

Lateral Fish Migrations Between Tonle Sap River and Its Flood Plain

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INTRODUCTION

The Mekong River, like most of the major tropical rivers, is very dynamic, and living conditions for aquatic organisms are constantly changing. Almost all Mekong fish species are consequently adapted to exploit different habitats in different seasons, and are thus migratory by definition (Northcote 1984).

Spectacular seasonal movements of huge quantities of fish characterize the Mekong. Many fish species swim hundreds of kilometers in order to reach their spawning grounds or dry season refuges (Poulsen *et al*, 2000). These impressive longitudinal migrations sometimes make people forget the shorter and more localized movements, which are integrated components in the life cycles of most fish species and not less important for the survival of the fish.

The seasonality of tropical rivers leads to the shift between a production phase (the flood season) and the survival phase (the dry season). Fish stocks in the beginning of the flood season are small, and “diluted” due to the sudden increase in the surface covered with water, and plenty of food is available in the recently inundated areas. Consequently at the onset of the flood there is a significant movement of fish between the dry season refuges and the flood plain, which is now available for the benefit of fish growth and reproduction.

Different species, however, exploit the flood plain in different ways. Some species spawn in the main river channel depending on the current to transport and distribute eggs and larvae into the flood plain, other species lay their eggs directly on the flood plain.

When the flood recedes all the fish move to their dry season refuges, which can be the main river channel or permanent water bodies on the flood plain (Welcomme 1985, Lowe-McConnell 1987). Local fishermen know that and have for generations divided the fish into migratory “white fish” and non-migratory “black fish” (Bardach 1959).

Understanding these dynamics on a species basis is crucial for the proper management of the fish resources and although it is useful as a starting point, the categorization into “black fish” and “white fish” is too coarse for future management purposes. Increased species-specific knowledge will enable the subsequent grouping of species into ecologically appropriate management units.

In line with this, the objective of this study is to create an alternative grouping of commercial fish species of the Mekong based on species-specific ecological information obtained through interviews and sampling data from the Tonlé Sap River.

