Zoological Research in Relation to Man and Environment. Zoological Society, Calcutta, India.

Vidthayanon, C., A. Termvidchakorn, and M. Pe. 2005. Inland fishes of Myanmar. Southeast Asian Fisheries Development Center.

Welcomme, R. L. 1988. International introductions of inland aquatic species. FAO Fisheries Technical Paper 294.