CGIAR Challenge Program on WATER & FOOD

ADAPTIVE PARTICIPATORY INTEGRATED ASSESSMENT
AND AGRO- ECOSYSTEM ANALYSIS
TO SUPPORT DECISION-MAKING
ON WATER ALLOCATION FOR FISHERIES AND AGRICULTURE
IN THE TONLE SAP WETLAND SYSTEM

- Water allocation in the Tonle Sap -
Challenge Program project n°71 (CP71)

FISHERIES COMPONENT

Integrating fish resources to Agro-Ecosystem Analyses

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List of acronyms

APIA:	Adaptive Participatory Integrated Assessment
AEA:	Agro- Ecosystem Analysis
CP:	Challenge Program
CAEA:	Commune Agro-Ecosystem Analysis
CAAEP:	Cambodia Australia Agriculture Extension Project
DAE:	Department of Agriculture Extension
DWRMC:	Department of Water Resources Management and Conservation
FiA:	Fisheries Administration
IFReDI	Inland Fisheries Research and Development Institute
IWMI:	International Water Management Institute,
LMB	Lower Mekong Basin
MAFF:	Ministry of Agriculture and Fisheries
MOWRAM:	Ministry of Water Resources and Meteorology
TIP:	Technology Implementation Procedure

I INTRODUCTION

A. OVERVIEW OF THE CP71 PROJECT

1. In October 2005, a consortium of partners led by the International Water Management Institute (IWMI) proposed a project aimed at integrating fish resources management in agricultural management in the Tonle Sap area. This 2-years project assistance was accepted for funding by the Challenge Program on Water and Food and started in January 2008.

2. The overall goal of this project is to improve allocation and use of water in combined farming and fishing systems in order to enhance food security of rural communities and water productivity.

3. In order to facilitate and optimize agricultural management in Cambodia, the Ministry of Agriculture and Fisheries (MAFF) has developed, during the Cambodia Australia Agriculture Extension Project (CAAEP), a participatory **Commune Agro-Ecosystem Analysis (CAEA)** system; this analysis uses participatory assessments to empower local communities and improve decision-making at the commune level. The CAEA approach is currently implemented in all provinces of Cambodia and the MAFF has committed to further implementation throughout the country. Importantly, the MAFF has identified a clear demand for a fisheries component to be included in the CAEA.

4. In Cambodia freshwater capture fisheries ranks 4th in the world in terms of estimated total catch (approximately 400,000 tons per year) and these fisheries account for about 12% of the country GDP. These fisheries are vulnerable to hydrological and habitat modifications arising from agricultural and water management practices (Lorenzen *et al.* 2007). However some of these practices can also support fisheries or increase overall system productivity.

5. This project proposes to improve fisheries considerations in the CAEA process used at the commune level. It is based on the **Adaptive Participatory and Integrated Assessment methodology (APIA)** and aims in particular to determine key variables relating to the management of water for combined fisheries and agriculture systems, and to integrate these variables. The assumption is that enhanced consideration of fisheries will allow a more efficient water management for the development of sustainable agro-ecosystems and better inform current commune, provincial and national planning processes.

KEY APPROACHES

Agro-Ecosystems Analysis
The AEA is a consultative participatory methodology that generates information about agro-ecosystems; it allows identifying key issues raised by the development of agro-ecosystems, and helps classifying these issues and finding solutions, based on local priorities. The approach relies on interactions with farmers; it integrates and weights productivity, stability, sustainability and equitability in order to identify the best possible local management decision. This approach now forms the primary planning tool of the Cambodia's National Rural Development Program).

Adaptive Participatory and Integrated Assessment
APIA is a methodology addressing the impacts of irrigation on fisheries in tropical countries. The approach, focused on production and livelihoods, intends to support improved management and sustainability of land, water and fish resources. It builds upon frameworks for Environmental Impact Assessment but integrates across disciplines and sectors. The method was developed at IWMI (Nguyen Khoa *et al.* 2005a,b) and was tested in Lao PDR and Sri Lanka.

6. In short, the objective of this project is to integrate fisheries, thanks to the APIA experience and inputs from fisheries and water specialists, into the CAEA approach

7. The main project objectives are:
- to identify key fisheries variables to be considered in CAEAs through the contributions of an interdisciplinary team of scientists and local stakeholders at community and provincial levels
- to test the revised AEA trough a comparative analysis of initial vs. revised CAEAs in selected pair sites.
- to inform local and national stakeholders on the potential tradeoffs between agriculture development and fisheries, and the implications in terms of the allocation and management of water in agro-ecosystems

8. The main project outputs will be:
- improved guidelines for participatory Commune Agro-ecosystem Assessment considering fisheries in agro-ecosystems
- enhanced database capable of storing information from the assessments and producing summary reports of the information
- improved capacity of the core training team and provincial technical teams to implement the revised CAEA
- communication materials to document and disseminate the approach: training materials for the revised CAEA (English and Khmer languages); and documentation of technical and process lessons for international dissemination in two discussion papers

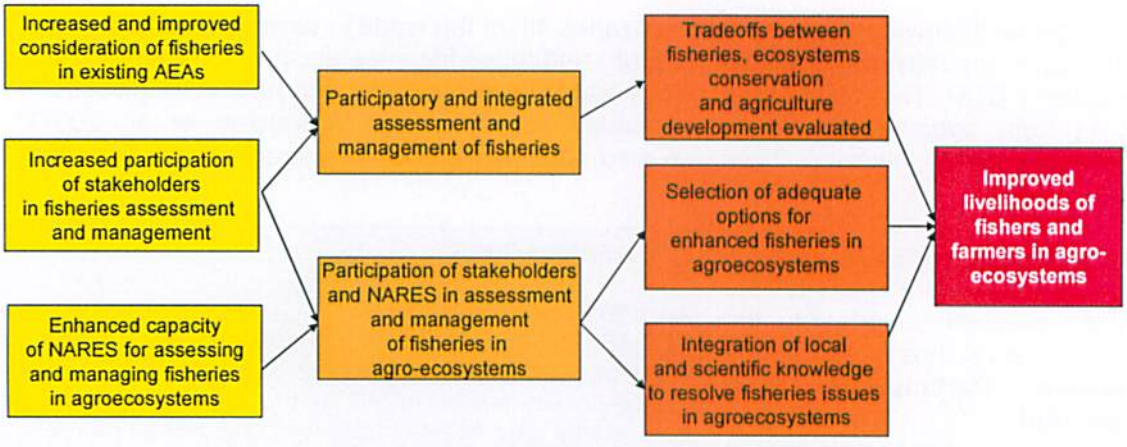


Figure 1: Simplified overview of the project

B. OVERVIEW OF THE FISHERIES COMPONENT IN THE CP71 PROJECT

9. The general objectives of the Fisheries component are:
- to contribute to the review of existing fisheries and aquaculture information, assessment and data collection systems and existing databases from a fisheries perspective
- to determine key questions that could be asked at the commune level that would enable the identification of fisheries issues for different agroecosystem zones. These would include both threats and potential threats to fisheries based on key ecological variables and opportunities that fisheries and aquaculture could represent in local livelihoods.

B.1. Background of the Fisheries component

10. This project is part of a string of activities focussing either on the Tonle Sap or on the whole Mekong Basin. It will take advantage of the previous projects, will create synergies current ones or will inform future ones. The section below details several of these activities.

11. Among the projects that can contribute most to the current activity can be named:
- – WorldFish/IWMI project **"Modeling the Management of Water Flows to Optimize Aquatic Resource Production in the Mekong Basin"** in 2000-2001. During this project factors driving the fish production in the Basin were identified (Baran *et al.* 2001, Arthington *et al.* 2004) and a model of the fish production in the Mekong Basin was produced (Baran *et al.* 2003).
- WorldFish's **"Mekong Initiatives"** project, in which Cambodian inland fisheries were reviewed (Baran 2005) and valued (Baran *et al.* 2007d), the biological requirements of important Cambodian fish species were summarised (Chheng *et al.* 2005, Leng *et al.* 2006), and the importance of migration factors was quantified (Baran 2007)
- – ADB/WorldFish **"Capacity building of IFReDI"**, phases I and II. During this project IFReDI biologists were trained, Tonle Sap fish biology was studied and a model of the Tonle Sap fish production was initiated (Baran and Jantunen 2005). This model focussed on hydrological, ecological and migration factors as drivers of fish production.
- CNMC/ADB/WorldFish project **"Influence of built structures on Tonle Sap fisheries"**. This project allowed identifying the hydrological requirements of Tonle Sap species (Baran *et al.* 2007a) and the respective role of various types of built structures (dams, irrigation schemes, roads, etc) on fish resources (Arthur *et al.* 2007, Baran *et al.* 2007b). During this project the BayFish model of Tonle Sap fish production was upgraded in order to integrate a fisheries component, and completed (Baran *et al.* 2007c). The project also identified the types of developments and modes of operation that are beneficial or detrimental to rural livelihoods (Ratner *et al.* 2007).

B.2. Activities planned in the Fisheries component

12. The specific activities of the Fisheries component are threefold: review of the situation, biological assessment and changes in the CAEA methodology to include fisheries resources, and reports including recommendations.

13. As a part of the **situation review**, the Fisheries component will:
- review with IFReDI staff the AEA collection systems and databases of the Department of Agriculture Extension (DAE), in order to understand what agroecosystem zones need to be considered and the structure, the logic of the database and potential for inclusions of fisheries-related information in the system;

- review the existing fisheries assessment methods, including the FiA fisheries demand assessment;
- review, together with staff from the FiA Divisions (CFDD, Aquaculture, Domain, Post-harvest etc.), the extension materials developed by each of the Divisions and identify to what extent these represent Technology Implementation Procedures (TIPs) for particular issues.
- identify what sorts of issues might need to be considered for each agroecosystem zone based on existing TIPs and information.

14. As a part of the **biological assessment and changes in the CAEA methodology**, the Fisheries component will:
- identify, in collaboration with IFReDI staff, the variables relevant to the description of sustainable fish production in agroecosystems. This includes i) hydrological, environmental, habitat, biological variables and fish responses to environmental changes (these variables will be identified on the basis of existing published ecological information and WorldFish models of Tonle Sap fish production), and ii) trends in fish catches (e.g. production, species composition, species targeted by fishers) in relation to changes in land use and water; these trends will be identified by reference to previous surveys of local ecological knowledge done by WorldFish and IFReDI.
- undertake, in collaboration with FiA staff and other stakeholders, an analysis of the potential fisheries opportunities and threats against agroecosystem zones using the reviews and the previous fish production assessments as a basis.

15. In terms of reporting, the Fisheries component will:
- summarize the conclusions of the situation review in a brief report
- summarize the variables relevant to the description of sustainable fish production in agroecosystems;
- summarize in a brief report information that it would be desirable for the CAEA process to generate for different AEA zones in a way that is compatible with the approach and structure of AEA collection systems and databases in place at the DAE, so that they can be integrated in these systems for data collection at the commune level. The report will include a checklist of key questions in fisheries issues;
- contribute to a review assessing the extent to which the CAEA process was able to successfully integrate fisheries aspects and generate information on fisheries issues;

16. The main outputs of the Fisheries component will be:
- an overview report integrating situation review, variables relevant to the description of sustainable fish production, and changes required in the CAEA process;
- a contribution to a possible article about project methods and findings in the Cambodian Journal of Agriculture by the end of the project.

II SITUATION REVIEW

A. REVIEW OF THE AEA COLLECTION SYSTEMS AND DATABASE

17. Discussions between IFReDI, WorldFish and DEA scientists, supplemented by field visits, have allowed identifying some specificities inherent to the respective approaches of fishery specialists and agronomists, as well as semantic issues detailed below.

A.1. Respective approaches and semantics

A.1.1. "Ecosystem": one word for two notions

18. While ecosystems can be simply defined as "all the interacting parts of the physical and biological world" (Ricklefs, 1990), agroecosystems are "ecological systems modified by human beings to produce food, fibre or other agricultural products" (Conway, 1987); as Conway stipulates, their complexity arises primarily from the interaction between socio-economic and ecological processes.

19. In brief, for an ecologist an ecosystem is a homogenous environment where a certain kind of animal can live and breed, while for a farmer an ecosystem (or more specifically an agroecosystem) is a heterogeneous set of environments from which he can extract various resources (Figure 2). In the first case the viewpoint is that of the animal or plant considered, in the second one the viewpoint is that of the farmer (including socio-economic considerations).

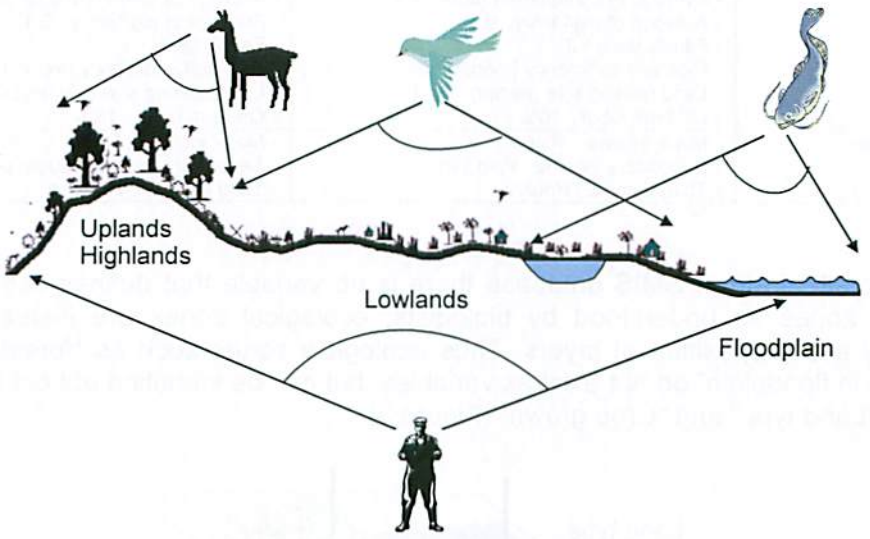


Figure 2: Different understandings of the word "ecosystem"

A.1.2. Consequences of different perceptions of "ecosystems"

20. The difference in perspectives has initially created some misunderstanding in the project between agronomy and fisheries scientists, who were using the same word with different meanings. Thus fisheries scientists searched the FSMIS database to identify within each commune a few ecosystems or ecological zones suitable to fish (e.g. rice fields,

floodplains) while for DAE scientists, the database is made of about 500 ecosystems, the word "ecosystem" being in this context synonymous of "commune".

21. Similarly there is misunderstanding between agronomists and fisheries scientists when using the term "agroecosystem zones". For Agronomists it mainly relates to a combination of physical, agronomic and socio-economic features (Land type, Soil type, Crops grown, Landholding, etc, see Table 1) whereas for fisheries scientists it only relates to physical features, but with a finer resolution than that necessary to agronomists. Thus the database does not allow specifying, for instance, whether a given agroecosystem zone includes ponds that *could be* used for aquaculture development, nor whether flooding originates from rainfall of from a swollen river. These points are essential to the identification of migration issues and of fish-related development options.

Table 1: Example of agroecosystem description in the FMSIS database

2. AE Name	Lowland Lower Terrace	Lowland Middle Terrace
3. Land Type	- Residential/homestead area - Lowland lower terrace	- Residential/homestead area - Lowland middle terrace
4. Topography	Gently sloping	Flat
5. Land Use	- Permanent agriculture	- Permanent agriculture
6. Cropping System	- Sequential multiple cropping	- Sequential multiple cropping
7. Crops Grown	- Dominant crop: Wet season paddy rice - Secondary crop: Maize - Third crop: Vegetables	- Dominant crop: Wet season paddy rice - Secondary crop: Vegetables - Third crop: Sweet potato
8. Water Source	Some irrigation: - Pump system	Some irrigation: - Pump system
9. Hydrology	Seasonally inundated Flood between Sep to Oct	Seasonally inundated Flood between Sep to Oct
10. Soil Type	Soil group : - Krakor cracking Soil fertility : - High soil fertility	Soil group : - Prateah Lang loamy subsoil Soil fertility : - Low soil fertility
11. Socio-eco	- Average of cattle/family labor : 1.3 - Average of pig/family : 0.6 - Family labor : 3 - Rice self-sufficiency (month) : 6 - Land holding size (hectar) : 0.61 - Off-farm labor : 16%	- Average of cattle/family labor : 1.3 - Average of pig/family : 0.45 - Family labor : 3 - Rice self-sufficiency (month) : 6 - Land holding size (hectar) : 0.62 - Off-farm labor : 18%
12. Income Source	- Major income : Rice - Secondary income : Wild fish - Third income : Poultry	- Major income : Rice - Secondary income : Sugar palm - Third income : Wild fish

22. More generally, in the FSMIS database there is no variable that defines ecosystems or ecological zones as understood by biologists; ecological zones are instead implicitly defined by a superposition of layers. Thus ecological zones such as "forested hills" or "rice fields in floodplain" do not exist as variables, but can be identified at best by crossing variables "Land type" and "Crop grown" (Figure 3).

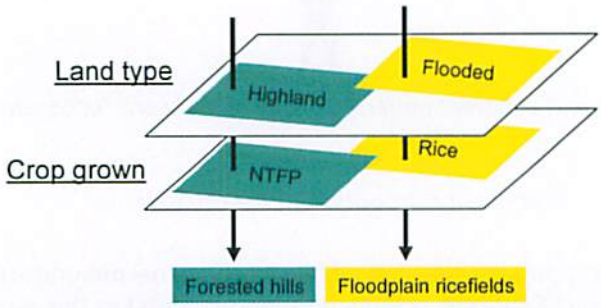


Figure 3: Identification of 2 ecological zones from database layers

A.1.3. Ecological zones relevant to fisheries in the database

23. On the previous bases, a request was transmitted to the DAE on 19/08/08, in order to extract from the FMSIS database a table, in Excel format, including, for each commune present in the CAEA database, all data available, in English, for the following LUT variables:
Commune; IrrigationType; Topography; WaterSource; IssuesInv; CropGrown; Hydrology; LandType; WaterReq; InundType; DiscipInv; LandUse; ProbAddressed; IncSource; SubSyst;

24. The intention was to run a multivariate analysis on this data table to identify patterns in data (e.g. floating rice concurrent with flooding, land use correlated to topography, income negatively correlated to highlands, etc). This systematic approach would thus have used the actual information from the database to create a typology of ecosystems reflecting the main associations between natural and agronomic components of the agroecosystem (Figure 4). Among the ecological zones identified, several zones would have involved fisheries issues.

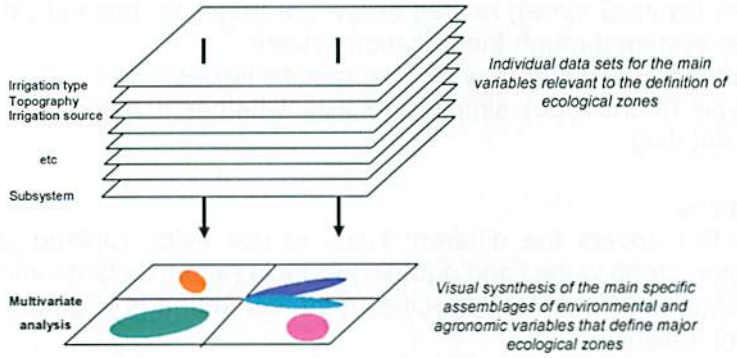


Figure 4: Data analysis approach for the definition of ecological zones

25. However it was made clear on 25/08/08 that the table needed could not be extracted from the database; the latter is strongly protected against external queries and interventions, and the DAE analysts do not have full access to this database that has been progressively created and secured by external consultants. As a consequence an alternative approach to the identification of ecosystem zones, based on expert knowledge, had to be devised.

26. In that perspective, land type is the main factor of importance to fish in the database. In the current CAEA approach and database, this variable includes 6 types of land: Highland; Upland; Lowland upper terrace; Lowland middle terrace; Lowland lower terrace; Residential area; Seasonally flooded. In fact, the first four categories correspond to altitude, while the two last ones apply to different levels of altitude (Figure 5).

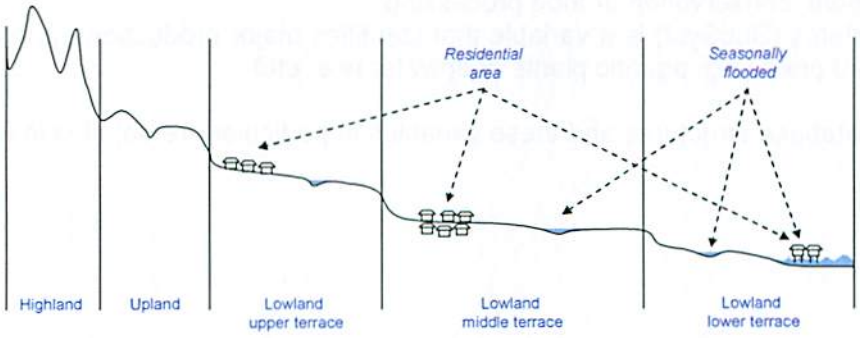


Figure 5: Land types in the current CAEA approach

A.2. Overview of the FSMIS database

27. The Farming Systems Management Information System (FSMIS database) of the DAE is clearly documented (Craig *et al.* 2004) and we won't review that database here; we simply propose an overview of that database highlighting a) project data gathered during the CAEAs; b) secondary data complementing the CAEA data, and c) variables of relevance when dealing with fisheries issues. The latter variables can be identified as follows.

28. Environmental variables
- - Commune; for location
- - Type of land (variable LandType); this is the most important variable from a fisheries perspective; it defines, in a transect, the altitude and the kind of natural environment
- - Topography; this complements the previous variable and gives indication about the land slope
- - Hydrology; this defines to what level a commune is flooded;
- - Origin of water (WaterSource); rainfed or level of irrigation; this indicates how wild fish can arrive in the system through the irrigation system
- for fish, and pump/groundwater may involve specific issues;
- - Inundation type (InundType) simply specifies whether if inundation originates from rainfall or from flooding.