1.1 Study area

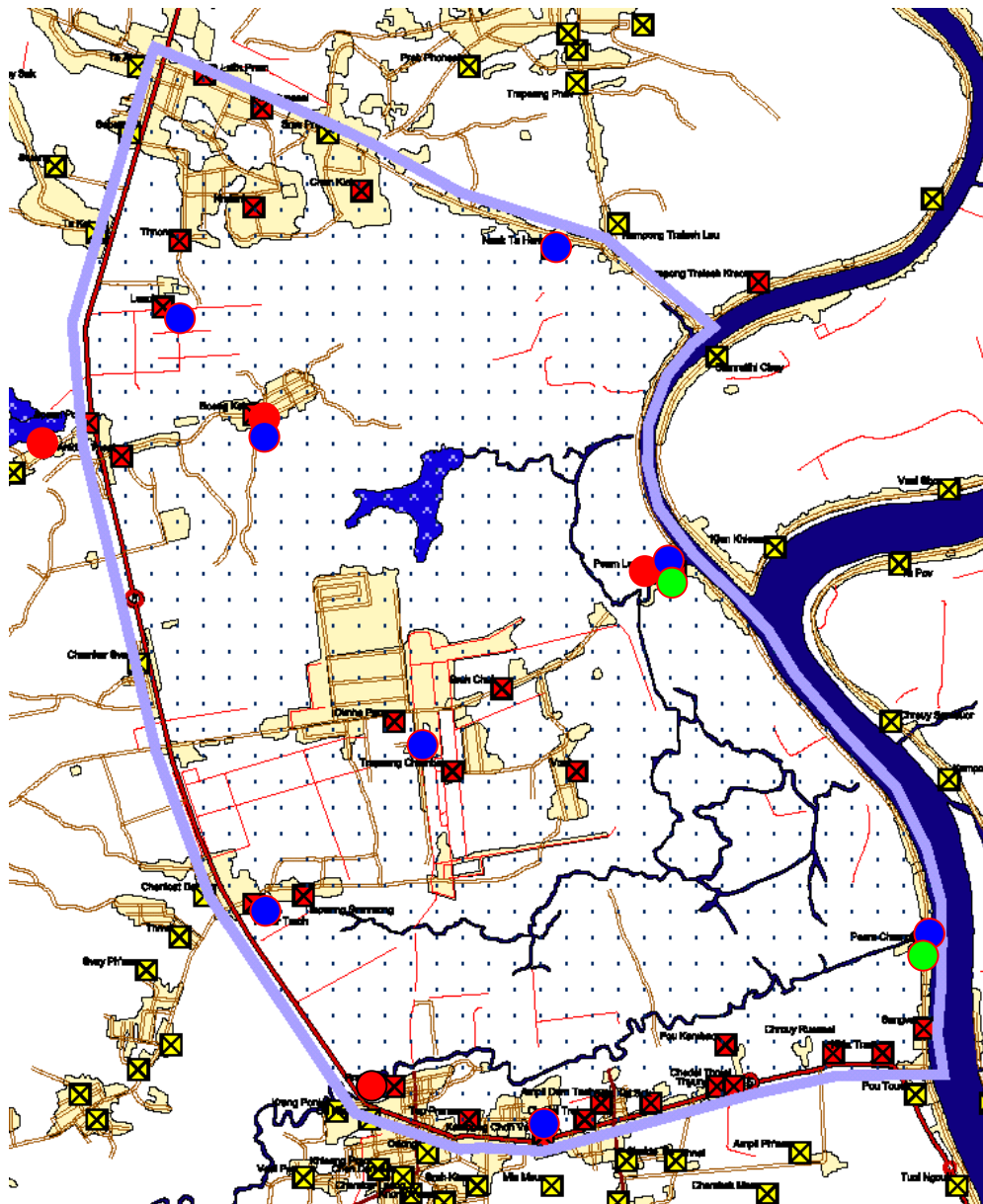


Figure 1: The study area. Blue dots show villages participating in the logbook survey, green dots indicate Lungvek and Piem Chumniek Canals, and red dots mark where fishermen were interviewed. An additional interview was done in an area outside the map.

The 120 km long Tonlé Sap River is an important tributary to the Mekong. It has its origin in the Great Lake and joins the Mekong at Phnom Penh. During the rainy season from June to September the water level of the Mekong River rises faster than the level of the Tonlé Sap, the current reverses, and the Tonlé Sap quickly overflows its banks thereby inundating vast areas for more than six months every year (Pétillot 1911, Pedersen 1999).

Owing to the construction of dikes/roads along the river, large parts of the flood plain are now partly isolated from the river. River water can only enter and exit the flood plain through canals that cut through the embankments. These canals are the main migration corridors for the fish that exploit the flood plain during the flood. Enormous amounts of fish pass through the relatively few and narrow passages twice a year, i.e. in the beginning of either the flood or the dry season.

This study focuses on the flood plain around Lot N^o 18, an area which is inundated by a mixture of the rising water from the Tonlé Sap River and rainwater coming from the mountains in the west. This flood plain consists of a mosaic of flooded forest, shrubs, grassland, rice fields and permanent and seasonal water bodies. In the past four canals connected the flood plain with the river in this area, but only two, Piem Lungvek and Piem Chumniek, still exist because the other two have been blocked (see fig. 1). Piem Lungvek is the largest canal and is accessible to fish throughout the year, while Piem Chumniek dries up in December/January. In the dry season approximately 12 lakes are left in the area, but if the flooding has been limited in a particular year, and there has been a long period of drought, only one lake, Boeng Prang, is left (for a more detailed description of the area please refer to Ouch & Dubeau 1999, Pedersen 1999 and Hatfield Consultants Ltd. 2000).

2. Material and Methods

Fishermen fishing all the year in different parts of the flood plain were interviewed about the occurrence of fish species in permanent water bodies. In addition, they were asked about the size of the fish and whether the fish had eggs and, if yes, in which months.

