

## Country reports

# Present status of alien species in aquaculture and aquatic ecosystem in Cambodia

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*There is currently no well documented evidence of exotic species causing environmental harm in Cambodia*

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## Introduction

Cambodia is fortunate to have some of the most productive freshwater fisheries in the world. The Mekong, Tonle Sap and Bassac rivers, their tributaries, a number of lakes, and a vast area of floodplain are rich in aquatic resources which support these inland fisheries. An estimated 500 freshwater fish species (Rainboth, 1996) occupy various ecological niches, including plankton feeders, detritus feeders, piscivores, and omnivores. The Great Lake on the Tonle Sap is the largest lake in Southeast Asia, and supports inland fish production that provides food security and income generation for millions of people living in the country. Fish is the main source of protein for Cambodian people, with an estimated average per capita consumption of 30 to 40 kg/person/year. Recent estimates of Cambodia's freshwater capture fisheries indicate annual catches of 400 000 tons per year, having an annual retail value between US\$ 250-300 million.

Increasing urbanization, industry expansion, and rapid population growth result in the alteration of natural ecosystems. These factors, coupled with conflicts in water management, overfishing, and illegal fishing activities are all contributing to observed declines in wild fish production from inland waters. Human interference with aquatic ecosystems impacts natural aquatic habitat and the biodiversity of aquatic flora and fauna. This includes freshwater fishes supporting commercial fisheries that are threatened, and several indigenous fish species that are either endangered or extinct in Cambodia.

As capture fisheries decline, aquaculture can play an important role by augmenting fish production to provide sustainable food resources for Cambodians. Aquaculture producers use seed from indigenous fish collected from the wild, and several exotic fish species that have been introduced to Cambodia. The use of alien species in aquaculture is believed to increase fish production and improve the livelihood of rural populations. However, alien species can be a significant threat to aquatic biodiversity, and they have the potential to disrupt local aquatic ecosystems.





from the wild or imported from Thailand and Viet Nam are commonly cultured in ponds. Shrimp farming peaked between 1994-1996 with production of 600-750 tons, after which it declined drastically amounting to only 50 tons in 2002. Seaweed (cottony II) was introduced to Cambodia in 1999 from Malaysia for coastal farming.

## Introduction of alien/exotic fish

Alien species, also called exotic or non-indigenous species, are species that are not native to a specific locality or ecosystem, although they may be found elsewhere in the same country or beyond the country's borders. They represent all phyla, from microorganisms to various plants and animals, and are both terrestrial and aquatic.

Introduction of exotic fish species into Cambodia has occurred for decades. Fish have been introduced intentionally or by accident for various uses including commercial production and recreational purposes.

Although Cambodia has rich indigenous fisheries resources, many different varieties of alien fish species have been introduced for farming since 1969 to supplement the demand for fish seed from wild. The most common introduced species in Cambodia include carps, tilapia and a number of other African species. These species are desirable because they are readily reproduced in captivity, exhibit fast growth and adapt well to pond systems. Environmental concerns arise when these alien species escape the confines of the pond and spread into natural aquatic ecosystems where they compete with native species.

Some fish are intentionally released into the wild in closed reservoirs and canals to enhance the natural stocks and increase fish populations. A number of fish species were released intentionally to control aquatic weeds, while others were introduced for ornamental purposes and were subsequently intentionally or accidentally into natural water bodies.

Under heavy rainstorms or seasonal flooding, fish may escape from farms that are not properly fenced or poorly sited. Introduced plants may harbor eggs of other species that are inadvertently introduced along with them. In some cases, exotic species are knowingly introduced into native waters by private business creating the possibility that they will out compete the natives.



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*The decline of endemic fishes is most often reported in association with disturbed and polluted habitats*

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## Status of alien species in the natural ecosystem

### INFORMATION ON EXOTIC FISH FROM MIGRATION STUDIES

Since 1997, the Fisheries Program of the Mekong River Commission (MRC) has been assessing local knowledge in the Lower Mekong River Basin. The objective of the study is to provide information on the life cycles of important Mekong River fish species including the location and seasonality of migration and spawning. Databases resulting from these studies include records of exotic fish species, including many *Hypophthalmichthys molitrix*, *Labeo rohita*, *Cyprinus carpio*, *Oreochromis niloticus* and *Oreochromis* sp. These species have been widely recognized and recorded by local fisherman along the Mekong and its tributaries.

The MRC surveys in the Mekong mainstream included 12 670 records documenting a total of 191 species. In Mekong tributaries 6 616 records documented 173 species. A detailed listing of the species recorded is found in Table 2.