29. Agriculture variables
- - Crop grown; this covers the different kinds of rice fields (upland, dry season, wet season, recession, deep water) and aquatic products (aquatic plants and fish farming);
- - Water requirements (WaterReq) specifies if the commune is irrigated, rainfed or both; this is significant to fish;
- - Type of irrigation (IrrigationType); reservoirs and canals have different ecological properties and suitability for fish, so it is important to distinguish the type of water bodies available;
- LandUse; defines the level of human influence (gradient from fully agricultural to full conservation area);

30. Social variables
- - Problems addressed (ProbAddressed) reflect fisheries issues through items such as lack of water, overuse of pesticides, poor fish pond management, poor water quality, lack of fish, overfishing or fish mortality;
- - Discipline involved (DiscipInv) identifies the need for intervention of fisheries or aquaculture specialists, among others;
- - Income sources (IncSource); in this variable pond fish and wild fish are identified as possible sources of income
- - Issues involved (IssuesInv); probably a minor variable but could concern fish via water management, conservation or food processing;
- - Sub-systems (SubSyst) is a variable that identifies major production systems including fish-related ones (e.g. aquatic plants deepwater rice, etc)

The overall database structures and these variables in particular are detailed in Figure 6.

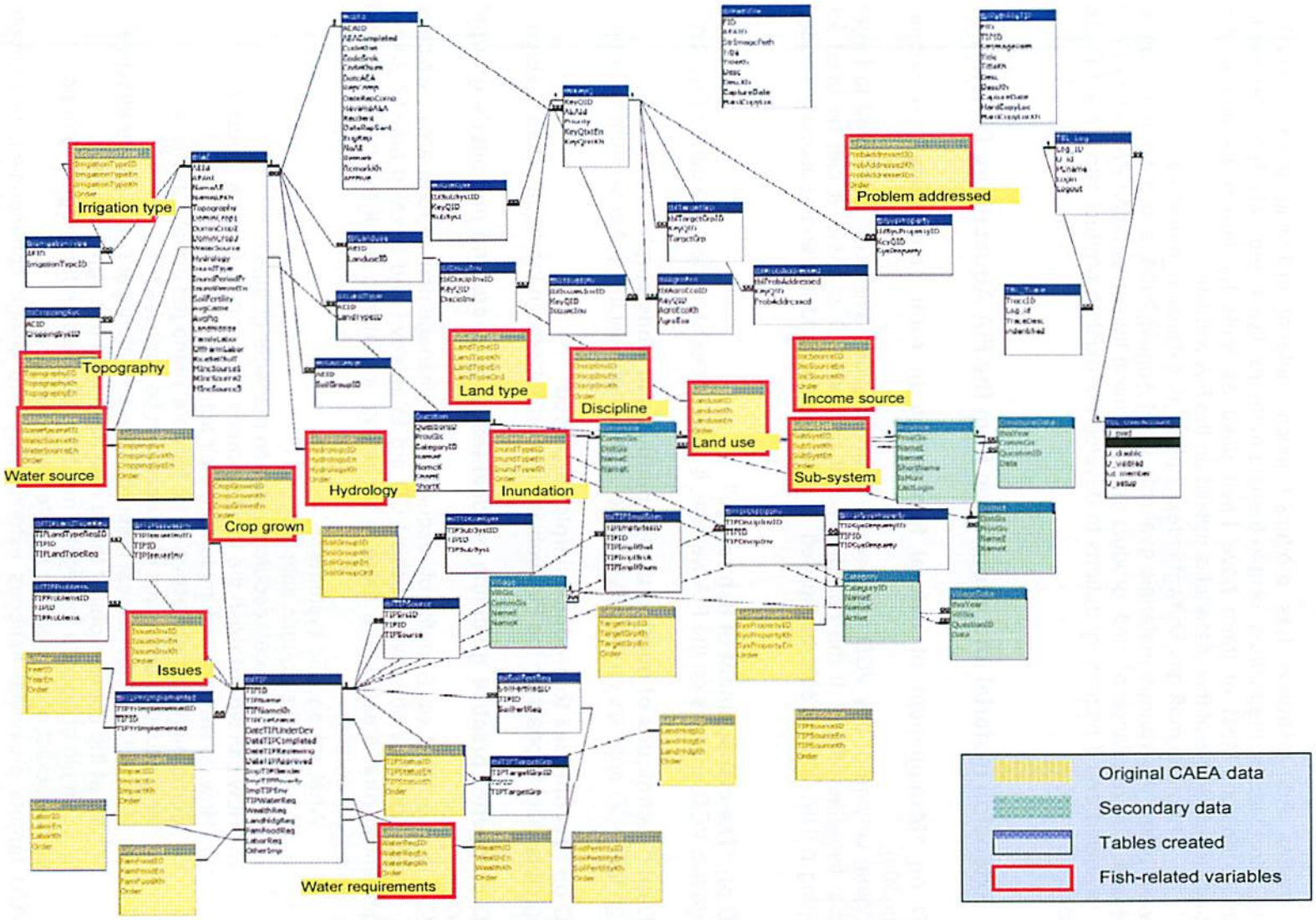


Figure 6: Structure of the FSMIS database and fish-related variables

B. REVIEW OF FISHERIES ADMINISTRATION EXTENSION MATERIAL AND INFORMATION

31. The Fisheries Administration has produced much material including posters, DVDs, booklets, short videos, magazines, simple training manuals, flyers, etc., which are related to fisheries extension. Most of them have been used as tools for farmer training at the community level. Some of this material is detaild on the FiA website:

http://fia.maff.gov.kh/twgf/index.php?page=extension_materials

We review below the various materials available as of August 2008, and detail their nature and content. The relevance of each product as a Technical Implementation Procedure (TIP) is also reviewed and if necessary options to develop the existing product into a full TIP are proposed.

B.1. Extension material and information from the FiA Aquaculture Division

32. **VCD on "Management of natural fish refuge in rural community"** (in Khmer, 20mn50s)

The original version of this VCD has been lost, and copies have been distributed to target provincial fisheries offices. If the narrative script of this VCD is found, it can be used for developing a TIP, which could be applied in both midland and lowland seasonally flooded zones.

33. **VCD on "The management of fish refuge"**

Although this VCD appears on the FiA website, it does not exist in the Aquaculture Division.

34. **VCD on "Techniques of nursing tilapia, puntius and white carp"**

Although this VCD appears on the FiA website, it does not exist in the Aquaculture Division.

35. **VCD on "Techniques to produce simple carp seed"**

Although this VCD appears on the FiA website, it does not exist in the Aquaculture Division.

36. **VCD on "better practice guideline of local resource users and manager's groups"** (in Khmer)

This VCD is also listed as "Benefits of resources user management in rural area", which is not its correct title. The objectives of this VCD are to improve and develop aquatic animal management in rural areas where there is no fishing, in order to meet the needs of rural people. This VCD details:

- What are aquatic systems?
- What are the aquatic animals?
- What are the local resource user and manager groups?
- How can we establish the local resource user and manager's groups?
- How do we plan and implement their action plans?
- Some management activities for farmers' managed aquatic systems
- How situation of aquatic resources can be assessed?
- How will we know if local resource user and manager's groups are effective?
- What the impressions of those who have tried this approach are
- Sample of agenda for regular meetings of users and managers' groups
- Checklist of activities for monitoring these groups

This VCD targets provincial fisheries extensionists and village communities, to promote aquatic animal management in aquatic systems managed by farmers. However it has not been well distributed. This important information can be used to develop a TIP which can be applied in midland or lowland seasonally flooded zones, for local authorities and village households to learn how to establish and manage the LRUMG to develop and improve their

owned aquatic system management in order to increase aquatic resources in their rural areas.

37.**Poster on fish refuge pond development and management** (in Khmer)
The poster presents the following steps on how to develop and manage a fish refuge pond in a village:

- why is the catch of fish in the village declining? Because of illegal and unsustainable fishing methods and activities as well as population growth;
- how could villagers have sufficient amount of fish to consume? By developing a community fish refuge pond where it would be strictly prohibited to harvest fish during the dry season; it would be managed by the established community by releasing native fish species (i.e. snakeheads, clariid catfishes, gouramis, climbing perches, etc) into this pond and by planting inundated vegetation around and in the pond to enhance fish habitats and stocks.

This poster is not a tip but could be developed into a TIP for floodplain or lowland zones where dry season ponds could serve as protected areas for breeders so that they increase the productivity of floodplain rice-fields in the next wet season.

38.**Poster on integrated fish farming system** (in Khmer)
The poster shows how to integrate small-scale pond fish culture in animal raising and vegetable and rice growing activities; i.e. using low-cost input on-farm resources to grow fish in pond or developing cost-effective aquaculture to secure fish food of a rural household.
This poster is not a tip but could be developed into a TIP for upland and midland zones where fish are in deficit.

39.**Calendar on integrated fish farming system** (in Khmer)
Same description and conclusions as above paragraph

40.**Booklet on small scale pond fish culture** (in Khmer)
This booklet introduces to simple pond poly-culture technologies (pond preparation, pond fertilization, pond fish stocking, pond management, feeding, and harvesting) for four exotic fish species (Nile tilapia, *Oreochromis niloticus*; silver carp, *Hypophthalmichthys molitrix*; common carp, *Cyprinus carpio*; and migral, *Cirrhinus cirrhosus*) and two indigenous fish species (silver barb, *Barbonymus gonionotus*; snakeskin gourami, *Trichogaster pectoralis*).
This booklet has already been further developed into a TIP in cooperation with the Department of Agriculture Extension (See # 5).


Nile tilapia (tilapia) *Oreochromis niloticus*


Silver carp (Karp sor) *Hypophthalmichthys molitrix*


Common carp (Karp samanh) *Cyprinus carpio*


Mrigal (Karp india) *Cirrhinus cirrhosus*


Silver barb (Chpin prak) *Barbonymus gonionotus*


Snakeskin gourami (Kan-thou) *Trichogaster pectoralis*

41.**VCD on "Small-scale fish pond culture"** (in Khmer, 22 minutes)
Same description and conclusions as in above paragraph.

42.**TIP on "Small-scale pond fish culture"** (in Khmer)
This is an existing TIP of small-scale pond fish poly-culture of four exotic fish species (tilapia, *Oreochromis niloticus*; silver carp, *Hypophthalmichthys molitrix*; common carp, *Cyprinus carpio*; and migral, *Cirrhinus cirrhosus*) and one indigenous fish species (*Barbonymus gonionotus*), which has been developed by Aquaculture Division in cooperation with the Department of Agriculture Extension. This TIP could be applied in priority in upland and midland zones characterized by fish deficit area. However escapees of these exotic fish species could have negative impacts on aquatic biodiversity.

43.**Booklet on rice-cum-fish culture** (in Khmer)
The booklet covers: (a) importance of rice-cum-fish culture, (b) seasonality; (c) location and size of rice-fields, (d) rice-cum-fish culture systems, (e) water level in rice-field, (f) canal system construction, (g) stocking fish species, (h) transportation and stocking of fish, (i) feeding and management, and (j) fish harvesting. Fish species detailed in this booklet are three exotic fish species: tilapia *Oreochromis niloticus*; common carp *Cyprinus carpio*; and mrigal *Cirrhinus cirrhosus*, and two indigenous species: snakeskin gourami, *Trichogaster pectoralis* and freshwater prawn *Macrobrachium rosenbergi*).

Freshwater giant prawn (Bang-korng) *Macrobrachium rosenbergii*

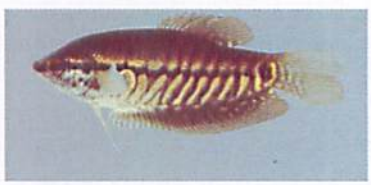
This booklet can be developed into a TIP, which could be applied in midland zones where the rural poor can adopt this simple rice-cum-fish culture technology to enhance both fish and rice food security and generate additional household income leading to reduction in fishing pressures on natural stocks in their commune or community. However escapees of these exotic fish species could have negative impacts on aquatic biodiversity.

44.**VCD on rice-cum-fish culture** (in Khmer, 29mn 44s)
Same descriptions and conclusions as in above paragraph.

45.**Overview of aquaculture in Cambodia** (in Khmer and English)
This is a report presenting the current situation and issues and problems regarding overall aquaculture development in Cambodia.
The report is not a TIP and cannot be developed to a TIP for resolving the local needs of the poor.

B.2. Extension material and information from the FiA Fisheries Domain and Conservation Divisions

46.**Booklet on seed production of the Snakeskin gourami *Trichogaster pectoralis*** (in Khmer)
This booklet aims at helping local fish seed entrepreneurs to produce the indigenous snakeskin gourami seed to supply the demand of small-scale fish farmers in villages or communes. The booklet covers: (a) biology, (b) broodstock selection, (c) broodstock pond preparation, (d) broodstock care, (e) spawning, (f) breeding and hatching, (g) fry nursing, (h) feeding, and (i) references. This booklet can be used by fisheries and aquaculture extension officers and NGOs to transfer this technology to local or village seed producers who

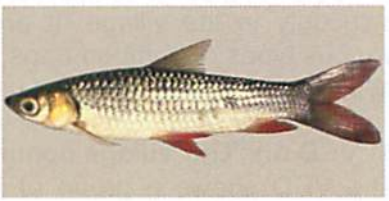


Snakeskin gourami (Kan-thou) *Trichogaster pectoralis*

are the main suppliers of seed to fish farmers in their villages or communes.
The information and technology published in this booklet can be upgraded and used to develop a TIP based on the guideline of the DAE. This TIP could be applied in all ecological zones (uplands, midlands and floodplains) to resolve the farmers' problem of fish food insecurity and to help them to generate additional household income.

47. **Booklet and VCD on seed production technology of the Hoeven's carp *Leptobarbus hoevenii*** (in Khmer)

This booklet presents (a) the biological characteristics of the indigenous fish species Hoeven's carp *Leptobarbus hoevenii*(taxonomic classification, morphology, life cycle, and natural reproduction), (b) seed production technology (brookstock pond preparation, stocking of broodstock, feed and feeding, broodstock selection for spawning induction, hormone selection and injection, inducing spawning, egg hatching, and larval rearing), (c) results (time of induced spawning, time of hatching, fecundity, fertilization rate, and hatching rate), and (d) conclusions and recommendations.



Hoeven's carp (Proloung) *Leptobarbus hoevenii*

The VCD has been poorly produced and need lots of improvement before dissemination to publics. With some improvement, the booklet can be used to develop a TIP, which could be applied in all ecological zones (floodplains, midlands or uplands) in order to enhance fish food security and generate additional household income of the rural poor.

48. **Booklet on seed production technology of the red tailed tinfoil *Barbonymus altus*** (in Khmer)

The indigenous red tailed tinfoil is one of the most popular fish species and its production comes from both wild fisheries and aquaculture; its wild stock is declining, leading to aquaculture development. The booklet covers (a) biology, (b) broodstock maturation, (c) breeding and hatching tank, (d) broodstock selection for spawning, (e) hormone selection and injection, (f) spawning induction and hatching, (g) fry rearing, (h) results, and (i) conclusions and recommendations.

The red tailed tinfoil (Ka-hae) *Barbonymus altus*

This booklet has not been well written; i.e. more editing work is needed. However the information and data can be used to develop a TIP which could be used in all ecological zones (i.e. floodplains, midlands or uplands).

49. **Booklet on seed production technology of the sutchi catfish *Pangasianodon hypophthalmus*** (in Khmer)

The sutchi catfish has a status as flagship species and contributes approx. 3% to the total freshwater fish production in Cambodia. This fish species is one of the most commercially important fish species in Cambodia aquaculture development. The annual aquaculture production of this species in Viet Nam was about 1 million tonnes these past few years.. The booklet covers (a) broodstock maturation and care, (b) broodstock selection for induced spawning, (c) hormone and dose (d) breeding and hatching, (e) larval rearing and fry nursing, (f) feed and feeding, and (g) references.

Sutchi catfish (Pra thom) *Pangasianodon hypophthalmus*

This booklet has been quite well developed but not widely disseminated. Therefore the information and data written in the above booklet can be used to develop a TIP based on the DAE's guidelines. The developed TIP could be applied in all ecological zones in Cambodia.

50. **VCD on "Advice from a father"** (in Khmer, 19 mn)
This VCD provides advice and awareness not to use electro shocks and mosquito net to fish, which are illegal fishing gears. The use of these two types of illegal fishing gears leads to negative impacts on fish abundance and fish catch, and finally increase poverty and food insecurity in the village. It provides advice to villagers to use traditional gears such as various types of bamboo traps, which can be made by villages using on-farm resources. The above information cannot be used for TIP development.

51. **VCD on "Our village community fisheries"** (in Khmer, 54 mn)
The VCD shows a group of fishers who used illegal and destructive fishing gears such mosquito net, electro shock and brush-park to catch all sizes of fish, including juvenile of many commercially important species, and the other group of fishers in a village used traditional traps which could catch only very few fish that could not meet the need of household daily food consumption. These illegal gears are very cheap and available at local markets, but have negative impacts on fisheries resources and lead to decrease in fish abundance and catch in the village. Use of electro-shock did not kill only fish but also threatened human life. So the local community decided to establish a community fishery within the village in cooperation with local fisheries officers followed the fisheries policy reforms of the government in order to manage fisheries resources in the village, including implementing fisheries law (gear use), protection of fish conservation zone and flooded forests. As a result, fisheries resources are abundant leading to increased household fish catch with big sized fish. Ultimately livelihood of the people in the village has been improved.
The above information combined with information in paragraph 54 can be used to develop a TIP on "Community fisheries development and management", which can be applied in lowland floodplain zone.

B.3. Extension material and information from the FiA Community Fisheries Development Division

52. **Important factors driving the success in community fisheries management** (in Khmer and English)
This report actually fails to identify important factors that drove the success in community fisheries management. It just reports three case studies conducted in three different provinces (Koh Kong, Takeo and Banteay Meanchey) and summarizes the results of the three cases.
The information in the above report cannot be used for developing any TIPs.

53. **Compilation on legal instruments related to community fisheries in Cambodia** (in Khmer and English)
This compilation of legal texts relating to community fisheries includes (a) Royal decree on the establishment of community fisheries, (b) Sub decree on community fisheries management, (c) Prakas (proclamation) on the community fisheries guidelines, (d) Prakas on model of community fisheries by law, (e) Prakas on Model of community fisheries internal rules, (f) Prakas on community fisheries management area agreement, and (g) model of community fishing area management plan.
Information of the above compilation could be used to develop several TIPs e.g. (a) how to legally establish a community fisheries in a village or commune where local fisheries resources could be managed by local community; (b) how to prepare fisheries community by-law which be applied in different ecological zones; (c) how develop community fisheries

internal rules and disciplines for different ecological zones; (d) how to identify and create a fish sanctuary in a community fisheries located in different ecological zones to protect and conserve fish resources for a sustainable fisheries co-management; (e) how to develop an effective and implementable community fisheries management plan for distinct ecological zones.

54. **Manual on fisheries co-management in Cambodia** (in English and Khmer)
The manual covers a) concepts of fisheries co-management; b) Process of community fisheries establishment; c) Facilitation of fisheries co-management: d) Gender issues in fisheries co-management; e) Trans-boundary issues; f) Problem solving; g) Conflict resolution; h) Modification and adaptation.
This manual is not a TIP but can be transformed to a TIP based on the DAE's guidelines. The developed TIP could be used by anyone who is involved in community fisheries establishment, development and management, including both individuals (particularly fishers) and organizations (esp. provincial fisheries Cantonments, divisions and *Sankat*, local and international NGOs, and civil society), whether or not they are currently involved in community fisheries or will be in the future. This TIP can only be applied in floodplain and marine ecological zones.

55. **PRIAC Policy Reform Impact Assessment, Cambodia in Kampong Cham, Pursat and Takeo (First round assessment report, 2004)** (in Khmer and English).
The report covers the development of workable methodology to assess (1) the effectiveness of the fisheries policy reforms, and (2) impacts on fisheries resources, poverty, food security, gender and age, ecology and institutional arrangements in Kampong Cham, Pursat and Takeo provinces. The report also determines policy recommendations to implement the policy reforms for sustainable fisheries management, particularly community based fisheries management or fisheries co-management.
PRIAC Policy Reform Impact Assessment, Cambodia in Kampong Thom and Prey Veng (second round assessment report, 2006) (in Khmer and English)
The report assesses impacts of the fisheries policy reforms on (1) different stakeholder groups, (2) institutional arrangements, and on poverty, and coping strategies of different stakeholder groups in the two provinces Kampong Thom and Prey Veng.
The findings of the above reports cannot be used for developing TIPs as they have implications for policy and plan development to achieve sustainable fisheries co-management.

B.4. Extension material and information from the FiA Institute for Post Harvest Fisheries Technology

56. **Cambodia post harvest fisheries overview** (in English)
The report covers information on (1) post harvest fisheries and wider policy, (2) the current situation in the post harvest fisheries sub-sector, (3) key changes and trends in the sub-sector and their cause, (4) impact of change on poverty, food security, employment and foreign exchange and GDP, (5) current intervention in the sub-sector and (6) intervention framework. The above knowledge and information are very useful for policy makers and planners for developing appropriate post harvest fisheries management plans in Cambodia; however they cannot be used for developing TIPs to be used by farmers in rural areas.

57. **Fish sauce production and its role in employment and food security** (in Khmer and English)
The report covers information of (1) history of fish sauce production in Cambodia, (2) current situation, (3) types of fish sauce production (large, medium and small-scale fish sauce production technologies), (4) imported fish sauce, (5) use of fish sauce and soy sauce, (6)

changes and impacts of change, (7) contribution of fish sauce to employment and food security, and (8) future of fish sauce production and consumption in Cambodia.
The information of the above report could be used to develop TIPs on small-, medium- and large-scale production technology of fish sauce, which can be implemented by private sector and rural households living in all ecological zones (lowlands, midlands and uplands).