The results of the interviews were combined with data from two AMFC studies in 1999-2000: the logbook survey and the bagnet census.

The logbook survey involved 110 small-scale fishers from eight villages, who were fishing in different flood plain habitats (see fig. 1). The villagers registered their own catches for an entire year including species, and fishing habitat (Ouch & Dubeau 1999).

In the bagnet census, the lot fisheries in the mouth of Lungvek and Piem Chumniek canals were continuously monitored during the operation from October to May - a period of approximately 140 days. Sub-samples were taken from some of the lifts every day and all the species in the sub-samples were identified and weighed.

Based on the three datasets, the fish species have been grouped according to their life strategies.

3. Results and Discussion

The interviewed fishermen reported more than 100 species of fish from the flood plain occurring either seasonally or all the year. This is more than the 77 species and species groups that were recorded in a logbook survey in the same area (AMFC unpublished). In the lot inventory from Piem Chumniek and Lungvek canals, 74 species and species groups were identified (AMFC unpublished).

The fishermen further reported that 61 fish species have eggs during the time they occur on the floodplain. Based on this information an outline of the life strategies of the species: *Anabas testudineus*, *Notopterus notopterus*, *Cirrhinus microlepis*, *Henicorhynchus siamensis* and *Belodontichthys dinema* is given, these species represent different life strategies.

Annex 1 represents an attempt to create an alternative, ecologically more appropriate grouping of all the species covered in the study.

Anabas testudineus

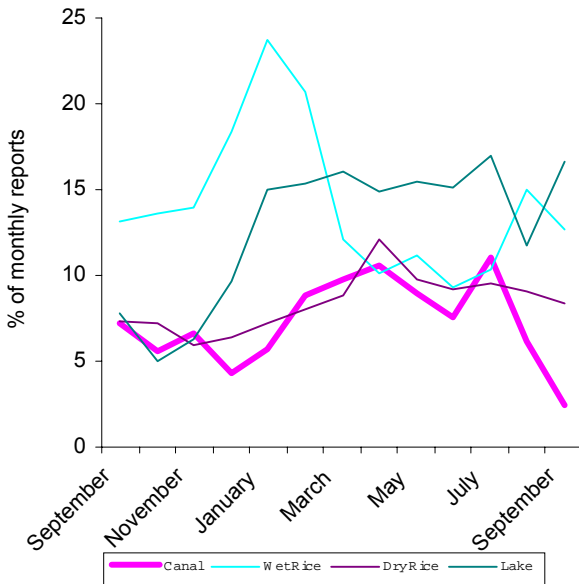


Figure 2: The percentage of monthly reports in the logbook survey reporting *Anabas testudineus*.

Anabas testudineus (Khmer name: Trey Kranh Srai) was reported to be present in the flood plain throughout the year, and this can be verified from the logbook data. *A. testudineus* occurred in a very high percentage of the catches all the year. The species has a preference for shallow standing water as can be seen by the high occurrence in the catches from the wet rice fields in the early dry season (fig. 2).

A. testudineus did not occur in the catches from the mouths of the two canals, so the species must be considered a permanent resident of the flood plain.

Eggs were reported in this species from May to August, which indicates a protracted spawning season, and further underlines the very opportunistic nature

of this species.

Notopterus notopterus

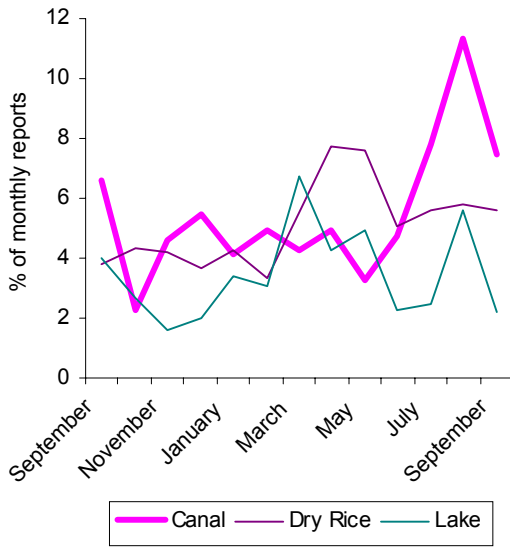


Figure 3: The percentage of monthly reports in the logbook survey of *Notopterus notopterus*