Table 1. Information on alien species introduced in Cambodia for aquaculture

Common name	Species	Source	Year	Aquaculture Use	Established in the wild	Ecological impact	Socio-economic impact
Silver carp	<i>Hypophthalmichthys molitrix</i>	Taiwan Viet Nam	1969 1981	Widely	Few	Unknown	Beneficial
Bighead carp	<i>Aristichthys nobilis</i>	Viet Nam	1981	Widely	Few	Unknown	Beneficial
Grass carp	<i>Ctenopharyngodon idella</i>	Viet Nam	1981	Widely	Unknown	Unknown	Beneficial
Common carp	<i>Cyprinus carpio</i>	Taiwan Viet Nam	1969 1981	Widely	Few	Unknown	Beneficial
Rohu	<i>Labeo rohita</i>	Viet Nam	1986	Widely	Few	Unknown	Beneficial
Mrigal	<i>Cirrhinus mrigala</i>	Viet Nam	1980	Widely	Unknown	Unknown	Beneficial
Catla	<i>Catla catla</i>	Viet Nam	1980	Widely	Unknown	Unknown	Beneficial
Java tilapia	<i>Oreochromis mossambicus</i>	Viet Nam	1980	Widely	Yes	in reservoir	Beneficial
Nile tilapia	<i>Oreochromis niloticus</i>	Viet Nam	1980	Widely	Yes	in reservoir	Beneficial
Red tilapia	<i>O. niloticus</i> x <i>O. mossambicus</i>	Thailand	1991	Widely	Unknown	Unknown	Beneficial
Hybrid catfish	<i>Clarias gariepinus</i> x <i>macrocephalus</i>	Viet Nam	1981	Widely	Unknown	Unknown	Beneficial
African catfish	<i>Clarias gariepinus</i>	Viet Nam	1981	Widely	Unknown	Probably yes	Beneficial
Giant gourami	<i>Osphronemus gouramy</i>	Viet Nam	2000	Few	No	Unknown	Beneficial
	<i>Pomacea canaliculata</i>	Asia	1990 1999	Rarely	Unknown	Adverse	Adverse
Silver pacu	<i>Piaractus brachypomus</i>	Viet Nam	2003	Unknown	Unknown	Unknown	Unknown
Cuban crocodile	<i>Crocodilus rhombiser</i>	Viet Nam	1986	Widely	Unknown	Unknown	Beneficial
Golden snail	<i>Pomacea</i> sp.	Thailand Viet Nam	1985 2001	Few	Yes	Adverse	Unknown
Seaweed	<i>Cottony II</i>	Malaysia	1999	Widely	Unknown	Unknown	Beneficial

Table 2. Recorded number of exotic species in the Mekong River mainstream and its tributaries

Species Name	Total Riparian Country Records	Total Cambodian Records	Provinces	Habitats	Remarks (for Cambodia only)
<i>Hypophthalmichthys molitrix</i>	57	27	Kratie, Stung Treng Kompong Cham, Kandal	Mekong River	40% do not know species name. 60% call as Chinese carp, Trey linh ( <i>Thynnichthys thynnoides</i> ) and Trey Krum Sar ( <i>Osteochilus melanopleurus</i> )
<i>Labeo rohita</i>	52	25	Kratie, Stung Treng Kompong Cham, Kandal	Mekong River	60% do not know species name. 40% call as Trey Krum ( <i>Osteochilus melanopleurus</i> ), Chinese Krum, Ka Ek Tmar, Ka Ek Crahom ( <i>Morulus chrysophekadion</i> )
<i>Cyprinus carpio</i>	96	27	Kratie, Stung Treng Kompong Cham, Kandal	Mekong River	63% do not know species name. 37% call as Trey Dong, Kachep, Panay, Keab Srong, Sawka keo or Trey Chen.
<i>Oreochromis niloticus</i> sp.	40	4	Kratie, Stung Treng Kompong Cham, Kandal	Mekong River	75% do not know species name. 25% call Tiger fish
<i>Hypophthalmichthys molitrix</i>	22	18	Kandal, Kompong Chhnang Stung Treng, Ratanakiri, Mondokiri	Tonle Sap and trib., Se Kong, Se San trib. Srepok trib., Srepok tributary	55% do not know species name. 40% call Trey linh Thom, linh Heu, or linh Kam 5% call silver carp
<i>Labeo rohita</i>	26	18	Kandal, Kompong Chhnang Stung Treng, Ratanakiri Mondokiri	Tonle Sap and trib., Se Kong, Se San trib. Srepok trib., Srepok tributary	90% do not know species name. 5% call Trey Kros ( <i>Osteochilus</i> ) 5% call silver carp
<i>Cyprinus carpio</i>		9	Kandal, Kompong Chhnang Stung Treng, Ratanakiri, Mondokiri	Tonle Sap, Se San, Srepok trib., Srepok tributary	88% do not know species name. 2% call Trey Pan Kov