58. **Fish market in Phnom Penh, Siem Reap and Sihanoukville** (in Khmer and English)
The findings of the study include (1) key characteristics of wholesale and retail markets in Cambodia, (2) fish marketing system in Cambodia, and (3) livelihoods of fish traders and others involved in fish marketing system.
The information of the report cannot be used for developing any TIPs as they are just the information of the status of fish marketing in Cambodia.

59. **Gender and post harvest fisheries sector** (in Khmer and English)
The report describes (1) gender roles in post harvest fisheries in Cambodia, (2) gender role in decision making in post harvest fisheries, (3) gender and policy and (4) gender related problems, needs and aspiration, and changes in post harvest fisheries.
This information cannot be used for TIP development.

60. **Salt production and use in post harvest fisheries** (in Khmer and English)
The report describes the status of salt production, distribution and marketing in Cambodia.
This information cannot be used for TIP development.

61. **The role of formal and informal credit in the fish marketing chain in Cambodia** (in Khmer and English)
The report covers (1) credit system in Cambodia, (2) role of banks, microfinance institutions and NGOs in the fisheries sector, and role of fish distributors, fish traders, fishers, fish processors and other stakeholders (fishing lot operators and fish farmers) in formal and informal credit systems. This information can be used for TIP development.

62. **Guideline to improve access to microfinance by poor fishing, processing and trading communities** (in Khmer and English)
The study focuses on (1) options to improve microfinance in fishing communities, (2) Cambodia microfinance sector, and (3) microfinance related roles and responsibilities of Fisheries Quality and Post Harvest Division.
The information and data from the above two reports can be used to develop TIPs on how the rural poor can have proper access to microfinance to enhance their livelihoods through fishing, fish farming, fish processing, and marketing of fish and fish products. The developed TIPs can be used in all ecological zones (i.e. uplands, midlands and lowlands).

63. **Fish exports and livelihoods of the poor** (in Khmer and English)
The study aims at providing an overview of fish export in Cambodia. Its findings include (1) fish trade and market characteristics, (2) fish species and quantities exported, (3) values of fish exports, (4) supply channel for fish exports, (5) legislation regarding fish exports, (6) formal and informal cost and margins in the fish export market chain, (7) main constraints for export markets, (8) solutions suggested by exports and other stakeholders, and (9) impacts of fish exports on food security in Cambodia.
The above information cannot be used for TIP development.

64. **Impacts of the fisheries policy reforms on the post harvest fisheries sector in Phnom Penh, Kampong Chhnang, Pursat and Banteay Meanchey provinces** (in Khmer and English)
The study aims at providing an understanding of impacts of the fisheries policy reforms on the livelihoods of different post harvest fisheries stakeholders including fish suppliers, fish traders, fish processors, fish transporters and fish consumers.

The above information cannot be used for TIP development.

65. **The import of fish into Cambodia** (in Khmer and English)
The report covers (1) fish species and products imported, (2) origins, quantities, quality and reasons of imports, (3) values of legal and illegal fish imports, Roles of government institutions in fish imports, (4) contribution of fish imports to national revenue, (5) marketing channel for fish imports, (6) consumption and use of imported fish, and (6) impacts of fish imports and potentials for import substitution.
The information of the above report cannot be used for TIP development as it is the status of fish imports from Cambodia's neighboring countries.

66. **The role of fish in food security and change in consumption patterns** (in Khmer and English)
The study was undertaken aiming at providing an overview of the roles and importance of fish in food security in the livelihoods of different groups of people in Cambodia, with particularly emphasis on the rural poor. The study also addresses fish consumption patterns to understand changing preferences and attitudes to fish consumption and how this is affecting fish supplies and markets.
The information of the above report cannot be used for TIP development as it is descriptive information.

67. **VCD on "Post harvest fisheries livelihood in Cambodia"** (in Khmer and English, 28mn)
This is not an extension material, although it appears in the FiA website extension materials section. It shows (1) importance of Cambodia fisheries in terms of income generation, food security, employment, and foreign exchange/export, (2) fish and fisheries of Cambodia, (3) fisheries management and key issues and challenges, and (4) overview of fish processing in Cambodia, including small, medium and large scale fish processing: salted/fermented small and big size fish, filleting fish, smoked fish, and frozen shrimp and crab meats.
The above overview information cannot be used for developing TIPs.

III BIOLOGICAL ASSESSMENT

68. Introducing fisheries considerations into Agroecosystem Assessments implies the integration of a few ecological elements familiar to tropical inland fisheries managers. These notions include ecological categories of fishes (or ecological fish guilds; section A1), ecological zones (section A2), ecological factors driving the fish production (section A3), connectivity and seasonality (section A4). These notions are detailed below, so that they can be integrated to the revised CAEA process.

A.1. Ecological guilds of fish

A.1.1. White, Grey and Black fish

69. Ecological guilds are defined here as groups of species, within assemblages, that have similar responses to environmental variations. The concept was first defined by Kryzhanovsky (1948) Guilds have been defined under different latitudes with various perspectives: reproductive guilds (Balon 1975), trophic guilds (Karr *et al.* 1986), guilds of responses to stream flow conditions (Bain *et al.* 1988, Leonard and Orth 1988). In the case of tropical riverine environments, the definition of guilds, focussing on "white fish" and "black fish", has been popularized by Welcomme (1985, 2001) and Lévêque and Paugy (1999). It has also been recommended as a management unit in Asian or Mekong floodplains rivers by Hoggarth *et al.* (1999), van Zalinge *et al.* (2004) and Baran *et al.* (2007a).

70. At least two, ideally three, types of fish should be distinguished in the CAEA. Each of these groups has very different ecological requirements, in particular in terms of migration needs and survival in the dry season, so they have different sensitiveness to agricultural developments that could block migration routes, and to hydrological migrations and triggers. The most robust fishes are the black fishes, as long as they are not fished out in ponds in the dry season; white and grey fishes are more sensitive because they do need to migrate away to complete their life cycle, and their migration is largely triggered by hydrological modifications. So if their migration route is interrupted or if the hydrological cycle is perturbed, the abundance of these species in catches is likely to drop significantly.

• **"Black fish"** or "Resident fish", i.e. the ecological group of species with limited lateral migrations and no longitudinal migrations. These tough fish are able to survive in swamps and ponds all year round. The group of "resident fish" includes: *Channidae* (Snakeheads), *Clariidae*, *Bagridae* (*Mystus* sp.) and *Anabantidae*

Examples:

Channa striata (Snakehead murrel)

ត្រីរ៉ស់ ឬ ត្រីផ្គក់ (Ros / Phtuk)

Clarias batrachus (Walking catfish)

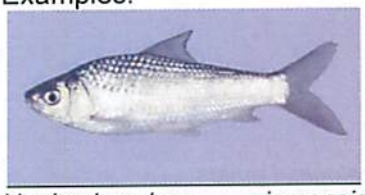
ត្រីអណ្តែងរឹង (Andaeng reung)

Anabas testudineus (Climbing perch)

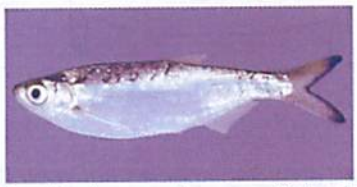
ត្រីក្រាញ់ (Kranh)

• **"White fish"** or "Mekong migrants", i.e. the ecological group of species showing long distance migrations, in particular back to the Mekong mainstream. This group includes many cyprinids (e.g. "Trey riel" *Henicorhynchus spp.* and *Cirrhinus sp.*) but also most *Pangasidae*.

Examples:



Henicorhynchus siamensis (Siamese mud carp)
ត្រីរៀលកុប (Riel top)



Paralaubuca typus (Pelagic river carp
ត្រីស្លឹកឬស្សី (Sleuk russey)

Boesemania microlepis (Boeseman croaker)
ត្រីប្រម៉ា (Proma)

• **"Tonle Sap migrants"** or "grey fish". This ecological group, initially proposed by Régier *et al.* (1989), and acknowledged in the Mekong Basin by Poulsen *et al.* (2002), is made of fish that are not grey in colour but ecologically intermediate between the two previous groups, corresponds to fishes that do not spend the dry season in floodplain ponds, but do not undertake long distance migrations either. They tend to spend the dry season in Tonle Sap tributaries and their ecological and physiological characteristics are intermediate between those of black and white fish (Table 2) .

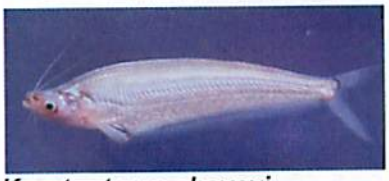
Table 2: Characteristics of Grey fish

	Grey fish
Oxygenation	Gills and adaptations to hypoxia
Tolerance to hypoxia	Low to medium oxygen rates
Type of muscular fibres	Red or white
Migrations	Short range longitudinal migrations, lateral migrations
Body shape	Body compressed laterally, spiny, usually with strong scales
Color	Dark, usually ornamented and colored
Reproduction guild	Nest builders and guarders, lay eggs on the substrate, phytophiles
Dry season habitat	Tributaries or edges of the main stream
Wet season habitat	Floodplain

Examples:

Belodontichthys dinema
ត្រីខ្លាំងហាយ (Khlang hay)

Mystus albolineatus
ត្រីកញ្ឆែះចាយ (Kanhchos bai)



Kryptopterus cheveyi
ត្រីកំភ្លៀវស្តឹង (Kamphleav stung)

71. In the Tonle Sap Basin, out of 296 species, 55 are classified as white fish, 18 are classified as black fish, 24 are characterized as Grey fish[1] and 199 are undetermined (Baran *et al.* 2007e and Figure 7).

[1] The latter grey fish species are:

Arius maculatus (Trey Kaock in Khmer), *Arius sona* (Kaock), *Arius stormii* (Kaock), *Arius thalassinus* (Kaock), *Arius truncatus* (Kaock), *Barbonymus gonionotus* (Chhpin prak), *Belodontichthys dinema* (Khlang hay), *Chitala blanci* (Kray), *Coilia lindmani* (Chunlungh moan), *Hemibagrus wyckii* (Chhlang khmao), *Hemisilurus mekongensis* (Kromorm), *Hyporamphus limbatus* (Phtoung), *Kryptopterus bicirrhis* (Kes prak), *Kryptopterus cheveyi* (Kamphleav stung), *Kryptopterus cryptopterus* (Kamphleav khlanh), *Micronema bleekeri* (Kes krohorm), *Mystus albolineatus* (Kanhchos bai), *Parachela maculicauda*

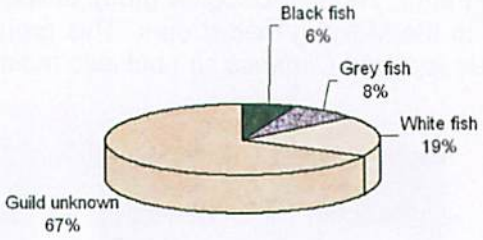


Figure 7: Distribution of Tonle Sap species between 3 ecological guilds

A.1.2. A more specific classification of Tonle Sap fish

72. Ecological data on 296 species gathered for an overview of Tonle Sap species (Baran et al 2007e, have been analyzed in view of refining the classification of Tonle Sap fish for management purposes. There are 54 species for which the following information is available and complete:

    Latin name; Family; English name; Khmer name in Khmer; Khmer name in roman; Maximum total length (cm); Life span (years); Length at maturity (cm); Trophic level; Status; Habitat; Resilience; Migration; Migration type; Guild

73. Preliminary analyses showed that i) all these species are actually native species, so the Status variable was suppressed; ii) there is a high correlation (r= 0.973) between "Maximum total length" and "Length at maturity", so only "Max total length" was kept for further analyses.

74. Given the heterogeneous nature of these data, including continuous and discrete variables, a specific multivariate analysis called Hill and Smith analysis was used (Hill and Smith 1976, Thioulouse *et al.* 1997). Raw results are briefly presented here (Figure 8) and an interpreted version is discussed below

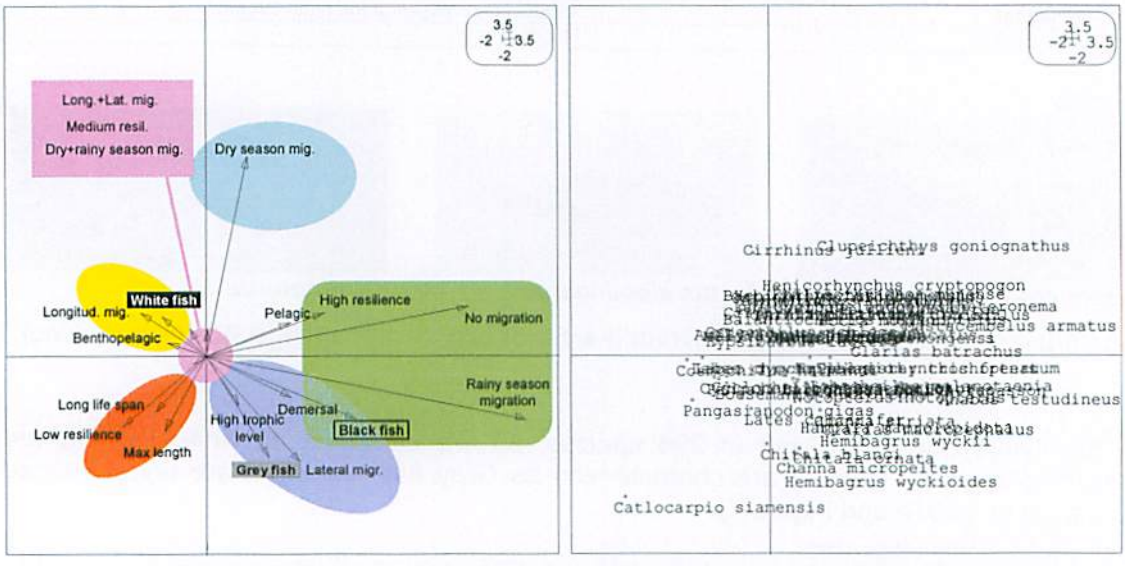


Figure 8: Results of the Hill and Smith analysis of fish ecological data

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(Chunteas phluk), *Parachela oxygastroides* (Chunteas phluk), *Parachela siamensis* (Chunteas phluk), *Parachela williamminae* (Chunteas phluk), *Parambassis apogonoides* (Kanhchras thom), *Parambassis wolffii* (Kantrorng preng), and *Xenentodon cancila* (Phtoung),

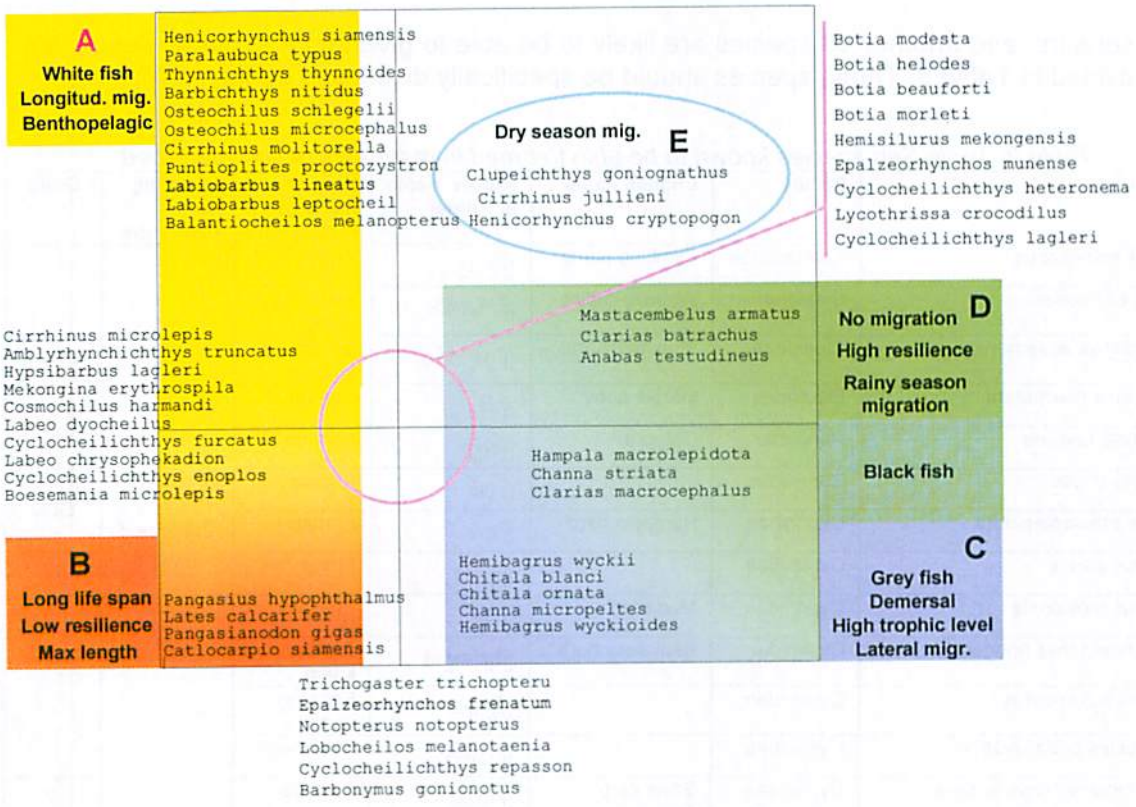

Figure 9: Interpreted results of the Hill and Smith analysis

This figure shows that based on existing ecological knowledge of 54 fish species, four main fish groups (or guilds?) and four intermediate groups can be identified in the Tonle Sap fish community:

1) group A: typical white fish characterized by longitudinal migrations and benthopelagic habitat; they tend to migrate rather in the dry season; a typical species is *Henicorhynchus siamensis;*

2) group B: sensitive species characterized by a long life, a big size and a low resilience; a typical species is *Pangasianodon gigas*.

A number of species are actually characterized by a position intermediate between these two groups; however they are too heterogeneous to constitute another specific group

3) group C: typical grey fish, characterized by a high trophic level, lateral migrations, and a rather demersal habitat (life on the bottom). *Chitala* species are typical of this group.

4) group D: species such as *Anabas testudineus* characterized by no migrations, a high resilience and abundance during the rainy season.

Interestingly this typical black fish such as *Channa striata* are intermediate between groups C and D; this means that the "Black fish" guild is rather heterogeneous and made of more subtle ecological sub-groups. This also probably reflects the blurred limit between Back and Grey fish, the latter group being ecologically closer to Black fish than to White fish.

Two additional unclear groups of fish can be identified: i) those characterized mainly by migrations during the dry season, such as *Cirrhinus jullieni*, and ii) a fuzzy group of fish located at the center of the analysis, whose ecological characteristics are mixed or indistinct.

A.1.3. Reservoir breeders

75. In view of aquaculture development or reservoir stocking, it is important to identify species that can breed in reservoirs. The previous data set detailed above has been analyzed in that perspective; 13 species have been identified as known to breed in

reservoirs, and another 13 species are likely to be able to given their ecology; details are provided in Table 3. These species should be specifically discussed during AEAs.