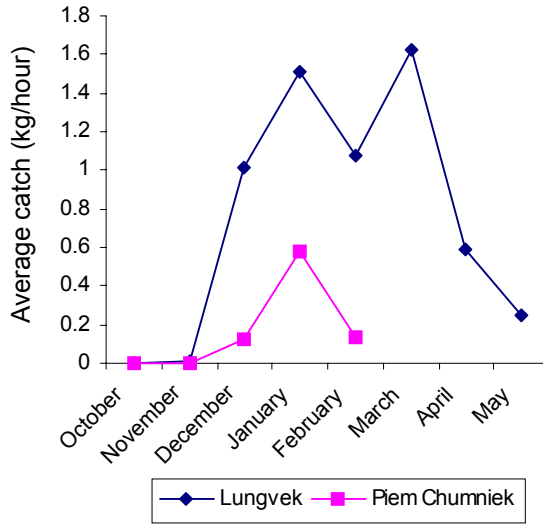


Figure 4: The monthly average catch (kg/hour) of *Notopterus notopterus* in the Lungvek and Piem Chumniek canals.

Notopterus notopterus (Khmer name: Trey Slat) was reported by the fishermen to occur in the flood plain all

the year. That statement can be verified from the logbook data, which also show that the species is caught all the year (fig. 3).

In August, there is a marked increase in the number of reported catches from canals. The catches in the canals decrease again in September. This pattern indicates that the fish move to other habitats (fig. 3). In December to March *N. notopterus* is caught in large amounts in the bagnet fisheries (fig. 4) implying that many individuals of this species are migrating to the Tonlé Sap River in order to disperse themselves towards the end of the dry season.

The fishermen also told us that *N. notopterus* have eggs in the abdomen in May-June, indicating that it is spawning in the flood plain during this period. It is reasonable to expect that all individuals of a certain species to spawn in the same habitat type. The fish retreating to the river are therefore probably returning to the flood plain in May-June in order to spawn with the flood plain sub-population.

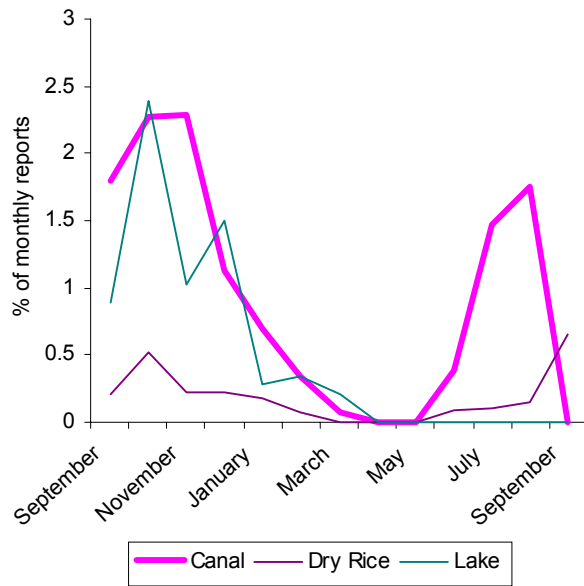
Cirrhinus microlepis

Figure 5: The percentage of monthly reports in the logbook survey of *Cirrhinus microlepis*.