#### EXOTIC FISH SPECIES IN FISHING LOT AREAS

This information on exotic species in fishing lot areas was gathered in the regions around Phnom Penh, and the provinces of Kandal, Kampong Cham, Siem Riep, and Battambang. Informal interviews were conducted with key participants including fishing lot researchers, fisherman, and fishing lot owners. The survey was focused on the annual production of exotic fish in fishing lot areas. The survey results are described below:

##### Phnom Penh

There is a fishing area in the outskirts of Phnom Penh City known as Chung Ek fishing lot or fishing lot number 1, which covers the area around Chung Ek Lake. The following four exotic species were caught in this area, common carp (*Cyprinus carpio*), bighead carp (*Aristichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), and tilapia (*Oreochromis* sp.)

During the fishing season of 1997-2000, the Chung Ek fishing lot reported capturing from 20-60 kg per year of these exotic species. As a result of the year 2000 fishery reform, this lot has been terminated and released to the fishing community. Recent communication with villagers fishing in this area indicate that the exotic species mix is predominately tilapia.

### Kandal Province

The exotic species production from fishing lot numbers 01, 03, 04, 05, 13, 14, 16, and 17 during the 1999-2000 harvest season was around 300 kg-500 kg/year. The catch was primarily common carp (*Cyprinus carpio*), Indian carp (*Labeo rohita*), and tilapia. Individual fish were small with sizes ranging from 0.2 kg to 1 kg per fish. Fishing gear included bag and seine nets, and catches occurred from January to March.

### Kampong Cham Province

In Kampong Cham province during the fishing season of 1998-1999, exotic species caught in fishing lot number 10 included common carp (*Cyprinus carpio*), Indian carp (*Labeo rohita*), and tilapia. Approximately 50 to 60 Tilapia were captured per year with a size range from 0.3-0.5 kg/fish. Average sizes for the common and Indian carps were between 2-4 kg/fish. Long, trough shaped bamboo traps are used in this fishery and the season extends from October through December.

### Siem Riep Province

The quantity of exotic species caught from fishing lot numbers 04, 05, 06 and 07 in Siem Reap was approximately 1 600 kg in 1997-1998, and only 720 kg in 2000-2001. The primary exotic species was Rohu (*Labeo rohita*), referred to by local people as "Indian carp". Production statistics can be found in Table 3.

Table 3. Rohu (*Labeo rohita*) production from fishing lot Numbers 4, 5, 6, 7 in Siem Reap Province 1997-2001

Fishing lot Number	1997-98		1998-99		1999-00		2000-01	
	Weight (kg/head)	Quantity (kg)	Weight (kg/head)	Quantity (kg)	Weight (kg/head)	Quantity (kg)	Weight (kg/head)	Quantity (kg)
04	1-5	105	0.8-4	29	1-5	21	0.8-2	5
05	2-5	312	2-5	175	3-6	247	2-6	140
06	2.5-5	450	2-5	225	4-8	250	2.5-8	350
07	2-5	750	2-4	300	3-6	280	2-5	225
<b>Total</b>		<b>1617</b>		<b>729</b>		<b>798</b>		<b>720</b>

## Common ornamental fish species in Cambodia

Since the Angkor era of the 11th century the culture of ornamental fish culture has been a part of Cambodian tradition. Many famous authors in Cambodia such as Troeung Ngear and Pikho Som have written many pages about the beauty of fish in water. Some folk tales feature the wild gourami fish and many people are involved in the culture of this species. It is very popular for people to culture the Siamese fighting fish in small jars or bottles as a hobby and for competition, especially during the New Year's celebration.

Ornamental fish are mostly exotic species. Among 31 common ornamental fish species in Cambodia, there are 10 indigenous species and 21 exotic species. Exotic species are imported from Thailand, Viet Nam, Singapore and Malaysia. Some famous indigenous species like the Siamese fighting fish, or *Trey Krim* are also available in neighboring Thailand and Viet Nam. Tiger barbs (*Trey Khlar*) and the Asian bonytongue (*Trey Tapowt*) are expensive and popular

fish which can also be found in neighboring countries. Exotic species such as angelfish, koi, and gold fish which are easily bred in aquaria without hormone treatments are not imported to any significant degree.