Table 3: Tonle Sap species known to be able to breed in reservoirs or likely to breed

Latin name	Family	English name	Khmer name in Khmer	Khmer name in roman	Breeding in reservoirs	Guild
Anabas testudineus	Anabantidae	Climbing perch	ត្រីក្រាញ់	Kranh	Confirmed	Black
Clarias batrachus	Clariidae	Walking catfish	ត្រីអណ្តែងរឹង	Andaeng reung		
Clupeichthys aesarnensis	Clupeidae	Thai river sprat	ត្រីបណ្តូលអំពៅ	Bandol ampeuo		
Oxyeleotris marmorata	Eleotridae	Marble goby	ត្រីជីរ	Domrei		
Pristolepis fasciata	Nandidae	Catopra	ត្រីកន្ត្រប់	Kantrob		
Hampala dispar	Cyprinidae		ត្រីខ្មាន់	Khman		Grey
Hampala macrolepidota	Cyprinidae	Hampala barb	ត្រីខ្មាន់	Khman		
Cirrhinus jullieni	Cyprinidae		ត្រីផ្ការចរ	Phkar char		White
Cirrhinus molitorella	Cyprinidae	Mud carp	ត្រីផ្កាអ	Phkar ko		
Cyclocheilichthys apogon	Cyprinidae	Beardless barb	ត្រីស្រកាក្តាម	Sraka kdam		
Labiobarbus lineatus	Cyprinidae		ត្រីខ្នងវែង	Khnomg veng		
Puntioplites proctozystron	Cyprinidae		ត្រីច្រែងែង	Chra kaeng		
Hypophthalmichthys molitrix	Cyprinidae	Silver carp	ត្រីការបស	Karb sor		?
Bagrichthys macracanthus	Bagridae	Black lancer catfish	ត្រីចេកខ្ទុំ	Cheik tum	Likely	Black
Channa lucius	Channidae		ត្រីកញ្ជែងជ័យ	Kanhchoun chey		
Channa micropeltes	Channidae	Giant snakehead	ត្រីឆ្តោ	Chhdau		
Channa striata	Channidae	Snakehead murrel	ត្រីរស់ផ្ទៃក់	Ros / Phtuk		
Clarias macrocephalus	Clariidae	Broad/Bighead catfish	ត្រីអណ្តែងទន់	Andaeng toun		
Clarias meladerma	Clariidae	Blackskin catfish	ត្រីអណ្តែងទន់	Andaeng toun		
Clarias nieuhofii	Clariidae		ត្រីអណ្តែងងាង	Andaeng ngang		
Datnioides pulcher	Datnioididae	Siamese tiger perch	ត្រីឡា	Khla		
Barbonymus gonionotus	Cyprinidae	Java /Silverbarb	ត្រីឆ្ពិនប្រាក់	Chhpin prak		Grey
Cephalocassis borneensis	Ariidae		ត្រីក្តក	Ka-ork		
Chitala chitala	Notopteridae	Clown knifefish	ត្រីក្រាយ	Kray		
Micronema micronema	Siluridae		ត្រីកែស្តង់	Kes thom		
Labeo chrysophekadion	Cyprinidae	Black sharkminnow	ត្រីកែក	Ka-ek		White

A.2. Ecological zones

A.2.1. Aquatic ecological zones in agroecosystems

The notion of ecological zone is central the AEA approach and in ecology as well. Zoning allows identifying untapped potentials and minimizes the risk of conflicts by assessing how different interests can be methodically accommodated in a geographic area. However the notion of ecological zone is specific to several factors: scale (microscopic to oceanic),

species (microbial, animal, vegetal, etc), environment (terrestrial or aquatic, marine or riverine, etc), temperature, etc. More specifically, ecological zones have been defined in rivers based on morphology or sedimentology, plants, fish or invertebrates communities (review in Amoros and Petts 1993), and ecological zones have been identified in floodplain systems (e.g. Welcomme 1985, Copp 1989). None of these classifications covers the diversity of zones included in an agroecosystem, since the latter can extend from floodplains to upland areas, including lakes, ponds and other closed water bodies.
From a fishery/AEA perspective, one of the most relevant classifications is actually the typology proposed by Roggeri (1995) for wetlands (Table 4):

Table 4: Specific ecological units in different geomorphological units

	Geomorphological units						
	Alluvial lowlands	**Headwater lowlands**	**Small overflow valleys**	**Lake drawdown areas**	**Lake shallows**	**River/Lakes depressions**	**Isolated depressions**
Periodically flooded ecosystems							
Flooded forest	Common	Rare	Common	Common	Rare	Common	Rare
Flooded grassland	Common	Common	Common	Common	Rare	Common	Rare
Seasonal shallow water bodies	Common	Common	Common	Common	Rare	Common	Rare
Marshes and swamps							
Floodeed grasslands	Common	Common	Common	Common	Common	Common	Rare
Marshes/herbaceous swamps	Common	Common	Rare	Common	Common	Common	Rare
Swamp forests	Common	Rare	Rare	Common	Rare	Common	Common
Peat swamps	Rare	Common	Rare	Common	Rare	Common	Common
Permanent shallow water bodies	Common	Rare	Rare	Rare	Rare	Common	Common

Roggeri (1995) also proposes a derived typology for management purposes; a simplified version of this typology is detailed in Table 5:

Table 5: Specific ecological units in the different wetland types

	Wetland types		
	Floodplain	**Swamp**	**Shallow lake, pond**
Periodically flooded ecosystems			
Flooded forest	Common	Common	Rare
Flooded grassland	Common	Common	Common
Seasonal shallow water bodies	Common	Common	Common
Marshes and swamps			
Floodeed grasslands	Common	Common	Rare
Forests	Common	Rare	Rare
Permanent shallow water bodies	Common	Common	Rare

A.2.2. Ecological zones for fish

From a fish perspective, it is also challenging to determine ecological zones since several spatial and temporal scales are combined. Thus Wootton (1991) identify a need for a combination of i) refuge habitats (juveniles, adults), ii) feeding habitats (juveniles, sub-adults, adults) and iii) spawning habitat (adults); migrations occurring between these 3 components. Lévêque (1999) moves a step forward and integrates time in this identification of fish habitats in relation of biological functions, as is reflected in Figure 10:

HABITATS	TIME	SPACE	FUNCTIONS	LEVEL
Shelter	Hour	10 m	Rest	Individual
Shelter+ Feeding	Day	100 m	Home range	Individual
Shelter+Feeding+ Breeding	Year	1-500 km	Life cycle	Population
Shelter+Feeding+ Breeding+Spreading	Century	1000 km	Colonization	Species

Figure 10: Fish habitats in relation to space, time and biological functions

This identification of "fish zones" is not immediately applicable to the case of AEAs, but highlights the dimensions that must be kept in mind when dealing with the sustainable exploitation of fish. These dimensions have to be reflected in the questions asked to farmers during the AEA process, and in the management decisions subsequently taken.

A.3. Environmental factors driving fish production

76. A number of ecological and biological studies (So *et al.* 2001, Arthington *et al.* 2004, Baran and Jantunen 2005, So *et al.* 2006, Baran 2007, etc) have shown that fish stock (i.e. fish abundance) is driven by three main groups of factors pertaining to either hydrology, habitat or migrations(Figure 11).

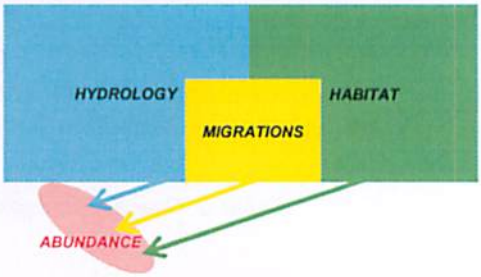

Figure 11: Groups of factors driving fish abundance

77. According to these studies, in the field of hydrology, the three factors most important to fishes are: i) the maximum water level reached each year during the rainy season; the higher that level, the more habitat accessible to fish for feeding and breeding; ii) the duration of the flooding or wet season; a longer wet season is beneficial to fish that have better conditions to grow; iii) the timing of the flood; it is thus believed that an early flood is beneficial to fish recruitment.

78. As for the environment, the most important factor to fish is the nature of the vegetation flooded (either flooded forest, or bushes, or grassland such as rice fields). Flooded forest is considered to be the habitat most favorable to fish (Chevey 1932, Chevey 1933; Van Zalinge *et al.* 2001), followed by shrubs then by grassland. Actually the respective value of each habitat has never been formally demonstrated but this classification reflects the best available knowledge.

79. In terms of migration, many studies have demonstrated the exceptional importance of migrations in the Mekong system; in fact 87% of species whose migration status is known are migratory species (i.e. among well known fish, only 13% are non-migrants). If the migration is interrupted by constructions such as dykes or dams, then the cycle cannot be completed and a drop in production can be feared in the following years, as demonstrated in multiple floodplain systems in the world (Kruskopf 2007). However built structures can also consists of irrigation schemes that create water bodies in the dry season and thus constitute additional habitats for resident fishes

The various factors driving fish production in the Tonle Sap are summarized in Figure 12.

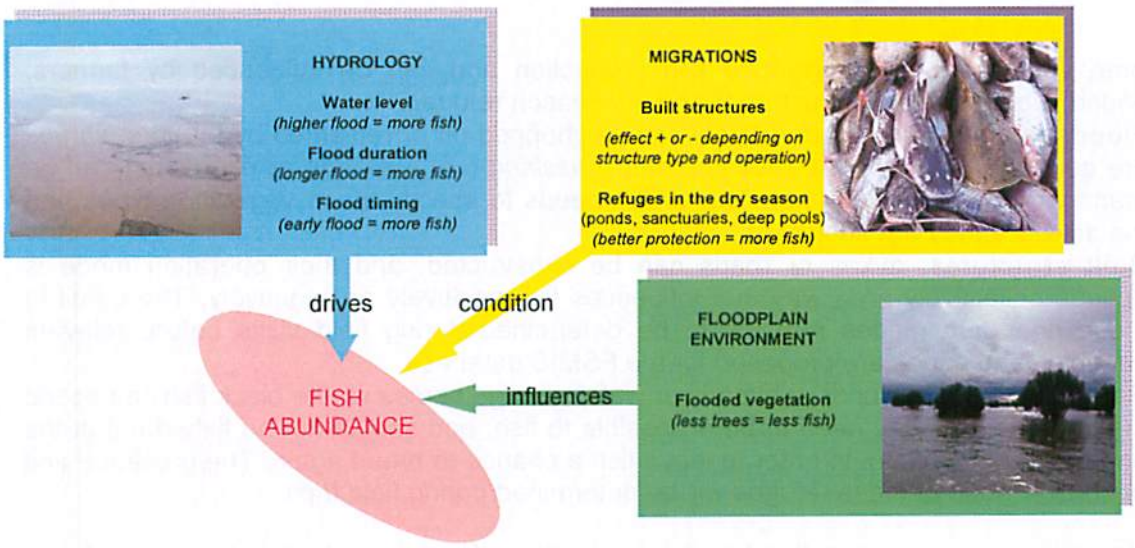

Figure 12: Main factors driving the fish production in the Tonle Sap (adapted from Kurien et al. 2006).

80. The above factors have been integrated in a model (Baran and Jantunen 2005, So *et al.* 2006), where the main variables but also their specific relationships are identified (Figure 13).The overall model developed in 2006-2007 (Baran *et al.* 2007c) includes more variables and a module representing the fishery sector, but these elements have been simplified here.

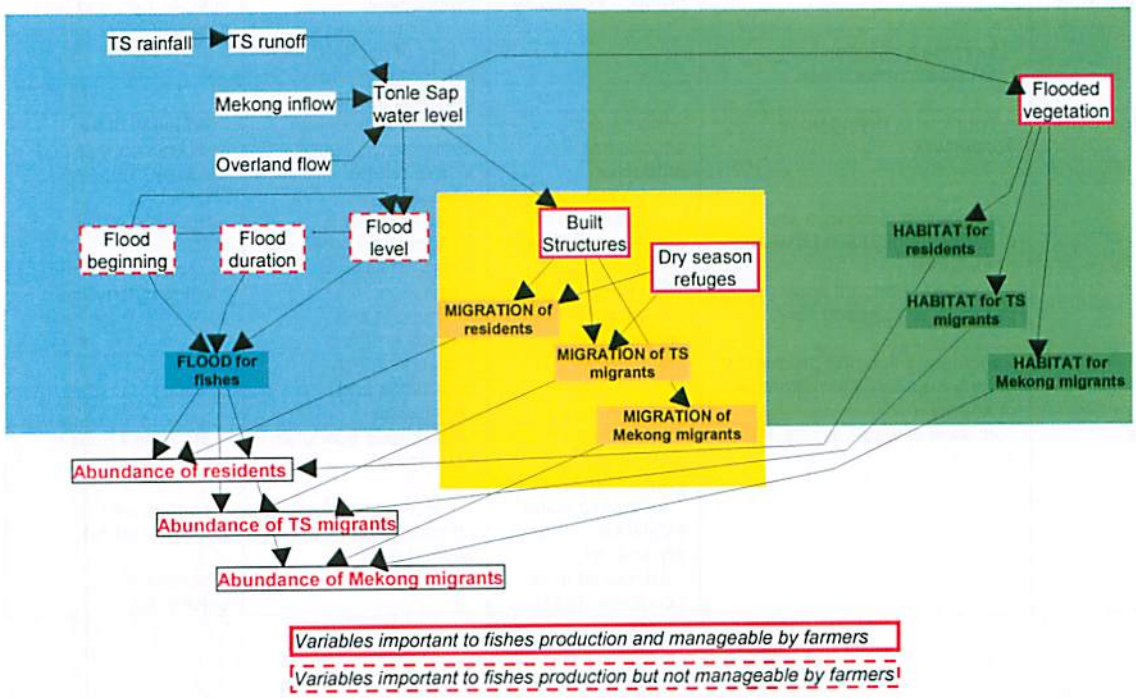

Figure 13: Overview of the variables driving fish production, and their relationships

81. Three variables are important to fish production but not necessarily manageable by farmers: **flood level**, **flood beginning** and **flood duration**. More generally it is important, during the revised AEA process, to reflect these variables through specific questions, so that factors crucial to fish production sustainability are reflected in future improved assessments.

82. Three variables are important to fish production and can be influenced by farmers: flooded vegetation, built structures[2] and dry season refuges.

- **Flooded vegetation**: *flooded forest* can be chopped off or replanted by farmers; *shrubs* are generally cleared for cultivation, and *grassland* (i.e. wetlands or rice fields) can be managed to stock fish or not. The CAEA needs to specify these vegetation types and the activities they are subject to.
- **Built structures**: dykes or roads can be constructed, and their operation mode is defined collectively, in a way that influences fish positively or negatively. The detail of these operation modes remains to be determined during field visits before relevant variables and codes are proposed for the FSMIS database.
- **Refuges** consist of ponds, wetlands or water storage bodies where black fish can spend the dry season. They need to be accessible to fish, and should not be fished out at the end of the dry season, in order to leave fish a chance to breed again. The presence and operation mode of these refuges will be determined during field trips.

83. Generally speaking, agricultural and infrastructure development influence water flows, connectivity, flooded vegetation and fish refuges; this development brings along positive and negative consequences, as detailed in Table 6. The EIA process has to highlight these tradeoffs for farmers to make informed management decisions.

Table 6: Management options and their consequences (modified from Baran et al. *2007a)*

MANAGEMENT OPTIONS	ENVIRONMENTAL CHANGES	POSITIVE CONSEQUENCES	NEGATIVE CONSEQUENCES	SPECIFIC IMPACT ON FISHERIES
Agricultural intensification	- loss of flooded forest - increased pollution (pesticides, herbicides)	Increased crop production security	Loss of natural aquatic productivity - loss of habitats (incl. fish foraging and breeding areas)	- reduction in fish species richness and diversity
Irrigation dams	- reduction or drying up of floodplains - changes in discharge and water level (modified base and peak flows) - modified seasonal flows (in particular dry season flows) - decreased flooding (frequency, extent, duration and magnitude of floods)	- increased agricultural production - stabilization of downstream flows - increased water availability in the dry season	- reduced floodplain connectivity, hence loss of natural productivity - loss of habitats, foraging and breeding areas for fish - inhibition of movement and migration of fish - change in fish migrations and distribution	- reduction of in species richness and diversity - reduction of fish stock - falling catch rates
Canals	- change in water availability	- increased agricultural production - increased water availability in the dry season - increased area accessible to fish	- increased floodplain connectivity - introduction of alien species (if between watersheds)	- increased habitat area - connectivity between habitat - better fish catchability

[2] *Built Structures* consist in a diversity of constructions or items set up by man that contributes to changing the hydrology of a natural system. Built Structures can consist of constructions that:
(i) oppose water outflow (e.g., dams, weirs, irrigation schemes, dykes, levees);
(ii) prevent water inflow (e.g. embankments, polders, flood control works);
(iii) alter water inflow or outflow (e.g., roads, railways, drainage canals, agricultural works, banks modifications);
(iv) degrade water quality (e.g., plants with aqueous effluents, mining and mineral processing facilities, sewerage systems, and dredges).

Table 6 (continued)

Ponds	- water storage	- more water security - more habitat for fish - constitute fish refuges in the dry season if not fished out	- increased risk of water-borne diseases	- very positive impact if managed carefully
Dikes, roads	- habitat partitioning - changes in the level of the water table	- control of water levels - protection from extreme or flash floods - increased access to resources	- reduction of floodplain connectivity - loss of habitats (incl. fish foraging and breeding areas) - restriction of fish migrations - change in species richness and diversity - changes in species distribution	- reduction in fish stock - increased catchability of fish

A.4. Connectivity and seasonality

84. **Connectivity**, as used in this document, refers to landscape connectivity and is defined as "the degree to which the landscape facilitates or impedes movement among resource patches" (Taylor et al. 1993). According to Brooks (2003), this landscape connectivity has two components: i) structural connectivity, i.e. the spatial structure of a landscape, that can be mapped, and ii) functional connectivity, i.e. the biological response of individuals to landscape features. A high degree of connectivity is essential to the sustainability of fishery resources, as detailed in more than 300 studies (Kruskopf 2007). This is explained by the fact that most fish need different habitats (i.e. different water levels, different currents, different sources of food, etc) at their different life stages, and thus need to migrate between different habitats in the course of their life (Figure 14).

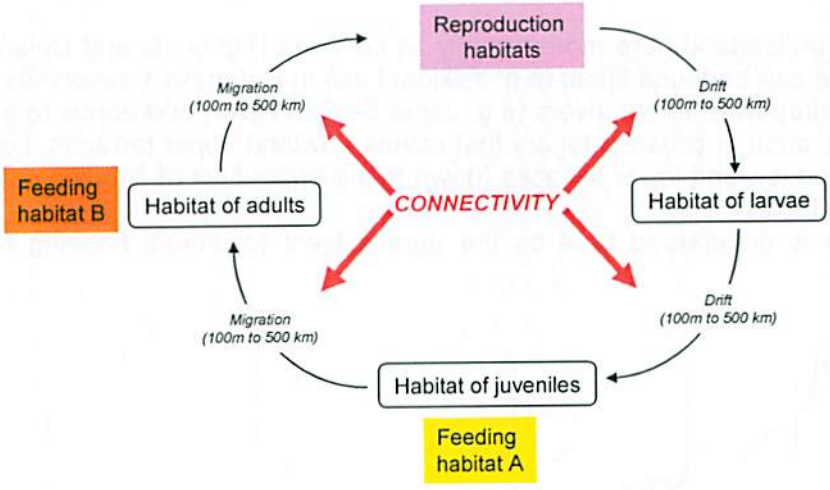

Figure 14: Connectivity and fish life stages

85.

86. **Seasonality** is an essential feature of the Tonle Sap environment, and it is important, in the course of AEAs and in view of management purposes, to assess whether a water body is permanent or disappears during the dry season. This is the justification for a classification of ecological zones integrating seasonality.

IV MODIFICATIONS PROPOSED TO THE AEA PROCESS

87. Fisheries represent one third of the contribution of the primary sector to Cambodia's GDP (Kurien et al. 2006), and fishing and fishing-related activities represent a secondary occupation for 28.5% of the inhabitants of the Tonle Sap provinces (Keskinen 2003). Despite its very significant contribution to life and meals, fish paradoxically gets little attention and a low status in the hierarchy of values in Cambodia. Thus fish issues are very often overlooked in the agriculture sector, and even in the mind of farmers.

A. COMMON GROUND BETWEEN CURRENT AEA AND FISHERIES NEEDS

88. We analyse below how to combine the above ecological factors, important from a fish resource perspective, with the variables dealt with in the AEA process. In this process the nature of TIPs available is a filter leading to a sharp focus on realistic manageable units for which information is available.

89. The main perspective common to farmers and to the fish resource is the altitude: fish abundance is largely proportional to altitude (more fish in lowland areas). The altitude factor is reflected in the CAEA approach by the Land type variable; this variable includes the following states:

    Highland; Upland; Lowland upper terrace; Lowland middle terrace; Lowland lower terrace; Residential area; Seasonally flooded

    In fact unlike the 5 five states, the two latter states are not altitude-related but can apply to several altitude zones.

90. From the perspective of fish sources and of the habitats they depend on, six land types are too many, and can be reduced to three **Altitudes**: Upland, Lowland, and Floodplain (Figure 15).

- *Upland* is understand here more broadly as covering Highlands and Uplands; this is an area where can be found lakes (e.g. Yaklom Lake in Ratanakiri), reservoirs (for irrigation or from hydropower dams), rivers (e.g. upper Se San River) and ponds (e.g. in farms).
- *Lowland* is another broad category that covers Lowland upper terraces, Lowland middle terraces and lowland lower terraces (down to the upper limit of flooding coming from the Tonle Sap Lake)
- *Floodplain* is understood here as the area subject to annual flooding by Tonle Sap waters.

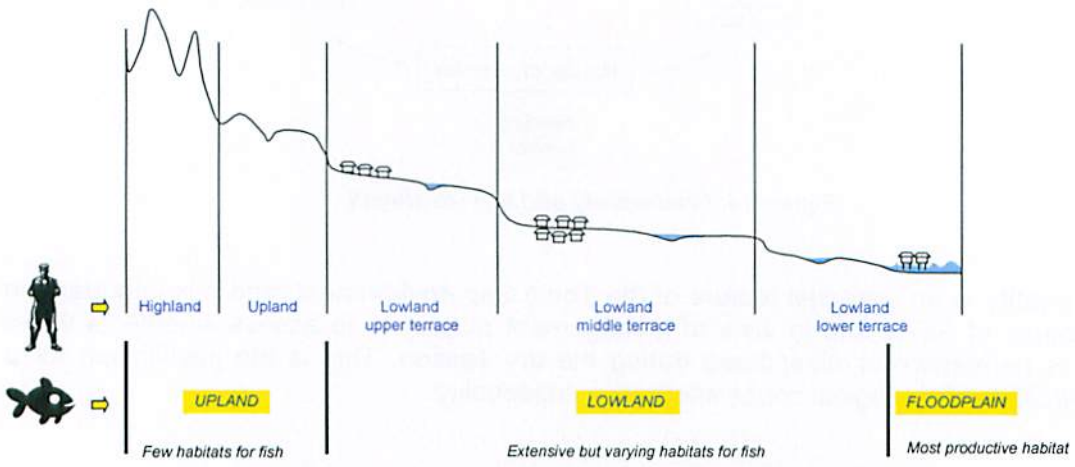

Figure 15: Land types from a fish resource perspective

91. The next criterion that is important to fish resources is the **Seasonality**, i.e. whether the water body they depend on is permanent or seasonal. This determines the species that can be found in (e.g. black fish) and the management approach (e.g. the ecological role, management or exploitation strategy of a permanent lake are different from those of a temporary pond). This two criteria are to be considered for water bodies within ecological areas: *Permanent* or *Seasonal*.

92. Last, **Connectivity** is an important factor that drives the fish production: when the water body is *closed* (e.g. upland lake or reservoir), the fish population is local and there is little turnover, whereas in the case of *connected* water bodies such as streams and floodplain ponds, migration issues are important and drive the ecology of the system. These different criteria are illustrated in Figure 16.