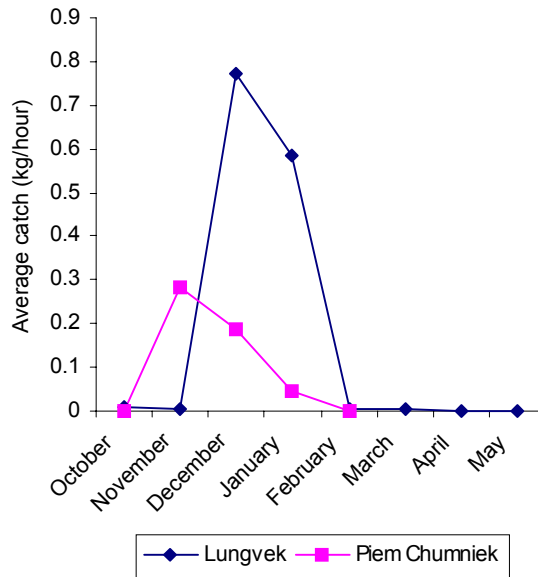


Figure 6: The monthly average catch (kg/hour) of *Cirrhinus microlepis* in the Lungvek and Piem Chumniek canals.

Cirrhinus microlepis (Khmer name: Trey Pruol): According to the fishermen this species only occurs in the flood plain in the flood season. Again this is consistent with the logbook data that show that the species has disappeared completely from the flood plain by the end of the dry season (fig. 5). At the time when *C. microlepis* disappears from the flood plain it starts appearing in the catches in Lungvek and Piem Chumniek canals (fig. 6) suggesting that it migrates to the Tonlé Sap River from where it returns with the flood the following year.

The fishermen never observed this fish with eggs. This is a strong indication that the species is spawning in the river, a conclusion which is consistent with earlier findings (Poulsen *et al*; 2000).

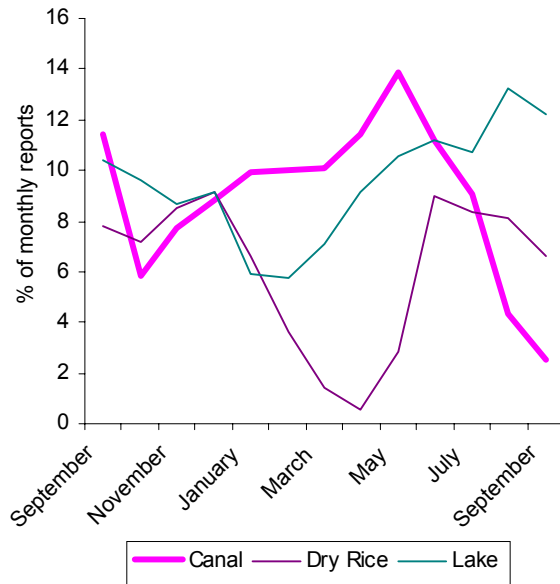


Figure 7: The percentage of monthly reports in the logbook survey of *Henicorhynchus siamensis*.

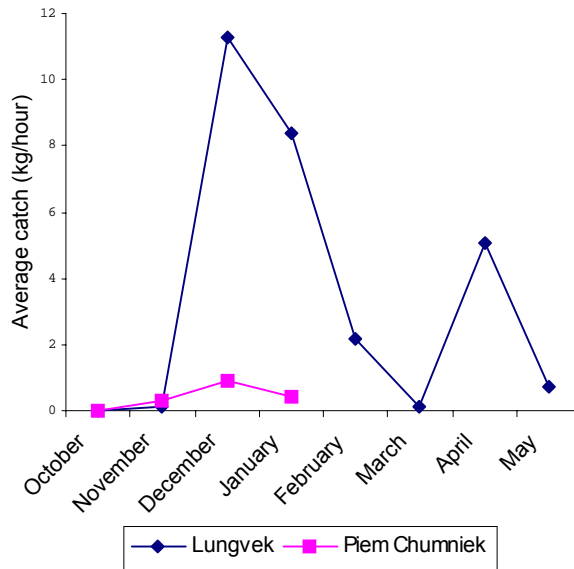


Figure 8: The monthly average catch (kg/hour) of *Henicorhynchus siamensis* in the Lungvek and Piem Chumniek canals.