Socioeconomics often dictates the species of fish hobbyists will enjoy. Most people, especially government staff, use inexpensive seed like goldfish which are readily available. Wealthier hobbyists possess more expensive species such as the Golden Asian Bonytongue, also known as the golden arowana or dragonfish. These fish are renowned for their beauty and good luck. As ownership of these fish for beauty and luck becomes more widespread, many people in the cities will be encouraged to culture them as a business. Businessmen currently import some exotic ornamental species from Thailand and Viet Nam, and also engage in local breeding programs for additional species. The culture of ornamental fish has been characterized as serving three purposes: 1. beauty, 2. small-scale business and 3. medium-scale business (Vaddhna, 1996).

Table 4. Exotic species caught in fishing lot Numbers 01, 02 and 03

Species	1999-00		2000-01	
	Quantity Kg/year	Weight Kg/head	Quantity Kg/year	Weight Kg/head
<b>Fishing lot Number 01</b>				
Indian carp ( <i>Labeo rohita</i> )	150	-	300	0.3-0.6
Common carp ( <i>Cyprinus carpio</i> )	no record	-	130	0.2-0.5
Silver carp ( <i>Hypophthalmichthys molitrix</i> )		-	70	0.2-0.5
<b>Total</b>	<b>150</b>		<b>500</b>	
<b>Fishing lot Number 02</b>				
Indian carp ( <i>Labeo rohita</i> )	12.5	2-3	-	-
Common carp ( <i>Cyprinus carpio</i> )	17	-	-	-
Silver carp ( <i>Hypophthalmichthys molitrix</i> )	14	-	-	-
<b>Total</b>	<b>43.5</b>			
<b>Fishing lot Number 03</b>				
Indian carp ( <i>Labeo rohita</i> )	-	2.5-5	-	-
Silver carp ( <i>Hypophthalmichthys molitrix</i> )	-	0.5	-	-
<b>Total</b>	<b>15*</b>			

\* Exotic carps not identified to species

## Impacts of introduced exotic species of fish

There is currently no well documented evidence of exotic species causing environmental risks in Cambodia. It is likely that exotic species in Cambodia are having both positive and negative impacts on various economies in the country, while one would anticipate that impacts on aquatic ecosystems and biodiversity would be detrimental. Introduced fish may hybridize with endemic fish species, alter habitats, impact water quality, compete for food and space, prey on native fish and result in the introduction of exotic parasites and diseases (Courtenay and Stauffer, 1984; Moyle *et al.*, 1986 and Arthington, 1989).

Introduction of exotic fish species for aquaculture could improve protein supplies and create job opportunities, especially for the rural poor located far from natural water bodies in remote locations. Most exotic species introduced in Cambodia are easy to breed and grow

very fast in pond environments with minimal inputs. On the other hand, introduction or aquaculture of exotic species in natural water bodies may reduce fishery catch.

There is no study in Cambodia documenting whether introduced fish have altered aquatic habitats or had other impacts on local species and populations. However, there are reports from elsewhere indicating that exotic species can change the biological, chemical and physical characteristics of local environments to the detriment of local species. Feeding behaviors of exotic fish that uproot plants and disturb sediments can impact prey items for indigenous fish that feed on organisms in lake or streambed sediments. The disturbance of bottom substrates by European carp (*Cyprinus carpio*) during feeding has been attributed to increased turbidity (McCrimmon, 1968). This has implications for other species that visually search for food and impacts photosynthetic abilities of plants. Loss of plants further destabilizes benthic sediments, water clarity continues to decline and the whole system spirals downward. Thus, environmental degradation results from loss of aquatic vegetation, erosion of riverbanks, increased water turbidity and higher nutrient levels. This can destroy habitat for native fish, invertebrates, and waterfowl.

Some introduced species compete aggressively with native species for food and space. Although some introduced fish successfully exhibit generalist feeding habits and trophic opportunism (Taylor *et al.*, 1984; Arthington and Mitchell, 1986), considerable overlap in the diets of introduced and endemic fishes have been reported in many systems (Arthington, 1989). Aggressive feeding of some species on certain plants could reduce their availability to local species. The decline of endemic fishes is most often reported in association with disturbed and polluted habitats. High reproductive rates of introduced species such as tilapia may easily result in offspring occupying space and using resources that would otherwise be available for use by endemic species. This is a serious concern, especially during the dry season when water is normally confined to small ponds.

Introduced species may prey on all life history stages of native fish including eggs, larvae, juveniles and adults. However, whether introduced species prey on local species is undocumented in Cambodia. Introductions of fish have been implicated in the importation of parasites and disease outbreaks. Although some parasites require intermediate hosts, many are not very host specific, and others have less complex life cycles.