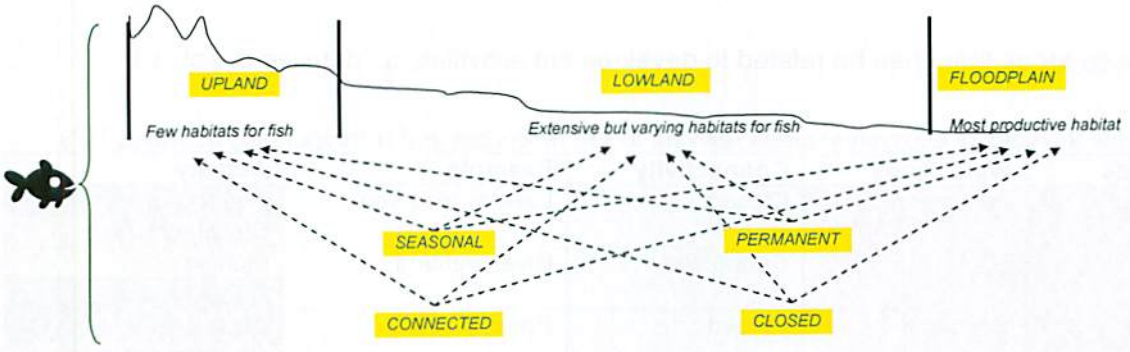

Figure 16: Main criteria relevant to fish when defining ecological zones

93. The combination of these 3 types of criteria (Land type/altitude, Seasonality, Connectivity) defines a set of water bodies for which different activities can be considered (Table 7).

Table 7: Ecological zones from the perspective of aquatic resources

Altitude	Water body	Connectivity	Example
Upland	Permanent	Closed	Lake or reservoir
		Connected	River/wetland
	Seasonal	Closed	Pond
Lowland	Permanent	Closed	Lake or reservoir
		Connected	River/wetland
	Seasonal	Closed	Pond/Canal
		Connected	Rice fields
Floodplain	Permanent	Connected	Great Lake
		Connected	River
	Seasonal	Connected	Pond/Canal
		Connected	Floodplain

This table is illustrated in Figure 17.

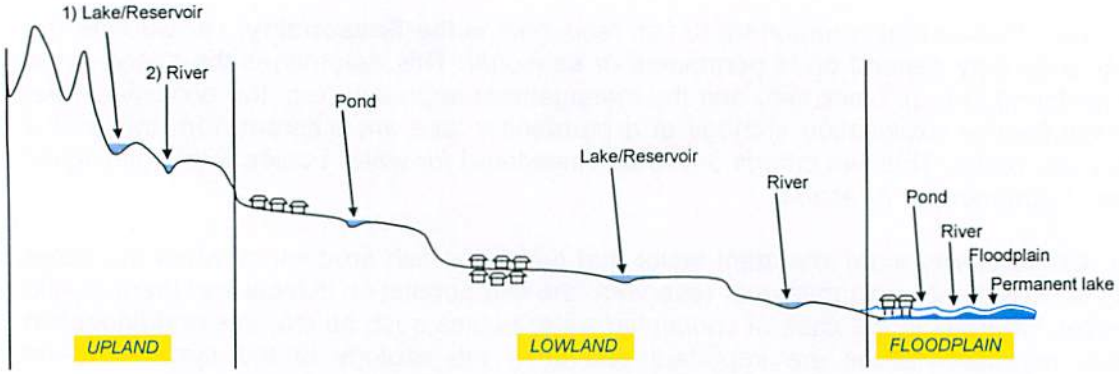

Figure 17: Main ecological zones to be considered from a fisheries perspective

94. These areas than then be related to development activities, as detailed in Table 8

95.

Table 8: Types of ecosystem areas relevant to fish resources and corresponding activities/TIPs

Altitude	Water body	Connectivity	Example	Activity
Upland	Permanent	Closed	Lake or reservoir	Aquaculture
				Stocking/fishing
		Connected	River/wetland	Fishing
				Conservation
	Seasonal	Closed	Pond	Aquaculture
				Stocking/fishing
				Conservation
Lowland	Permanent	Closed	Lake or reservoir	Aquaculture
				Stocking/fishing
		Connected	River/wetland	Fishing
				Conservation
	Seasonal	Closed	Pond/Canal	Aquaculture
				Stocking/fishing
				Conservation
		Connected	Rice fields	Stocking/fishing
Floodplain	Permanent	Connected	Great Lake	Fishing
		Connected	River	Fishing
				Conservation
	Seasonal	Connected	Pond/Canal	Fishing
				Stocking/fishing
		Connected	Floodplain	Fishing

B. QUESTIONS TO BE ASKED DURING THE AEA

96. This classification leads to questions to be asked during the AEA process; three levels of questions can be identified: 1) questions about water bodies, 2) questions about fish; 3) questions about economic aspects, and 4) questions about management objectives. Both are briefly detailed in tables below.

B.1.1. Questions about water bodies

97. It is recommended to start the AEA process integrating fisheries issues by characterizing the water bodies that can be found in the agroecosystem reviewed. Relevant question for this characterization are detailed in Table 9, where they are sorted by altitude.

Table 9: AEA questions about available water bodies

Highlands/Uplands	
	Are there permanent water bodies?
	Are they mainly closed (lakes/reservoirs) or connected (river/wetland)?
	Are there seasonal water bodies?
	Are they mainly closed (ponds)?
Lowlands	
	Are there permanent water bodies?
	Are they mainly closed (lakes/reservoirs) or connected (river/wetland/canal)?
	Are there seasonal water bodies?
	Are they mainly closed (ponds) or connected (canals)?
Floodplains	
	Are there permanent water bodies?
	In addition to the main lake, is there a river?
	Are there seasonal water bodies?
	Are these ponds in the floodplain or the floodplain itself?

98. Actually a preparation of the AEA should include maps gathering. These maps of local water bodies can be obtained, if not from local institutions, from the Atlas of Cambodia (interactive GIS on CDROM) or from Google Earth (http://earth.google.com/). These maps should be discussed with farmers during the AEA in order to identify in particular:
- water body names & types (rivers, lakes, floodplains);
- minimum dry season water depths (where *could* fish survive the dry season)
- fishing areas near villages

B.1.2. Questions about fish and fishing

99. The fisheries issues have been discussed in the previous sections; we review here the main related questions about fish and their environment to be addressed during the AEA process:

- Main **fish species** caught in each water body type? A flipchart of species, with Latin and Khmer names, is proposed as an annex to assist in the identification process. Identify in particular the possible presence of reservoir breeders among these species (see section A.1.3)
- **Importance of white, grey and black fishes** in the local ecology and economy? (see section A1 for details). Focus in particular on:

- typical white fish characterized by longitudinal migrations which migrate rather in the dry season, like *Henicorhynchus siamensis* (ត្រីរៀលតុប)
- typical grey fish like *Chitala* species (ត្រីកី), characterized by lateral migrations and a certain tolerance to mediocre environmental conditions.
- typical black fish such as *Anabas testudineus* (ត្រីក្រាញ់), characterized by no migrations and a high tolerance to harsh environmental conditions;
- sensitive or endangered species such as *Pangasianodon gigas* (ត្រីឆ្ពង) characterized by a long life, a big size and a low resilience.

- Fish species locally available and **candidate species for aquaculture development** (see section A.1.3).
- **Environmental factors**:
  - non controlled variables: (see section A3):
    flood level (up to where does the flood come?);
    flood beginning (when does the water start flooding the land in a normal year?);
    flood duration (how long does the land get flooded);
  - controlled variables:
    nature of the flooded vegetation (flooded forest, shrubs -including *Mimosa pigra*- or grassland, i.e. wetlands or rice fields);
    presence of built structures such as dykes or reservoirs, and their operation mode; accessibility of habitats fishing grounds to fish
    available refuges where black fish can spend the dry season. Are local fish stocks fished out in the dry season? If not, why not?
- **Location of spawning areas** of main species?

100. Below are the main questions about fishing to be addressed during the AEA process:

- Create a matrix (Fishing season x Gear type) and fill in that matrix with **relative catch values** (example in Table 10), in order to assess what are the most important/productive gears and who owns or operates them.

Table 10: Matrix Gear x Season

	Dry season (March-May)	Intermediate season (June-July)	Flood season (Aug.-Nov)	Migration season (Dec.-Feb.)
Gear 1	20% of the catch	40% of the catch	etc	etc
Gear 2	30% of the catch	20% of the catch		
Gear 3	not active	50% of the catch		
...				
Gear n	10% of the catch	not active		
Total contribution of gears to seasonal catch	100%	100%	100%	100%

- For the gear/season combinations producing the largest catches (i.e. the cells in the matrix with the highest percentages in each column, as highlighted in yellow in the above table), ask farmers:
    - Which species are caught?
    - What is the profitability (ratio between investment in gear construction/operation and profit from the catch, in order to identify concentrations of profit for particular gears)
    - How collective the catch is for these gears (in order to identify the benefit of a particular gear use for the whole community)?

B.1.3. Questions about economic aspects

101. Given the importance of fishing as a secondary occupation (Keskinen 2003, Hap *et al.* 2006), questions about fishing activities should be an essential part of the Seasonal Calendar, in particular for i) small-scale fishing activities (small gears requesting no licence and not subject to usage restrictions, that realize almost 50% of the national fish harvest), and ii) short but intensive activities generating much cash such as pond pumping for fishing (one day of pumping can generate several hundred dollars).

102. It is essential to also call farmer's attention on fish in the Gross Margin Analysis. With a value per kilo often much higher than that or staple crops, fish can substantially contribute, in some agroecosystems, to household income. In some cases, fishing can also generate an amount of cash that is relatively small but crucial; thus fish caught and sold on a market at the end of the dry season can be a way for farmers to get enough cash to buy rice seeds or seedlings for the next farming season. If farmers are not asked such questions during the RRA, they are unlikely to raise the issue.

103. We propose below an overview of economic issues to be discussed during the revised AEA process including fisheries (Table 10).

Table 11: Overview of fisheries issues in PRA tools

RRA Tool	Integration proposed
Maps	Locate fish production systems (aquaculture systems but also fishing grounds)
Time line	Specify fishing-related activities and relative importance over time
Transect	Specify fishing-related activities in space
Seasonal calendar	Identify fish-related activities, even when considered secondary Specify gender-specific activities in fisheries
Flow diagrams	Explore possible fish-related missed opportunities or innovations with farmers.
Wealth analysis	-
Problem trees	Ask confirmation that fish issues are not part of the problem tree
Venn diagrams	-
Gross margins	Assess the role of fish (fishing and aquaculture) in household income

104. These fish-related questions (both fisheries-related and aquaculture related) should be asked during the creation, with farmers, of the historical profile and of the transect diagram. The nature of these questions will be discussed with AEA implementers, for identification of a few simple and sharp questions to be asked. Fish-related questions should also be asked during the creation of the problem tree. It should be kept in an area where fish can be caught or grown, a naturally low fish abundance might not necessarily be a problem, but simply a missed opportunity. Therefore it is important to keep fish in the mind of the audience, so that option can be considered as a way to improve the productivity, stability, sustainability or even equity of the system.

B.1.4. Management aspects

105. Management aspects are essential in the operation and sustainability of a fishery. We detail below the most important questions regarding management of the fish resource, as summarized by Hoggarth *et al.* (1999).

- What regulations are there? (i.e. what are the access restrictions influencing the fishery)?
- Who made the regulations, and why?
- How long have the regulations been established? Have they significantly changed recently?
- Who enforces regulations? How are they enforced? What are the penalties for breaking? How often are penalties applied?
- Are there fishing conflicts or other problems? Are there issues with immigrant fishermen?

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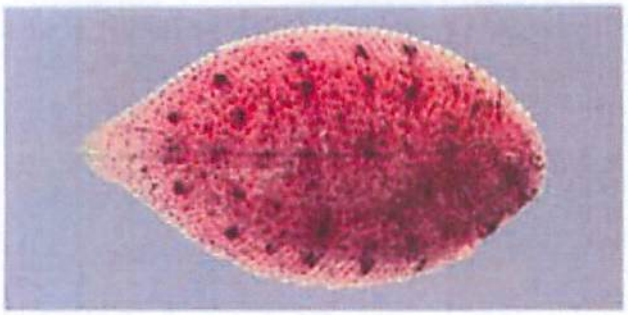
VI ANNEX 1: BIOLOGICAL INFORMATION ON 54 TONLE SAP SPECIES

Latin name	Family	Khmer name in Khmer	Khmer name in roman	Maximum total length (cm)	life span	Length at maturity (cm)	Trophic level	Status	Habitat	Resilience	Migration	Migration type	Guild
Anabas testudineus	Anabantidae	ត្រីក្រាញ់	Kranh	25.0	11.80	15.70	2.61	Native	Demersal	High	Rainy season	Lateral	Black
Hemibagrus wyckii	Bagridae	ត្រីឆ្នាំងខ្មៅ	Chhlang khmao	87.0	15.90	39.60	3.76	Native	Demersal	Medium	Dry+rainy season	Lateral	Grey
Hemibagrus wyckioides	Bagridae	ត្រីខ្យា	Khya	130.0	24.00	67.50	3.73	Native	Demersal	Low	Dry+rainy season	Lateral	Grey
Lates calcarifer	Centropomidae	ត្រីស្អង់	Spong	200.0	23.10	72.00	4.35	Native	Demersal	Medium	Dry+rainy season	Longit.	White
Channa micropeltes	Channidae	ត្រីឆ្តោ	Chhdau	159.0	22.20	67.50	3.85	Native	Benthopelagic	Low	Dry+rainy season	Lateral	Black
Channa striata	Channidae	ត្រីរស់ថ្លក់	Ros / Phtuk	122.0	9.10	53.50	3.73	Native	Benthopelagic	Medium	Dry+rainy season	Lateral	Black
Clarias batrachus	Clariidae	ត្រីអណ្តែងរឹង	Andaeng reung	47.0	4.00	30.70	3.31	Native	Demersal	High	Dry+rainy season	Longit.+Lateral	Black
Clarias macrocephalus	Clariidae	ត្រីអណ្តែងទន់	Andaeng toun	120.0	24.00	62.90	3.68	Native	Benthopelagic	High	Dry+rainy season	Lateral	Black
Clupeichthys goniognathus	Clupeidae	ត្រីបណ្តូលអំពៅ	Bandol ampeuo	11.0	2.30	6.40	3.10	Native	Pelagic	High	Dry season	Longit.+Lateral	White
Botia beauforti	Cobitidae	ត្រីកញ្ជ្រុក	Kanhchrouk	31.0	13.50	15.70	3.55	Native	Demersal	Medium	Dry+rainy season	Longit.	White
Botia helodes	Cobitidae	ត្រីកញ្ជ្រុកខ្នុត	Kanhchrouk chnot	37.0	15.70	18.50	3.31	Native	Demersal	Medium	Dry+rainy season	Longit.+Lateral	White
Botia modesta	Cobitidae	ត្រីកញ្ជ្រុកក្រហម	Kanhchrouk krohorm	31.0	13.50	15.70	3.36	Native	Demersal	Medium	Dry+rainy season	Longit.+Lateral	White
Botia morleti	Cobitidae	ត្រីកញ្ជ្រុក	Kanhchrouk	10.0	4.70	7.00	3.5	Native	Demersal	High	Dry+rainy season	Longit.+Lateral	White
Amblyrhynchichthys truncatus	Cyprinidae	ត្រីកំបុតច្រមុះ	Kambot chramos	49.0	16.70	23.80	2.38	Native	Benthopelagic	Low	Dry+rainy season	Longit.	White
Balantiocheilos melanopterus	Cyprinidae	ត្រីគ្រែតស្រង	Keat srang	43.0	14.90	21.20	3.01	Native	Benthopelagic	Medium	Dry+rainy season	Longit.	White
Barbichthys nitidus	Cyprinidae	ត្រីអណ្តាតពិ	Andarthpi	31.0	10.90	15.70	2.00	Native	Benthopelagic	Medium	Dry+rainy season	Longit.	White
Barbonymus gonionotus	Cyprinidae	ត្រីឆ្ពិនប្រាក់	Chhpin prak	40.5	14.20	24.10	2.36	Native	Benthopelagic	Medium	Dry+rainy season	Lateral	Grey
Catlocarpio siamensis	Cyprinidae	ត្រីគល់កាំង	Kulreang	300.0	96.80	141.40	2.92	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Cirrhinus jullieni	Cyprinidae	ត្រីផ្ការចារ	Phkar char	25.0	8.80	12.90	2.48	Native	Benthopelagic	Medium	Dry season	Longit.	White

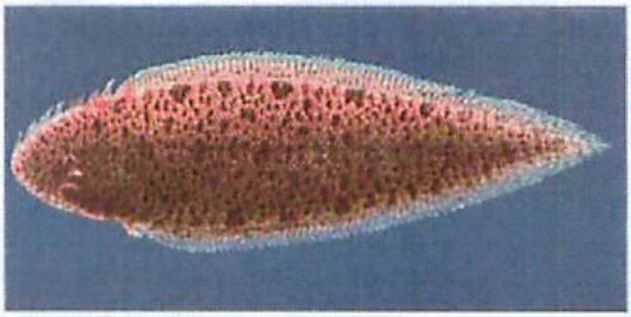
Cirrhinus microlepis	Cyprinidae	ត្រី ព្រួល/ក្រឡាំង	Pruol / Krolang	80.0	26.00	36.60	2.38	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Cirrhinus molitorella	Cyprinidae	ត្រីផ្ការ	Phkar ko	55.0	19.00	31.60	2.00	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Cosmochilus harmandi	Cyprinidae	ត្រី ឆ្កោក ឬត្រីកំពូលពាយ	Chhkok Kda / Kampoul Bai	100.0	32.00	53.50	2.00	Native	Benthopelagic	Low	Dry+rainy season	Longit.	White
Cyclocheilichthys enoplos	Cyprinidae	ត្រីឆ្កោក	Chhkaok	91.0	28.70	41.10	3.15	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Cyclocheilichthys furcatus	Cyprinidae	ត្រីឆ្កោកភ្លើង	Chhkaok phloeung	74.0	23.80	34.10	3.65	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Cyclocheilichthys heteronema	Cyprinidae	ត្រីឆ្កោកពុកមាត់បី	Chhkaok pukmotbai	15.0	5.50	8.20	3.27	Native	Benthopelagic	High	Dry+rainy season	Longit.+Lateral	White
Cyclocheilichthys lagleri	Cyprinidae	ត្រីស្រកាក្តាម	Sraka kdam	19.0	6.70	10.00	3.38	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Cyclocheilichthys repasson	Cyprinidae	ត្រីស្រកាក្តាម	Sraka kdam	35.0	12.30	17.40	2.62	Native	Benthopelagic	Medium	Dry+rainy season	Lateral	Grey
Epalzeorhynchos frenatum	Cyprinidae	ត្រីឈល់ចេក	Kul chek	15.0	5.60	10.00	2.31	Native	Benthopelagic	High	Dry+rainy season	Lateral	Grey
Epalzeorhynchos munense	Cyprinidae	ត្រីអណ្តាតពី	Andat pee	12.0	4.30	6.50	2.64	Native	Benthopelagic	High	Dry+rainy season	Longit.+Lateral	White
Hampala macrolepidota	Cyprinidae	ត្រីខ្មាន់	Khman	86.0	8.20	28.00	4.23	Native	Benthopelagic	Medium	Dry+rainy season	Lateral	Grey
Henicorhynchus cryptopogon	Cyprinidae	ត្រីរៀលអង្គាម	Riel angkam	15.0	5.60	10.00	2.00	Native	Benthopelagic	High	Dry+rainy season	Longit.+Lateral	White
Henicorhynchus siamensis	Cyprinidae	ត្រីរៀលតូប	Riel top	25.0	8.80	12.90	2.00	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Hypsibarbus lagleri	Cyprinidae	ត្រីឆ្ពិន	Chhpin	49.0	16.70	23.80	2.80	Native	Benthopelagic	Low	Dry+rainy season	Longit.	White
Labeo chrysophekadion	Cyprinidae	ត្រីកែក	Ka-ek	90.0	28.70	48.80	2.00	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Labeo dyocheilus	Cyprinidae	ត្រីចាបមុខមួយ ឬកែកពូក	Pava mouk muoy or Ka-ek pouk	90.0	28.70	48.80	2.00	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Labiobarbus leptocheila	Cyprinidae	ត្រីខ្ទះវែង	Khnorng veng	37.0	12.90	18.50	2.34	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Labiobarbus lineatus	Cyprinidae	ត្រីខ្ទះវែង	Khnorng veng	27.0	8.60	0.90	2.32	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Lobocheilos melanotaenia	Cyprinidae	ត្រីចង្វារនោង	Changva ronoung	25.0	8.80	12.90	2.00	Native	Demersal	Medium	Dry+rainy season	Lateral	Grey
Mekongina erythrospila	Cyprinidae	ត្រីបាស៊ីអ៊ី	Pase ee	55.0	19.00	26.50	2.00	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Osteochilus microcephalus	Cyprinidae	ត្រីក្រុស	Kros	30.0	10.50	15.20	2.00	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White