Henicorhynchus siamensis (Khmer name: Trey Riel) was reported by some fishermen to be present in the flood plain all the year, while others claimed that it was only there in the flood season. The logbook data clearly show that *H. siamensis* is present in flood plain lakes all the year (fig. 7). *H. siamensis* is, however, a very important species in the lot fisheries so it is evident that part of the population migrates to the river in order to disperse (fig. 8). These are the fish that get caught in the *dai* fisheries further downstream, where it is one of the most important species (Lieng *et al.* 1995).

The fishermen pointed out that *H. siamensis* has eggs from May to June, in the early flood season, strongly indicating that the species is a flood plain spawner, although none of the fishermen had actually seen it spawn. This is contradictory to findings by Poulsen *et al.* (2000), who concluded that the species spawn in the main river channel. It is unlikely that the species spawn in two so distinct habitats. The explanation may be that it is actually a different species because the *Henicorhynchus* group probably consists of a number of very similar species, and further taxonomic clarification is needed.

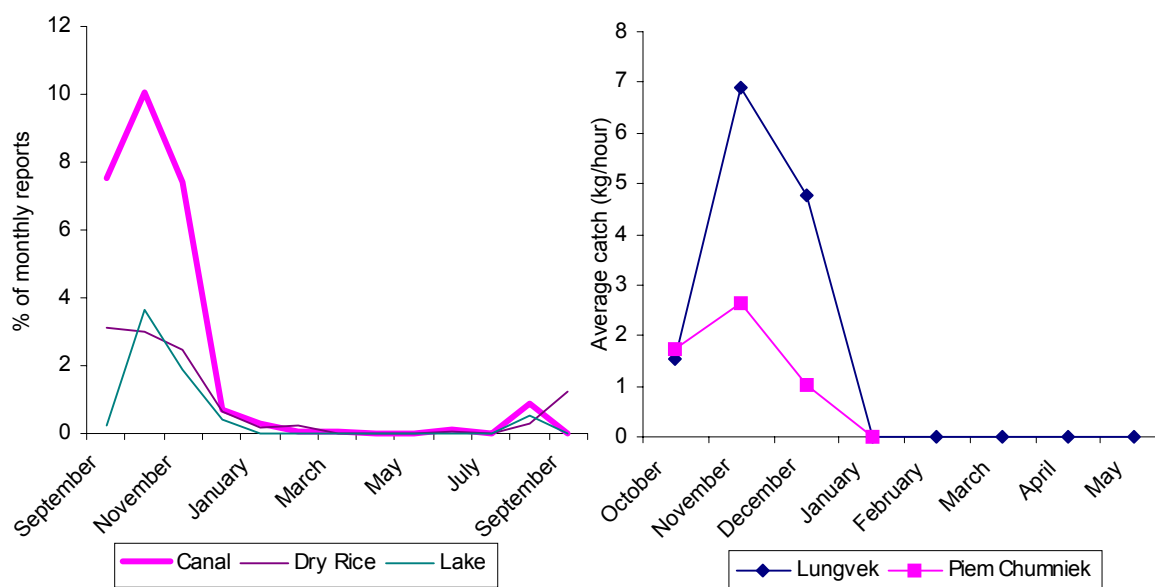
Belodontichthys dinema

Figure 9: The p
reports in the
Belodontichthys a

Belodontichthys dinema (Khmer name: Trey Klang Hay). According to some of the interviewed fishers this species occurs throughout the year in the flood plain. This cannot be confirmed by the logbook data, which clearly show that the species disappear completely from all flood plain habitats in the dry season (fig. 9). The very sharp increase in the catches of this species in the canal mouths in November-December also indicates that most individuals of *B. dinema* leave the flood plain (fig. 10) and migrate to the Tonlé Sap. *B. dinema* is very easy to identify so it is difficult to explain the discrepancy in the two data sets, and more studies are necessary to clarify the life cycle of this species.