#### EXISTING POLICIES ON INTRODUCTION OF FISH SPECIES

There are currently no detailed guidelines or regulations covering the importation of exotic species for culture that address environmental impact studies or environmental standards for fish farms. As a result, the development of freshwater aquaculture raises concerns about the potential negative impacts of introduced alien species on native fish stocks. Existing laws and regulations do, however, require activities undertaken be in compliance with international law including CITES, SPS, and the law of importation of goods.

The Department of Fisheries encourages culturing exotic species in earthen ponds or cages with appropriate safeguards in order to avoid the escape of these species into natural water bodies. The culture of indigenous fish species is one of the options that the Department of Fisheries is considering to further replace exotic species in aquaculture.



Table 5. The common alien ornamental fish culture in Cambodia\*

No.	Common name	Scientific name	Families
1	Black Ghost Knife Fish	<i>Sternarchus albifrons</i>	Apteronotidae
2	Giant gourami	<i>Ophronemus gouramy</i>	Anabantidae
3	Pearl gourami	<i>Trichogaster leeri</i>	Anabantidae
4	Red Finned Fish	<i>Metynnis</i> sp.	Characidae
5	Black Tetra Fish	<i>Gymnocorymbus</i> sp.	Characidae
6	Oscar	<i>Astronotus ocellatus</i>	Cichlidae
7	Angelfish	<i>Pterophyllum scalare</i>	Cichlidae
8	Discus	<i>Symphysodon discus</i>	Cichlidae
9	Jewel cichlid	<i>Hemichromis bimaculatus</i>	Cichlidae
10	Tiger Botia	<i>Botia macracantha</i>	Cobitidae
11	Koi	<i>Cyprinus carpio</i>	Cyprinidae
12	Goldfish	<i>Carassius auratus</i>	Cyprinidae
13	Bellybarred pipefish	<i>Hippichthys spicifer</i>	Indostomidae
14	Midget sucker catfish	<i>Hyostomus</i> sp.	Loricariidae
15	Guppy of million fish	<i>Poecilia</i> sp.	Loricariidae
16	Platy	<i>Platypoecilus maculatus</i>	Loricariidae
17	Badis	<i>Badis badis burmanicus</i>	Nandiae
18	Giant Arapaima	<i>Arapaima gigas</i>	Osteoglossidae
19	Swordtail	<i>Xiphophorus</i> sp.	Poeciliidae
20	Goonch	<i>Bagarius yarrelli</i>	Sisoridae
21	Malayan angel	<i>Monodactylus argenteus</i>	Toxotidae

\* The source and year of introduction of these ornamental fish is undocumented

#### FURTHER PLAN FOR CONTROLLING ALIEN SPECIES

- ▶ Cambodia should have strict rules for importing exotic animals including fish into Cambodia.
- ▶ Only species which have no negative impacts on the environment should be imported.
- ▶ Cambodia should promote aquaculture of exotic species but not in proximity to natural water bodies.
- ▶ The Ministry of Agriculture should prepare guidelines on the management and movement of fish and fish products.
- ▶ Implementation of international and regional codes of conduct should be undertaken.
- ▶ Aquaculture should be integrated with land use planning so that certain areas can be separated for aquaculture of exotic species.
- ▶ Fish stocking programs must release only indigenous species.
- ▶ More research should be carried out on the impacts of existing exotic species on the environment.

## Conclusion and Recommendations

Through surveys in fishing lots, exotic species production in five areas has been documented at approximately 1500-2000 kg per fishing season. The catch comprised primarily common carp (*Cyprinus carpio*), bighead carp (*Aristichthys nobilis*), silver carp (*Hypophthalmichthys molitrix*), and tilapia (*Oreochromis* spp.). Exotic species are present in great numbers in natural habitats of the Mekong River and its tributaries.

Given the landscape topography and seasonal flooding in the country, it is difficult for Cambodia to control the dispersal of alien fish in natural environments. Efforts to do so should involve collaboration among all countries within the greater Mekong/Langcang Basin.

There are no research programs in Cambodia to document annual production of exotic fish species in various habitats, or identify what impacts these exotics may have on other natural resources. As a result, if exotic species abundance increases in the future, it will be difficult to ascribe any changes in other natural resources to this increased abundance of exotic fish or other causes. This will complicate natural resource management. An impact assessment of exotic fish species in Cambodia should be developed. This would identify areas of concern, increase awareness, and improve the abilities of fisheries researchers and fisherman to identify alien species. A research program to study long-term impacts of exotic fish species on the environment and fisheries resources is very important for natural resource conservation and management.

Individual countries and their peoples have a responsibility help safeguard local environments from unwanted exotic fish species. The most important guideline to prevent alien fish from entering local environments is to not allow anyone to release exotic fish into waterways.

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