Osteochilus schlegelii	Cyprinidae	ត្រីឡុកសរ	Lotouk sor	49.0	16.70	23.80	2.00	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Paralaubuca typus	Cyprinidae	ត្រីស្លឹកឫស្សី	Sleuk russey	22.0	8.00	11.80	3.30	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Puntioplites proctozystron	Cyprinidae	ត្រីច្រែងកែង	Chra kaeng	30.0	10.90	18.50	2.70	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Thynnichthys thynnoides	Cyprinidae	ត្រីលិញ	Linh	25.0	9.10	15.70	2.31	Native	Benthopelagic	Medium	Dry+rainy season	Longit.+Lateral	White
Lycothrissa crocodilus	Engraulidae	ត្រីឆ្មាក្រពើ	Chhmar krapeu	37.0	5.90	18.50	3.71	Native	Pelagic	High	Dry+rainy season	Longit.+Lateral	White
Mastacembelus armatus	Mastacembelidae	ត្រីឆ្ជើង	Khchoeung	31.0	6.40	48.80	2.78	Native	Demersal	High	No migration	Longit.+Lateral	Black
Chitala blanci	Notopteridae	ត្រី កេ	Ka-ey	147.0	24.00	62.90	3.66	Native	Demersal	Low	Dry+rainy season	Longit.+Lateral	Grey
Chitala ornata	Notopteridae	ត្រីក្រាយ	Kray	122.0	20.60	53.50	3.68	Native	Pelagic	Low	Dry+rainy season	Lateral	Grey
Notopterus notopterus	Notopteridae	ត្រីស្លាត	Slat	74.0	13.00	34.10	3.50	Native	Demersal	Medium	Dry+rainy season	Longit.+Lateral	Grey
Trichogaster trichopterus	Osphronemidae	ត្រីកំភ្លាញសាមប្រែ	Kamphleanh srae	19.0	31.90	10.00	3.13	Native	Benthopelagic	High	Dry+rainy season	Longit.+Lateral	Black
Pangasianodon gigas	Pangasiidae	ត្រីគជ	Reach	300.0	7.30	141.40	2.30	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Pangasius hypophthalmus	Pangasiidae	ត្រីប្រាធំ	Pra thom	159.0	10.80	67.50	3.12	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Boesemania microlepis	Sciaenidae	ត្រីប្រម៉ា	Proma	122.0	15.20	53.50	3.72	Native	Benthopelagic	Low	Dry+rainy season	Longit.+Lateral	White
Hemisilurus mekongensis	Siluridae	ត្រីក្រម៉ម	Kromorm	80.0	2.60	44.00	3.3	Native	Demersal	Medium	Dry+rainy season	Longit.+Lateral	White

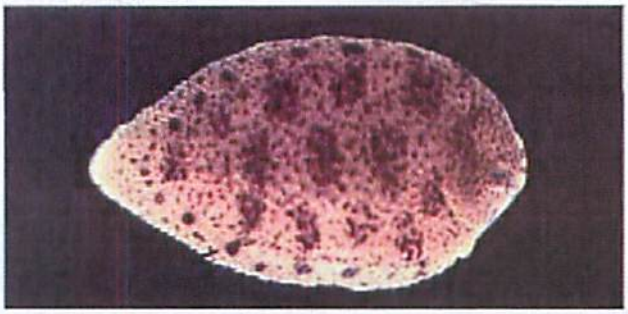
ANNEX 2: FLIP CHART FOR FISH SPECIES IDENTIFICATION



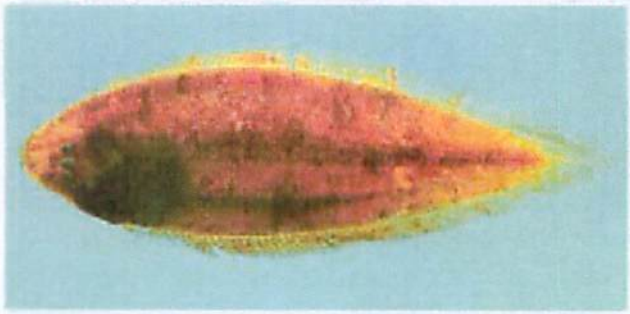
រូប១ ត្រីអណ្តាតឆ្កែ *Achiroides leucorhynchos* (N/A)



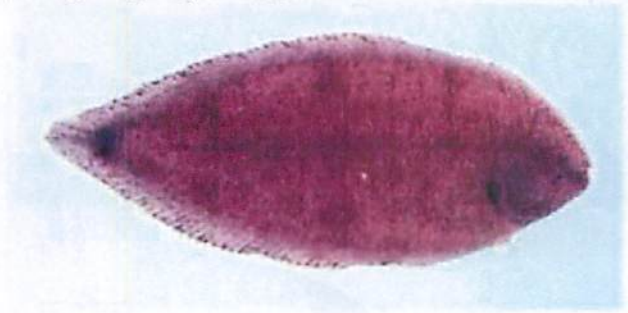
រូប២ ត្រីអណ្តាតឆ្កែ *Cynoglossus feldmanni* (N/A)



រូប៣ ត្រីអណ្តាតឆ្កែ *Euryglossa harmandi* (1)

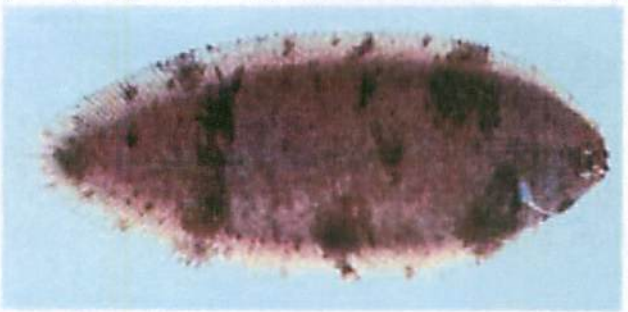


រូប៤ ត្រីអណ្តាតឆ្កែ *Cynoglossus punticeps* (N/A)

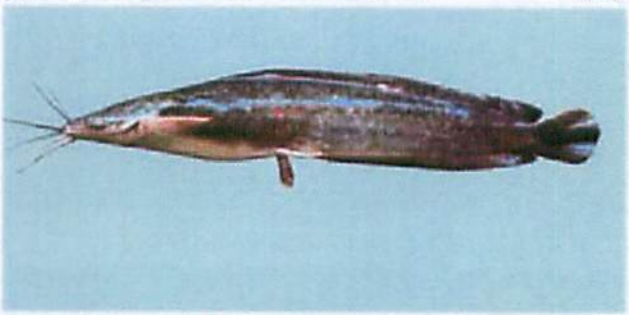


រូប៥ ត្រីអណ្តាតឆ្កែ *Euryglossa orientalis* (N/A)

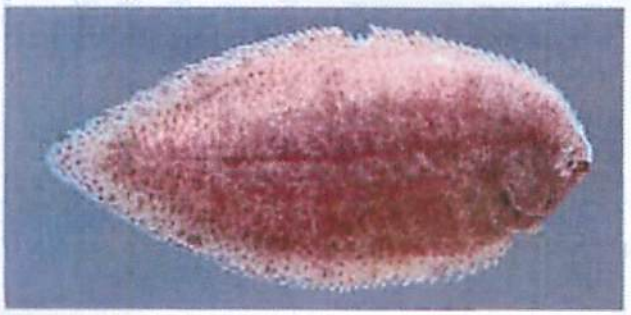
រូប៦ ត្រីអណ្តែងវែង *Clarias batrachus* (3)



រូប៧ ត្រីអណ្តាតឆ្កែ *Euryglossa panoides* (N/A)



រូប៨ ត្រីអណ្តែងអាហ្វ្រិក *Clarias gariepinus* (N/A)



រូប៩ ត្រីអណ្តាតឆ្កែ *Synoptura marginata* (N/A)

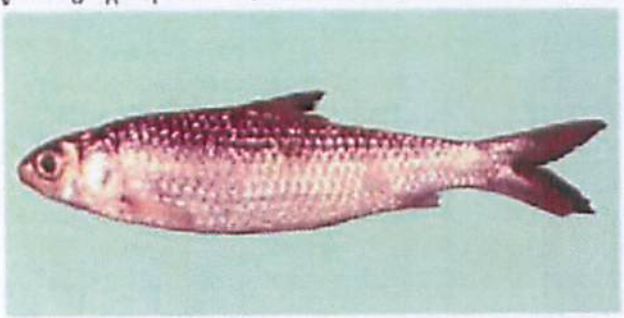
រូប១០ ត្រីអណ្តែងខ្ចី *Clarias macrocephalus* (3)

រូបទី១ ត្រីឆ្លោកភ្លើង *Cyclocheilichthys furcatus* (1)

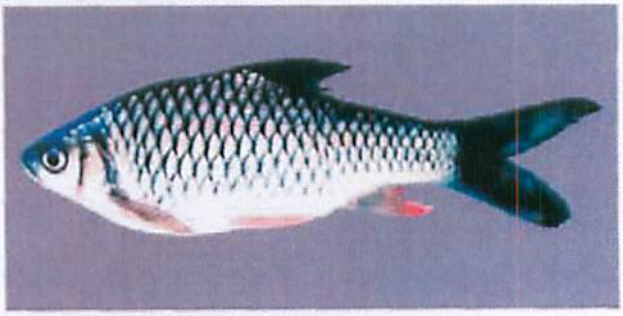
រូបទី២ ត្រីឆ្ពិន *Hypsibarbus lagleri* (3)

រូបទី៣ ត្រីឆ្លោកពុកមាត់បី *Cyclocheilichthys heteronema* (N/A)

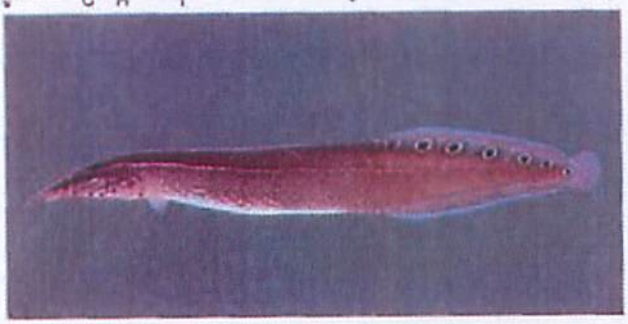
រូបទី៤ ត្រីឆ្ពិន *Hypsibarbus malcolmi* (3)



រូបទី៥ ត្រីឆ្លោកចិនខ្ចី *Albulichthys albuldoides* (1)

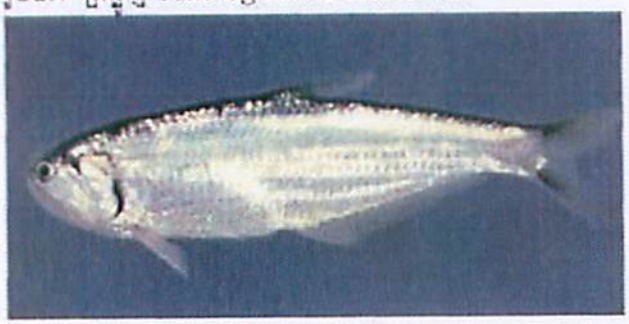


រូបទី៦ ត្រីឆ្ពិន *Hypsibarbus pierrei* (N/A)



រូបទី៧ ត្រីឆ្នូញ *Macrognathus siamensis*

រូបទី៨ ឆ្ពិនក្រហម *Hypsibarbus wetmorei* (2)



រូបទី៩ ត្រីឆ្នា *Setipinna melanochir* (N/A)

រូបទី១០ ឆ្ពិនមាស *Hypsibarbus sp. cf. vernayi ??* (N/A)

រូប៦១ត្រីឆ្ពិនមាស *Hypsibarbus sp. cf. vernayi ??*(N/A)

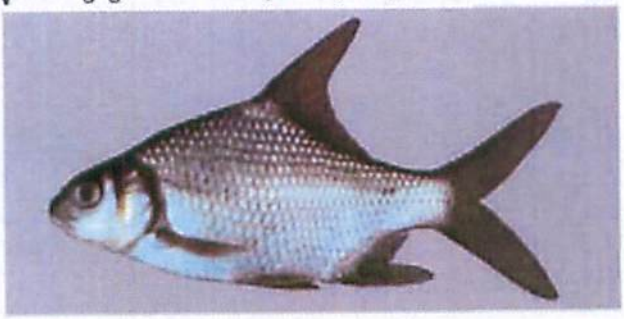
រូប៦២ ត្រីងរី *Oxyeleotris marmorata* (2)

រូប៦៣ ត្រីឆ្ពិនប្រាក់ *Barbonymus gonionotus* (3)

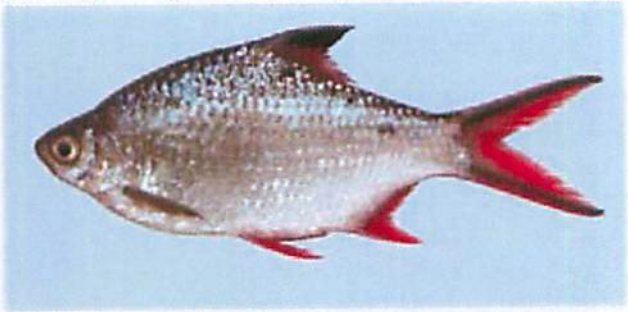
រូប៦៤ ត្រីក្អែក *Morulius/Labeo chrysophekadion*

រូប៦៥ ត្រីច្រកែង *Puntioplites falcifer* (2)

រូប៦៦ ត្រីកាបែហ្រម *Barbonymus altus* (3)

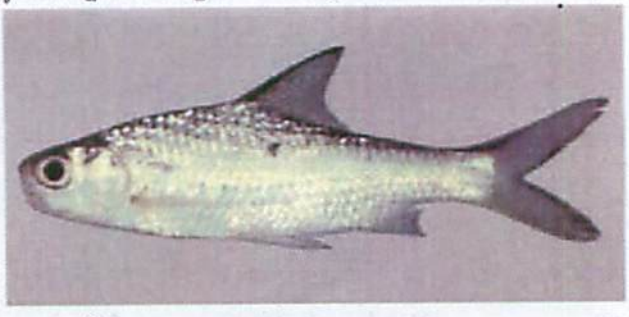


រូប៦៧ ត្រីច្រកែង *Puntioplites proctozysron* (2)



រូប៦៨ ត្រីកាបែឈ្វែង *Barbonymus schwanefeldi* (3)

រូប៦៩ ត្រីច្រកែង *Puntioplites sp. cf. waandersi* (2)

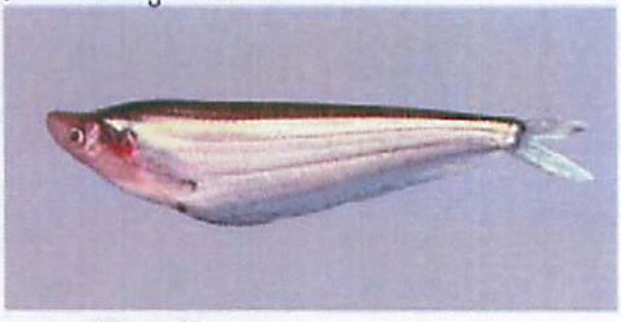


រូប៧០ ត្រីកំបុតច្រមុះ *Amblyrhynchichthys truncates* (1)

រូបទី១ កំពីស (3)

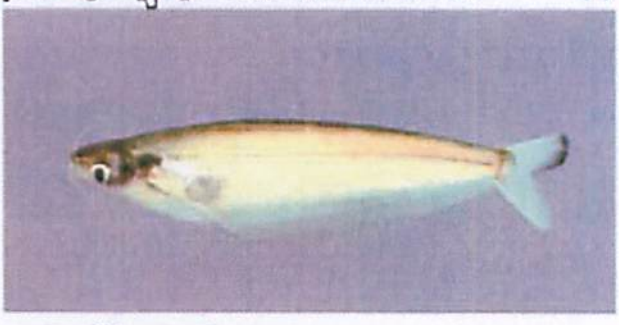
រូបទី២ ត្រីកំភ្លៅវ៉ *Kryptopterus schilbeides* (N/A)

រូបទី៣ ត្រីកំភ្លាញក្អក *Trichogaster microlepis* (3)

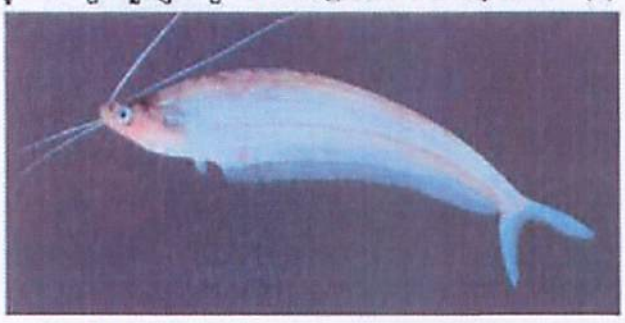


រូបទី៤ ត្រីកំភ្លៅវ៍ស្វីម *Kryptopterus cheveyi* (2)

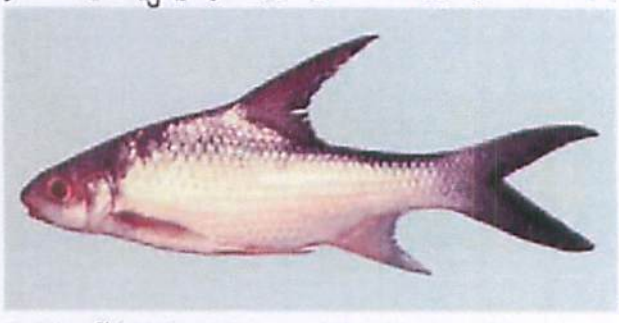
រូបទី៥ ត្រីកំភ្លាញសម្រែ *Trichogaster trichopterus* (3)



រូបទី៦ ត្រីកំភ្លៅវ៍ខ្លាញ់ *Kryptopterus cryptopterus* (2)

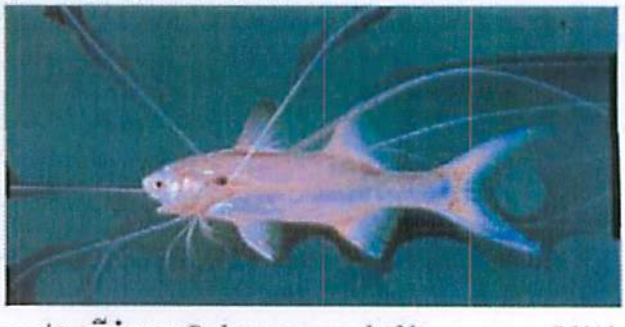


រូបទី៧ ត្រីកំភ្លៅវ៍ *Kryptopterus hexapterus* (N/A)



រូបទី៨ ត្រីកំពូលបាយ *Cosmochilus harmandi* (1)

រូបទី៩ ត្រីកំភ្លៅវ៍ *Kryptopterus moorei* (2)

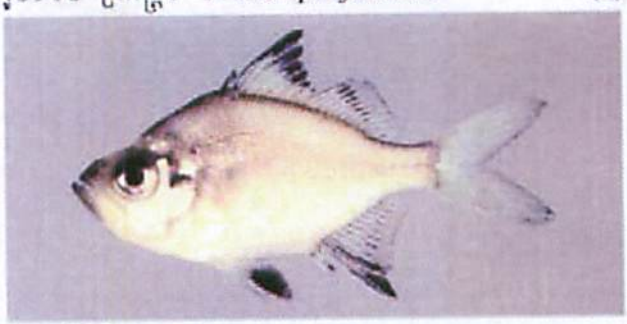


រូបទី០ ត្រីកំព្រាម *Polynemus multifilis* (N/A)

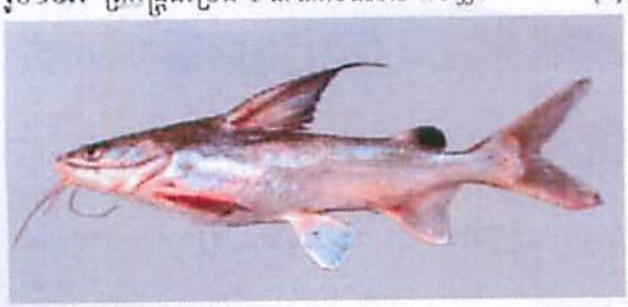
រូប១០១ ត្រីគុចរជ្រៀ/កញ្ជ្រៀ *Puntioplites bulu* (N/A)

រូប១០៣ ត្រីកន្ធរ *Trichogaster pectoralis* (3)

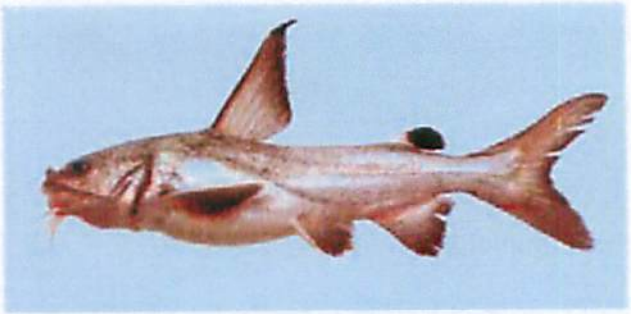
រូប១០៥ ត្រីកន្ត្រៀប *Pristolepis fasciata* (2)



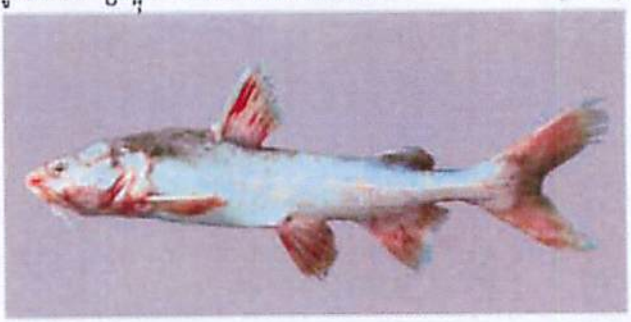
រូប១០៧ ត្រីកន្ត្រែងប្រែង *Parambassis wolffi* (2)



រូប១០៩ ត្រីក្អុក *Arius caelatus* ((N/A)

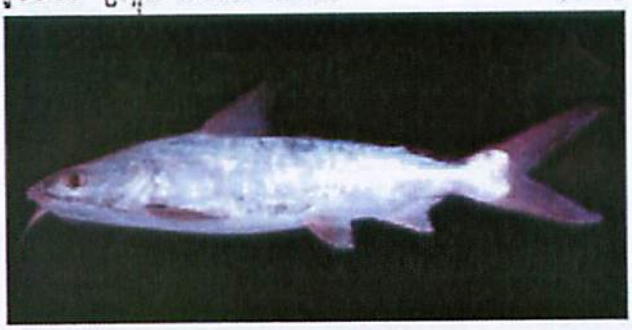


រូប១០២ ត្រីក្អុក *Arius maculatus* (N/A)