None of the fishermen had seen this fish with eggs, suggesting that it spawns in the main river channel.

IMPLICATIONS FOR FISHERIES MANAGEMENT

While access to the flood plain of course is crucial to all the fish species making use of it, the impact of restricted access (due to dike constructions, etc.) to the inundated areas, will be different for species with different life strategies. Species that can complete their life cycles on the flood plain are less dependent on open access to the river than species entering the flood plain seasonally to spawn and feed. Only in exceptionally dry years, where most water-bodies on the flood plain disappear, do these fish need a connection to other parts of the flood plain in order to repopulate areas where all fish have become extinct.

However, fish living throughout the year on the flood plain are sensitive to over fishing. When the lakes diminish in size, the fish become increasingly concentrated in a small volume of water and are very susceptible to fishing; in this period some fishermen tend to empty the ponds completely, thereby harvesting everything.

It can be predicted that high fishing pressure in combination with limited access to the flood plain will have a devastating effect on the fisheries. The species least sensitive to environmental

changes and high fishing pressure are likely to be the species which have subpopulations with dry season refuges in both the river and on the flood plain.

RECOMMENDATIONS FOR FURTHER STUDY

It is recommended to start a sampling programme in permanent water bodies in the dry season in order to clarify contradictions in the present study, and also to quantify the fish populations using different dry season refuges.

Sampling fish entering the flood plain in the beginning of the flood through the two canals may provide additional information about the quantities of fish coming in from the river in addition to providing information on their spawning habits.

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ANNEX 1 Grouping of fish

Species living all the year in the floodplains		Species migrating from river to flood plain		Species partly migrating from river to floodplain partly staying on flood plain throughout the year	
Family and Species	Spawning habitat	Family and Species	Spawning habitat	Family and Species	Spawning habitat
NOTOPTERIDAE		CLUPEIDAE		NOTOPTERIDAE	
<i>Chitala ornata</i>	Floodplain	<i>Tenualosa thibaudeaui</i>	River?	<i>Notopterus notopterus</i>	Flood plain
CYPRINIDAE		CYPRINIDAE		CYPRINIDAE	
<i>Barbodes altus</i>	Unknown	<i>Albulichthys albuloides</i>	River?	<i>Cyclocheilichthys armatus</i>	Flood plain
<i>Barbodes gonionotus</i>	Flood plain	<i>Amblyrhynchichthys truncatus</i>	River?	<i>Cyclocheilichthys enoplos</i>	River?
<i>Barbodes schwanefeldi</i>	Unknown	<i>Catlocarpio siamensis</i> (Juveniles)	River?	<i>Cyclocheilichthys repasson</i>	Flood plain
<i>Dangila siamensis</i>	Flood plain	<i>Cirrhinus microlepis</i>	River?	<i>Dangila</i> sp.	Flood plain
<i>Hypsibarbus lagleri</i>	Unknown	<i>Cosmochilus harmandi</i>	River?	<i>Hampala macrolepidota</i>	Flood plain
<i>Hypsibarbus malcolmi</i>	Flood plain	<i>Crossocheilus siamensis</i>	River?	<i>Henicorhynchus siamensis</i>	Flood plain
<i>Hampala dispar</i>	Flood plain	<i>Garra fasciacauda</i>	River?	<i>Hypsibarbus wetmorei</i>	Flood plain
<i>Henicorhynchus cryptopogon</i>	Unknown	<i>Lobocheilus melanotaenia</i>	River?	<i>Luciosoma bleekeri</i>	Flood plain
<i>Hypsibarbus vernayi</i>	Flood plain	<i>Osteochilus microcephalus</i>	River?	<i>Morulus chrysophekadion</i>	Flood plain
<i>Leptobarbus hoeveni</i>	Unknown	<i>Osteochilus waandersii</i>	River?	<i>Osteochilus melanopleurus</i>	River?
<i>Macrochirichthys macrochirus</i>	Unknown	<i>Probarbus jullieni</i>	River?	<i>Paralaubuca typus</i>	Flood plain
<i>Osteochilus hasselti</i>	Flood plain	<i>Probarbus labeamajor</i>	River?	<i>Puntioplites falcifer</i>	Flood plain
<i>Osteochilus lini</i>	Flood plain	<i>Tor tambroides</i>	River?	<i>Puntioplites proctozyson</i>	Flood plain
<i>Osteochilus schlegeli</i>	Unknown	GYRINOCHEILIDAE		<i>Thynnichthys thynnoides</i>	Flood plain
<i>Scaphognathops bandenensis</i>	Flood plain	<i>Gyrinocheilus pennocki</i>	River?	COBITIDAE	
<i>Scaphognathops stejnegeri</i>	Flood plain	SILURIDAE		<i>Acanthopsis</i> spp	Flood plain
BAGRIDAE		<i>Hemisilurus mekongensis</i>	River?	<i>Botia modesta</i>	Flood plain
<i>Bagrithys macropterus</i>	Flood plain	PANGASIIDAE		<i>Botia helodes</i>	Flood plain
<i>Mystus singarigan</i>	Flood plain	<i>Helicophagus waandersi</i>	River?	BAGRIDAE	
CLARIIDAE		<i>Pangasius bocourti</i>	River?	<i>Hemibagrus nemurus</i>	Flood plain
<i>Clarias batrachus</i>	Flood plain	<i>Pangasius djambal</i>	River?	<i>Mystus mysticetus</i>	Flood plain
<i>Clarias macrocephalus</i>	Flood plain	<i>Pangasius macronema</i>	River?		