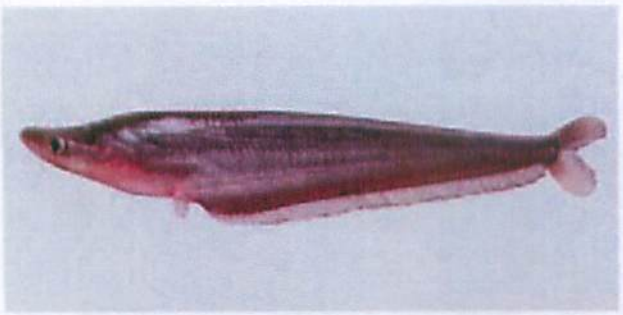
រូប១០៤ ត្រីក្អុក *Arius sona* (N/A)

រូប១០៦ ត្រីក្អុក *Arius stormi* (N/A)



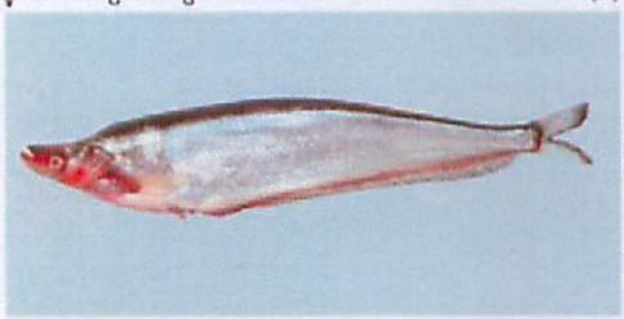
រូប១០៨ ត្រីក្អុក *Arius thalassinus* (N/A)

រូប១១០ ត្រីក្អុក *Arius truncates* (N/A)



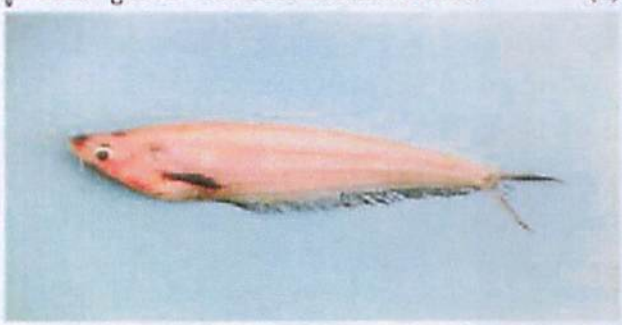
រូប១២១ ត្រីអេសក្រហម *Micronema bleekeri* (2)

រូប១២២ ត្រីខ្នាន់ *Hampala dispar* (3)

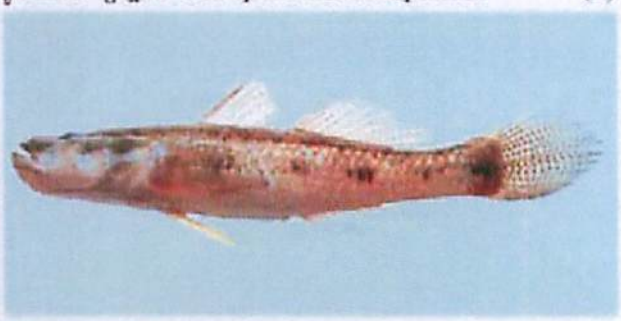


រូប១២៣ ត្រីអេស *Micronema micronema* (2)

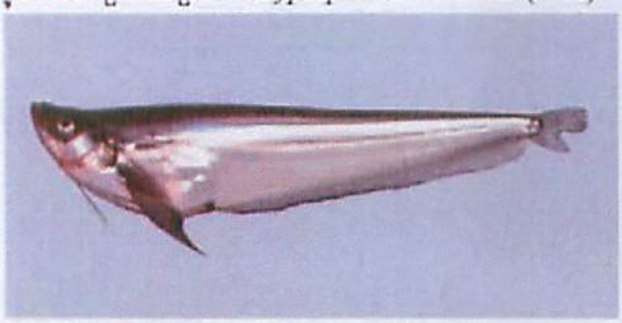
រូប១២៤ ត្រីខ្នាន់ *Hampala macrolepidota* (2)



រូប១២៥ ត្រីអេសជ្រាក់ *Kryptopterus bicirrhis* (N/A)

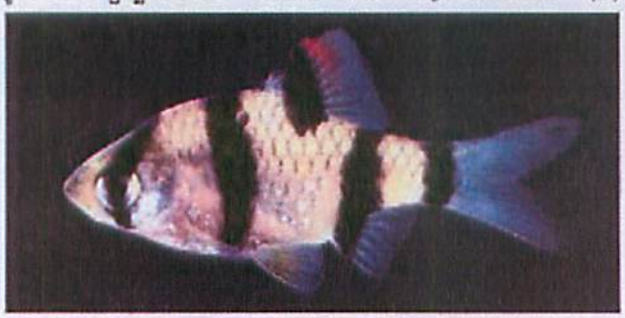


រូប១២៦ ត្រីក្សាន *Glossogobius aureu* (N/A)



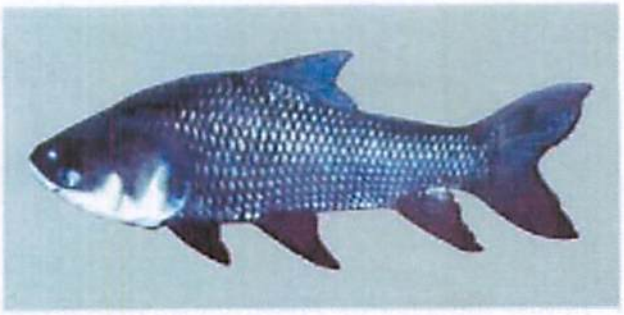
រូប១២៧ ត្រីត្នាំងហាយ *Belodonthichthys dinema* (2)

រូប១២៨ ត្រីខ្យា *Mystus wyckioides* (1)

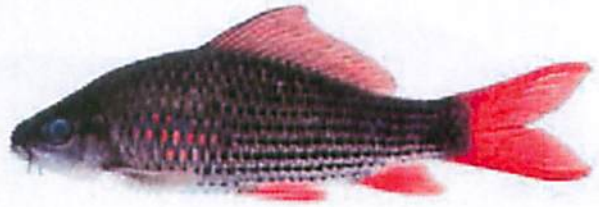


រូប១២៩ ត្រីខ្ចា *Systomus partipentazona* (N/A)

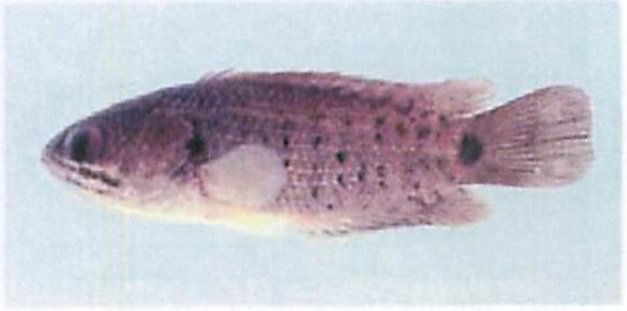
រូប១៣០ ត្រីគល់ចេក *Epalzeorhynchos frenatum* (N/A)



រូប១៣១ ត្រីអល់ភាំង *Catlocarpio siamensis* (1)

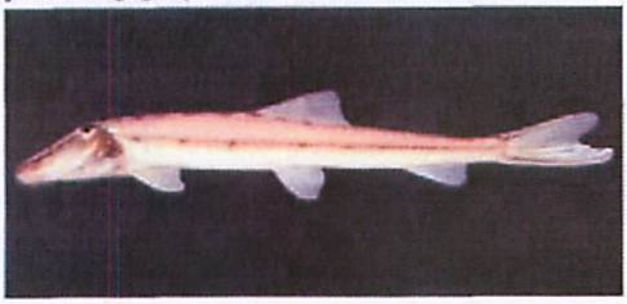


រូប១៣២ ត្រីក្រុស *Osteochilus hasselti* (N/A)



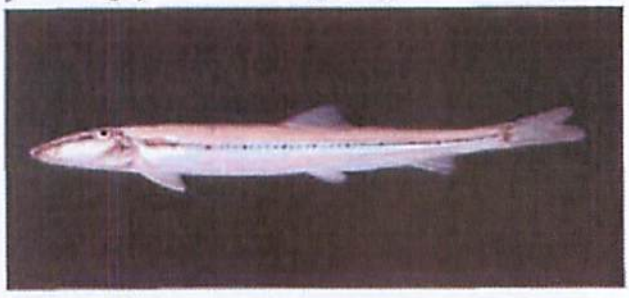
រូប១៣៣ ត្រីក្រាញ់ *Anabas testudineus* (3)

រូប១៣៤ ត្រីក្រុស *Osteochilus lini* (N/A)



រូប១៣៥ ត្រីប្លុសចេក *Acantopsis sp1* (N/A)

រូប១៣៦ ត្រីក្រុស *Osteochilus microcephalus* (N/A)

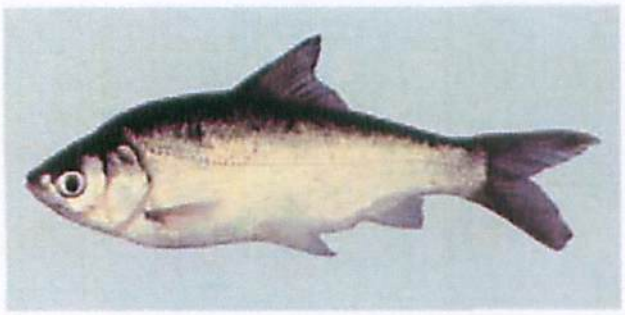


រូប១៣៧ ត្រីប្លុសចេក *Acantopsis sp2* (N/A)

រូប១៣៨ ត្រីក្រុស *Osteochilus waandersi* (1)

រូប១៣៩ ត្រីជ្រុំ *Osteochilus melanopleurus* (2)

រូប១៤០ ត្រីក្រុសភ្នំ *Poropuntius deauratus* (N/A)

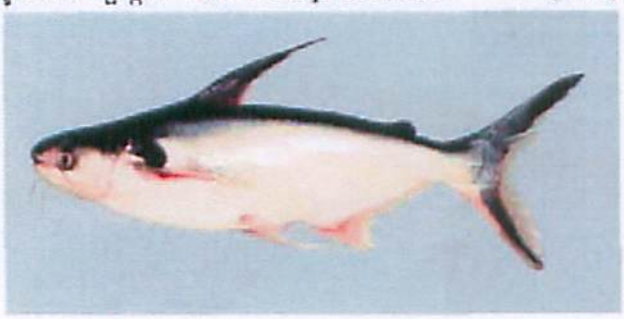


រូប១៤១ ត្រីលិញ *Thynnichthys thynnoides* (2)

រូប១៤៣ ត្រីលលកស *Osteochilus schlegeli* (3)

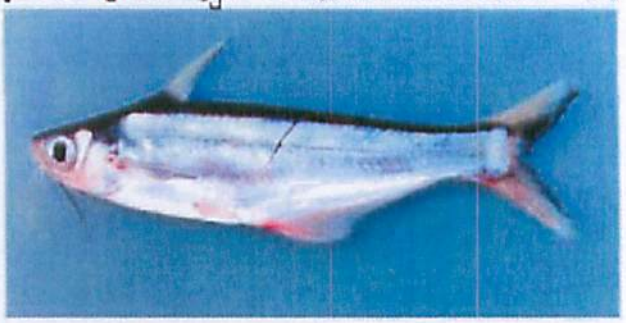
រូប១៤៥ ត្រីផ្គាក *Cirrhinus molitorella* (N/A)

រូប១៤៧ ត្រីផ្គាក *Cirrhinus prosemion* (N/A)

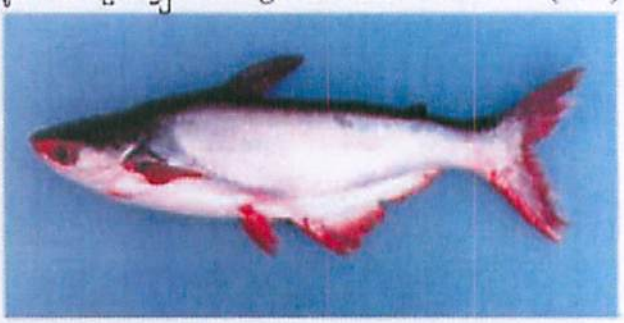


រូប១៤៩ ត្រីពោ *Pangasius larnaudii* (1)

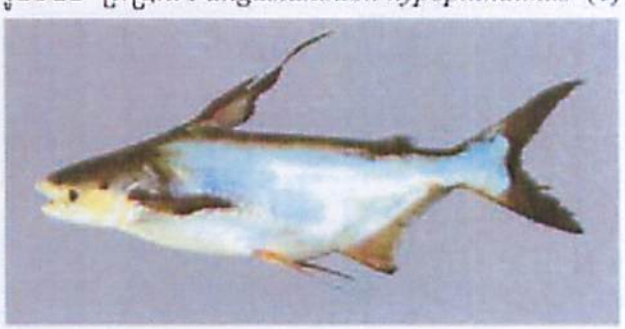
រូប១៤២ ត្រីពោ(ឈ្វៀត) *Pangasius micronemus* (1)



រូប១៤៤ ត្រីឈ្វៀត *Pangasius macronema* (N/A)

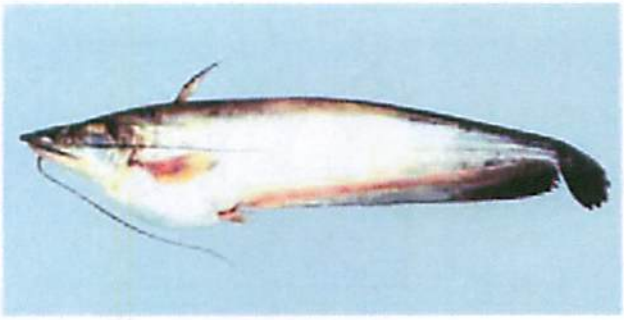


រូប១៤៦ ត្រីប្រាធំ *Pangasianodon hypophthalmus* (1)

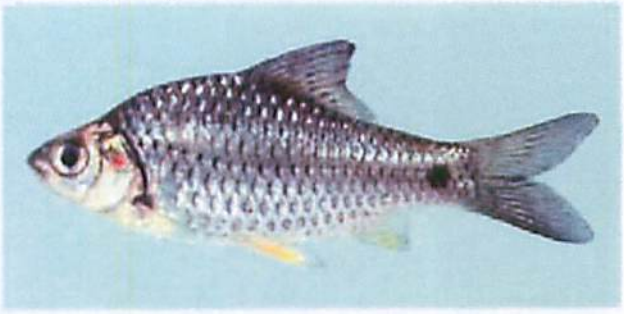


រូប១៤៨ ត្រីពោព្រុយ *Pangasius sanitwongsei* (N/A)

រូប១៥០ ត្រីឈ្វៀត *Pangasius pleurotaenia* (N/A)

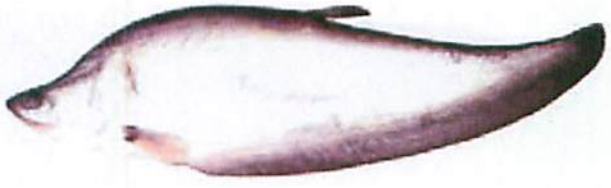


រូប១៧១ ត្រីសណ្តោយ *Wallago attu* (2)



រូប១៧៣ ត្រីសង្កត់ប្រាក់ *Puntius brevis* (N/A)

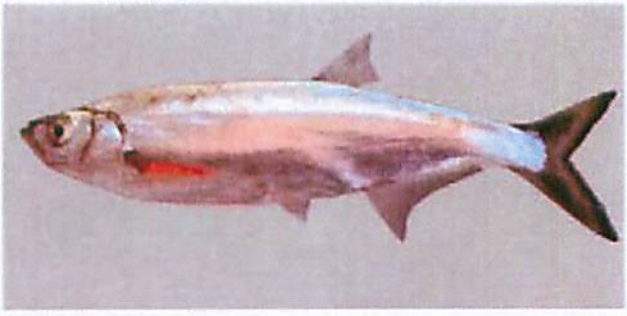
រូប១៧៥ ត្រីសង្កត់ប្រាក់ *Systomus aurotaeniatus* (N/A)



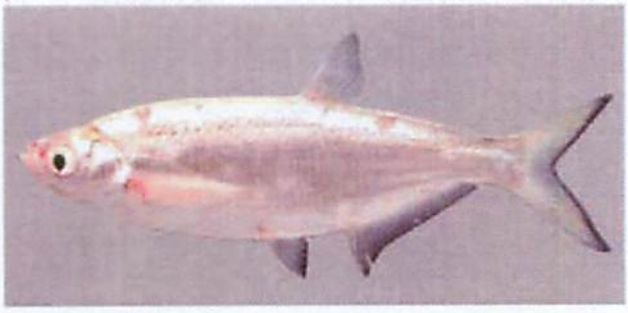
រូប១៧៧ ត្រីក្រាយស្រែ *Chitala lopis* (3)

រូប១៧៩ ត្រីស្លាត *Notopterus notopterus* (2)

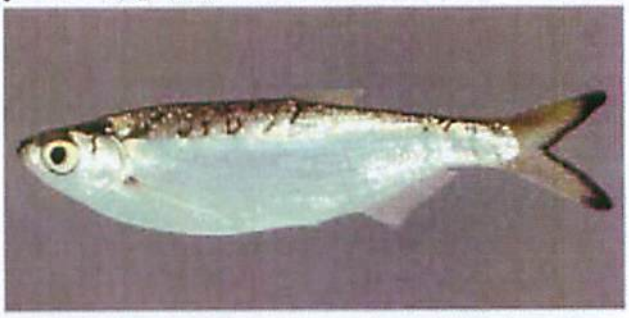
រូប១៧២ ត្រីស្លឹកបូស្សី *Paralaubuca barroni* (N/A)



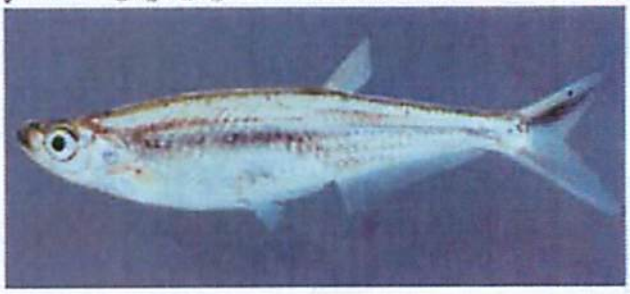
រូប១៧៤ ត្រីស្លឹកបូស្សី *Paralaubuca harmandi* (N/A)



រូប១៧៦ ត្រីស្លឹកបូស្សី *Paralaubuca riveroi* (N/A)



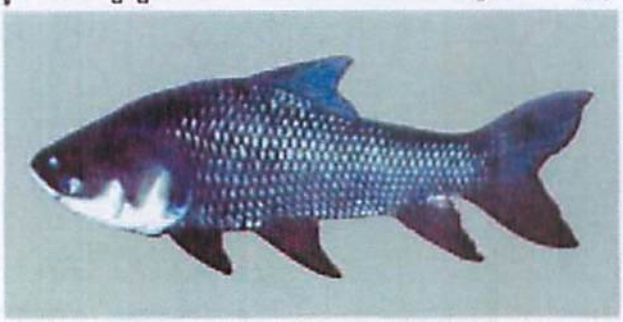
រូប១៧៨ ត្រីស្លឹកបូស្សី *Paralaubuca typus* (2)



រូប១៨០ ត្រីស្លឹកបូស្សី *Oxygaster anomalura* (N/A)

រូប១៩០ ត្រីត្រសក់ *Probarbus labeaminor* (1)

រូប១៩២ ត្រីត្រសក់ស *Probarbus labeamajor* (1)



រូប១៩៤ ត្រីគល់កាំង *Catlocarpio siamensis* (1)

រូប១៩៦ត្រីកន្ទុយក្រហម*Dischero dontus schroederi*(N/A)

រូប១៩៨ ត្រីខ្លា *Datnioides pulcher* (2)

រូប១៩១ ត្រីខ្លា *Datnioides quadrifasciatus* (2)

រូប១៩៣ ត្រីខ្លា *Datnioides undecrimradiatus* (2)

រូប១៩៥ ត្រីខ្យាច់ *Butis gymnopormus* (N/A)

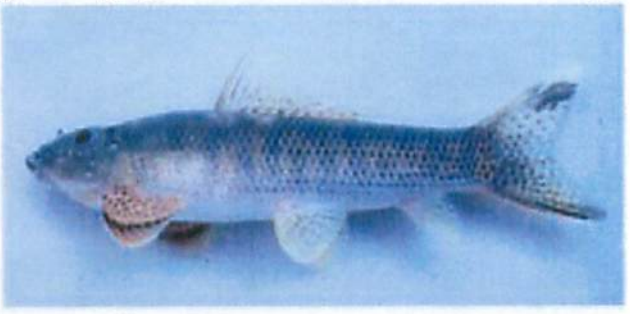
រូប១៩៧ ត្រីក្រឹម *Trichopsis schaleri* (3)

រូប១៩៩ ត្រីក្រឹម *Trichopsis vittata* (3)

រូប២០០ ត្រីលលកស *Ostechilus schlegeli* (3)

រូប២០១ ត្រីក្អែក *Tor tambroides* (1)

រូប២០២ ត្រីស្នក់ *Wallago leerii* (N/A)