SYNBRANCHIDAE	
<i>Monopterus albus</i>	Flood plain
MASTACEMBELIDAE	
<i>Macrogathus siamensis</i>	Flood plain
<i>Mastacembelus armatus</i>	Flood plain
<i>Mastacembelus favus</i>	Flood plain
ANABANTIDAE	
<i>Anabas testudineus</i>	Flood plain
BELONTIDAE	
<i>Trichogaster pectoralis</i>	Flood plain
<i>Trichopterus trichopterus</i>	Flood plain
CYNOGLOSSIDAE	
<i>Cynoglossus microlepis</i>	Unknown

<i>Pangasius pleurotaenia</i>	River?
<i>Pangasius siamensis</i>	River?
SISORIDAE	
<i>Bagarius bagarius</i>	River?
HEMIRHAMPHIDAE	
<i>Hyporhamphus limbatus</i>	River?
CHANNIDAE	
<i>Channa limbata</i>	River?
SOLEIDAE	
<i>Euryglossa harmandi</i>	River?

SILURIDAE	
<i>Belodontichthys dinema</i>	River?
<i>Kryptopterus cheveyi</i>	Flood plain
<i>Kryptopterus kryptopterus</i>	Flood plain
<i>Micronema apogon</i>	Flood plain
<i>Micronema bleekeri</i>	Flood plain
<i>Ompok hypophthalmus</i>	River?
<i>Ompok krattensis</i>	Flood plain
<i>Wallago attu</i>	Flood plain
PANGASIIDAE	
<i>Pangasianodon hypophthalmus</i>	River?
<i>Pangasius larnaudiei</i>	River?
BELONIDAE	
<i>Xenentodon cancila</i>	Flood plain
CHANDIDAE	
<i>Parambassis wolffi</i>	Flood plain
LOBOTIDAE	
<i>Coius undecemradiatus</i>	River?
TOXOTIDAE	
<i>Toxotes microlepis</i>	River?
NANDIDAE	
<i>Pristolepis fasciata</i>	Flood plain
ELEOTRIDAE	
<i>Oxyeleotris marmorata</i>	Flood plain
CHANNIDAE	
<i>Channa lucius</i>	River?
<i>Channa micropeltes</i>	River?
<i>Channa striata</i>	Flood plain
TETRAODONTIDAE	
<i>Monotreta barbata</i>	Flood plain