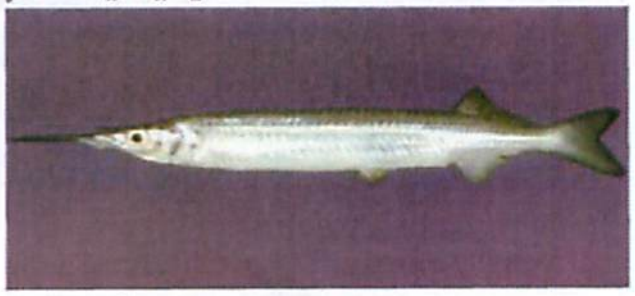


រូប២០៣ ត្រីស្នែក *Gyrinocheilus pennocki* (N/A)

រូប២០៤ ត្រីតាខែល *Hemibagrus filamentus* (2)

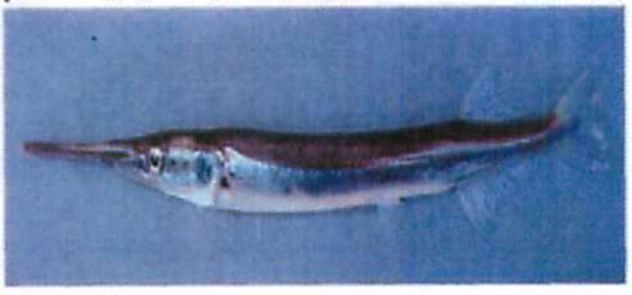
រូប២០៥ ត្រីចឺឡាពៀ *Oreochromis niloticus* (N/A)

រូប២០៦ ត្រីតាខែល *Mytus filamentus?????* (N/A)

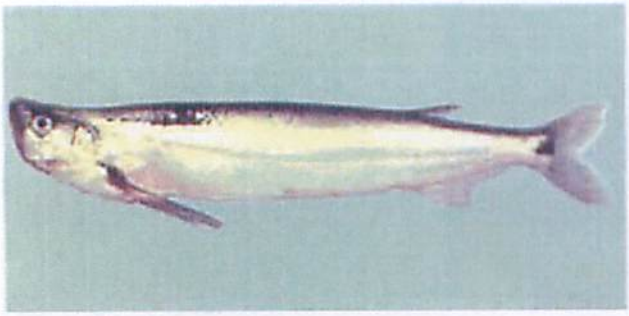


រូប២០៧ ត្រីជ្រោង *Hyporhamphus limbatus* (N/A)

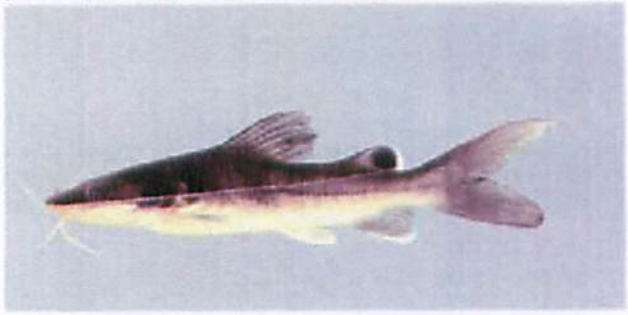
រូប២០៨ ត្រីកូបីត?? *Crossocheilus cobitis*



រូប២០៩ ត្រីជ្រោង *Xenentodon cancila* (2)

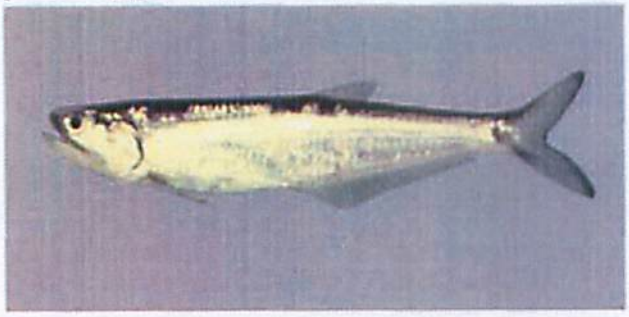


រូប២១០ត្រីដងខ្មែង *Macrochirichthys macrochirus* (2)



រូប២១១ ត្រីឆ្នាំង *Hemibagrus spilopterus* (1)

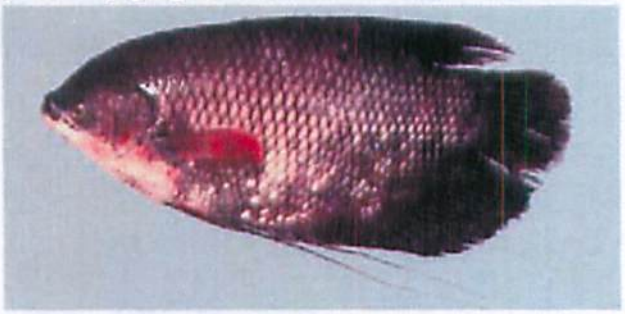
រូប២១២ ត្រីក្របើ *Bagarius bagarius* (1)



រូប២១៣ ត្រីឆ្នាក្រពើ *Lycothrissa crocodilus* (N/A)

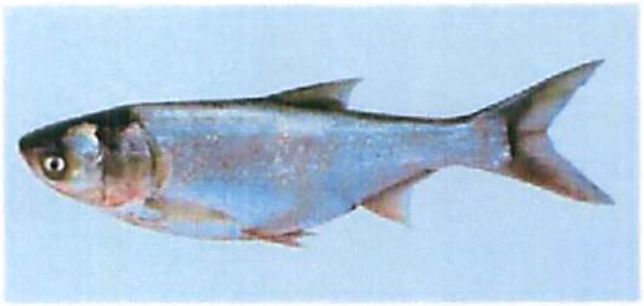
រូប២១៤ ត្រីគ្បៀតស្រង់ *Balantiocheilos melanopterus* (N/A)

រូប២១៥ ត្រីត្រីចៀកដំរី *Osphronemus gouramy* (N/A)



រូប២១៦ ត្រីរមាស *Osphronemus exodon* (N/A)

រូប២១៧ ត្រីអាជ *Pangasianodon gigas* (1)



ត្រីកាបស *Hypophthalmichthys molitrix*

ត្រី *Catla catla*

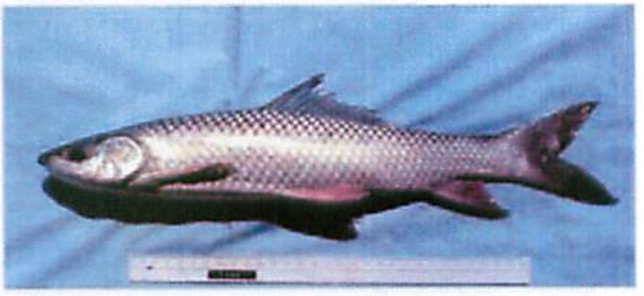
ត្រីកាបសមញ្ញ *Cyprinus carpio*

ត្រី *Grass carp*

ត្រីទីឡាព្យា *Oreochromis niloticus*

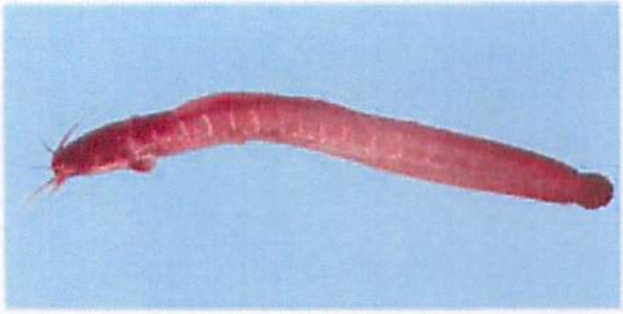
ត្រីមីក្រាល់ *Migral*

ត្រីកាបក្បាលធំ *Bighead carp*

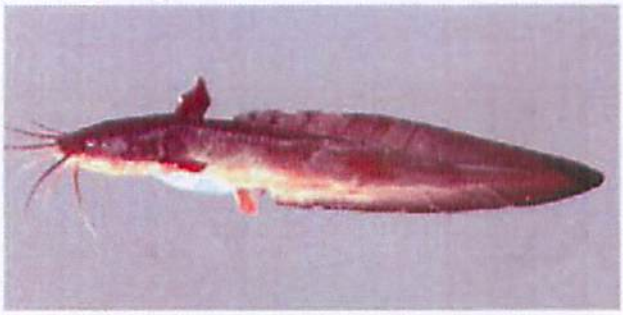


ត្រីរ៉ូហូ *Roho*

រូប១១ ត្រីអណ្តែងចន្ទ *Clarias meladerma* (3)

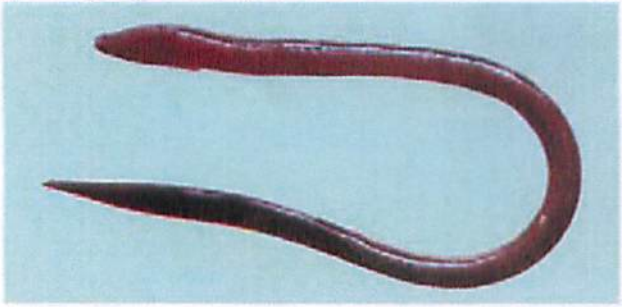


រូប១៣ ត្រីអណ្តែងហាំង *Clarias nieuhofi* (3)

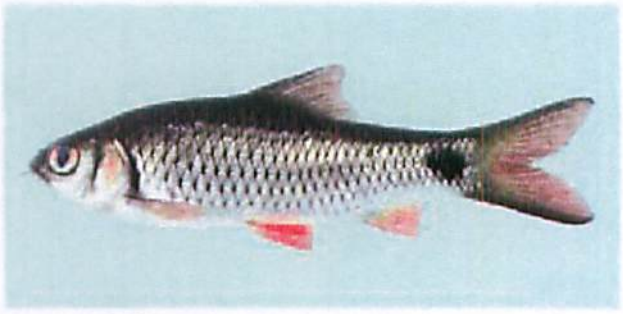


រូប១៥ ត្រីអណ្តែងចង្ហេ *Clarias canius* (1)

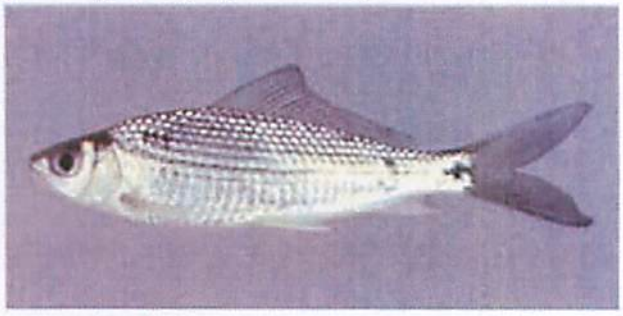
រូប១៧ ត្រីអន្ទង់ *Monopterus albus* (3)



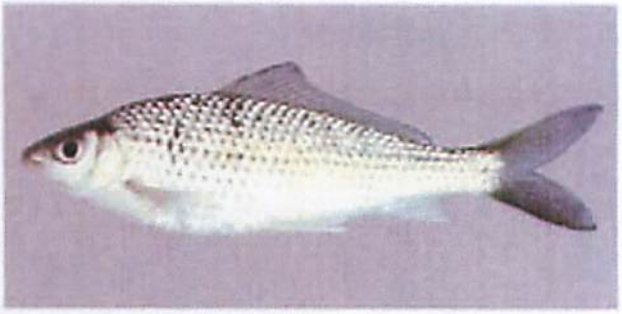
រូប១៩ ត្រីអន្ទង់ *Ophisternon bengalense* (N/A)



រូប១២ ត្រីអំពិលចុំ *Cystomus orphoides* (N/A)

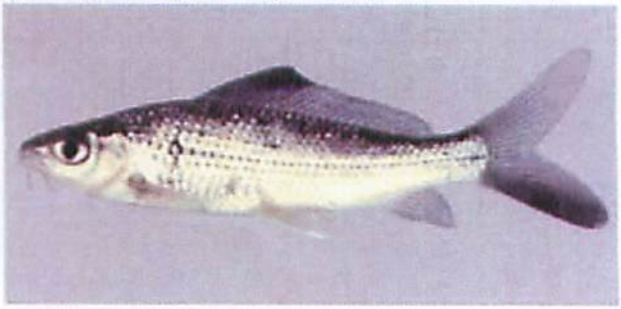


រូប១៤ ត្រីខ្លុងវែង *Dangila sp.cf.cuvieri* (2)

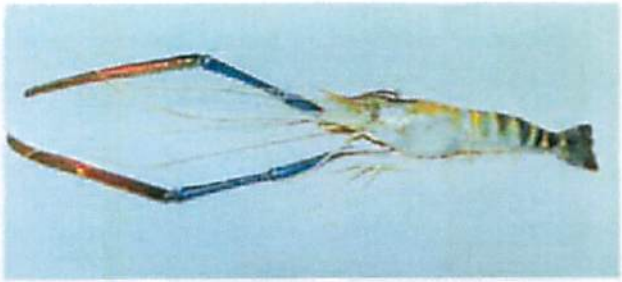


រូប១៦ ត្រីខ្លុងវែង *Dangila lineuta* (2)

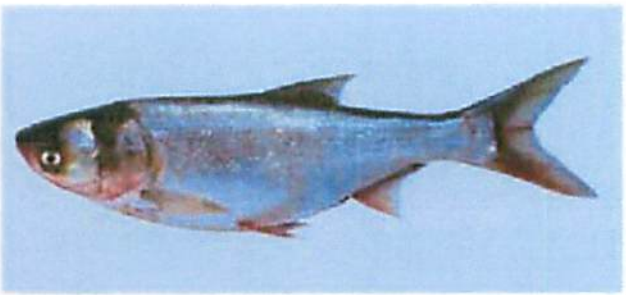
រូប១៨ ត្រីអាចម៍កុក *Dangila sp.cf.lineuta* (N/A)



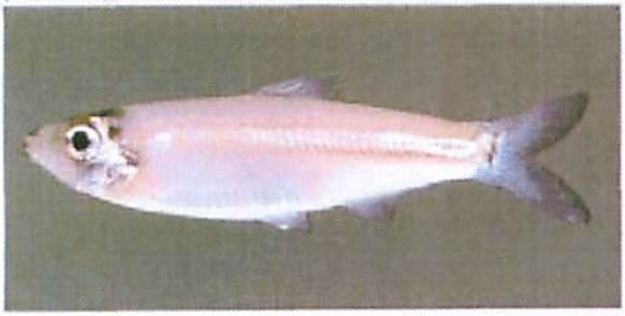
រូប២០ ត្រីអាចម៍កុក *Dangila spilopleura* (2)



រូប២១ បង្កង *Macrobrachium rogenbergii* (N/A)



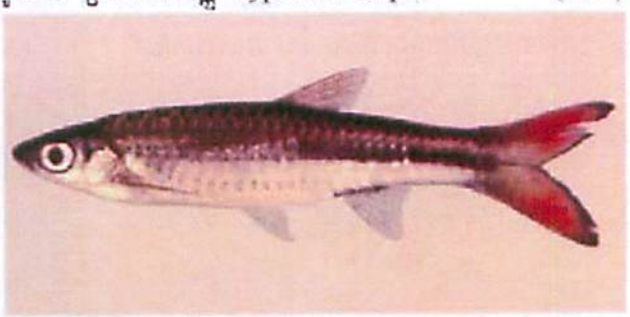
រូប២២ ត្រីកាបស *Hypophthalmichthys molitrix* (N/A)



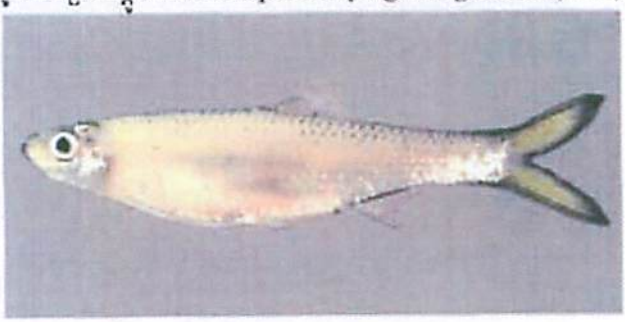
រូប២៣ ត្រីបណ្តូលអំពៅ *Clupeichthys aesarnensis*(N/A)

រូប២៤ ត្រីកាបសមញ្ញ *Cyprinus carpio* (N/A)

រូប២៥ត្រីបណ្តូលអំពៅ *Clupeichthys goniognathus*(N/A)

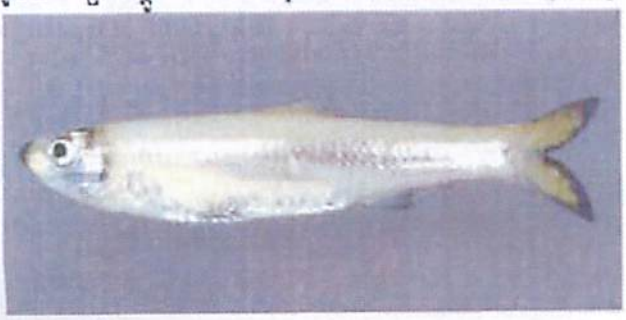


រូប២៦ ត្រីចង្ហា *Rasbota dusonensis* (N/A)



រូប២៧ ត្រីបណ្តូលអំពៅ *Clupeoides borneensis* (N/A)

រូប២៨ ត្រីចង្ហា *Rasbota hobelmani* (N/A)



រូប២៩ ត្រីបណ្តូលអំពៅ *Corica laciniata* (N/A)

រូប៣០ ត្រីចង្ហា *Rasbota myersi* (N/A)

រូបទី១ ត្រីចង្ហា *Rasbota pauciperforata* (N/A)

រូបទី៣ ត្រីចង្ហាឆ្នូត *Rasbota daniconius* (N/A)

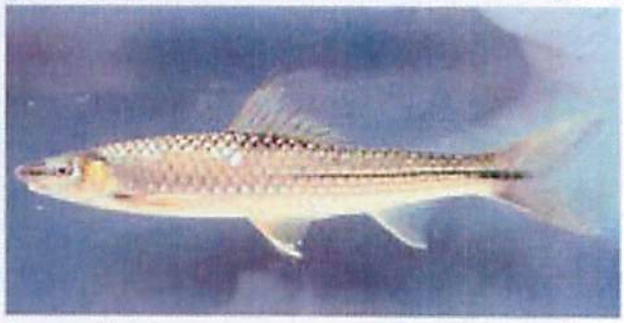
រូបទី៥ ត្រីចង្ហាឆ្នូត *Rasbota espei* (N/A)

រូបទី៧ ត្រីចង្ហាឆ្នូត *Rasbota paviei* (N/A)

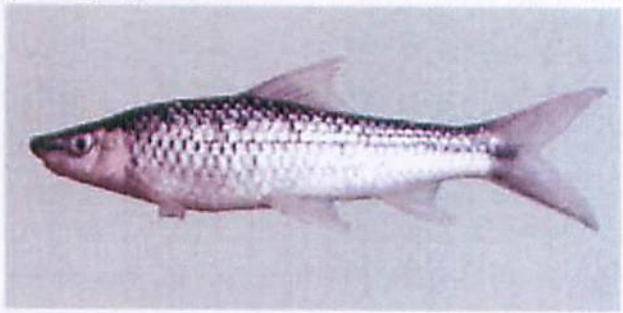
រូបទី៩ ត្រីចង្ហាមូល *Rasbota tornieri* (1)

រូបទី២ ត្រីចង្ហាក្បែង *Esomus longimanus* (1)

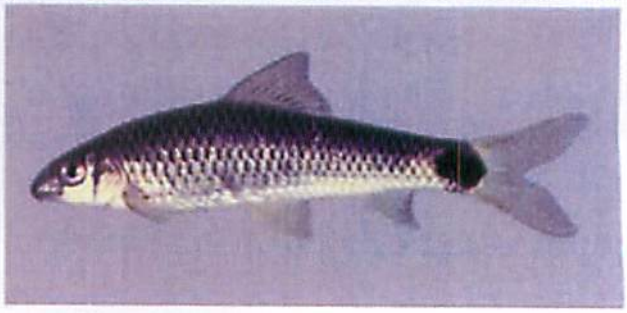
រូបទី៤ ត្រីចង្ហារនោង *Lobocheilos davisi* (N/A)



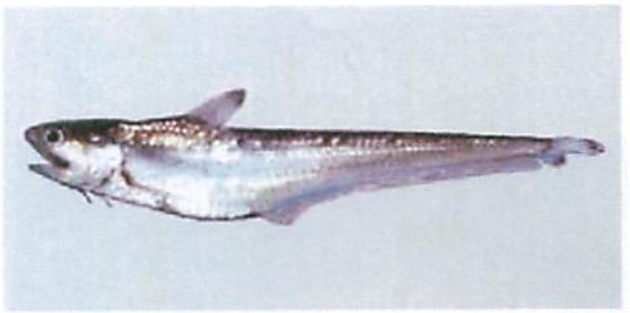
រូបទី៦ ត្រីចង្ហារនោង *Lobocheilos melanotaenia* (1)



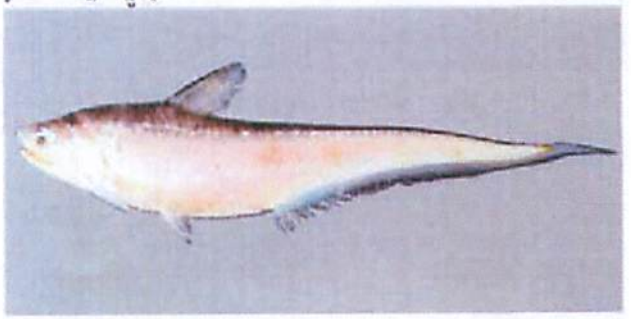
រូបទី៨ ត្រីចង្ហារនោង *Lobocheilos quadrilineatus* (1)



រូបទី១០ ត្រីចង្ហាជញ្ជក់ *Crossocheilus reticulates* (N/A)

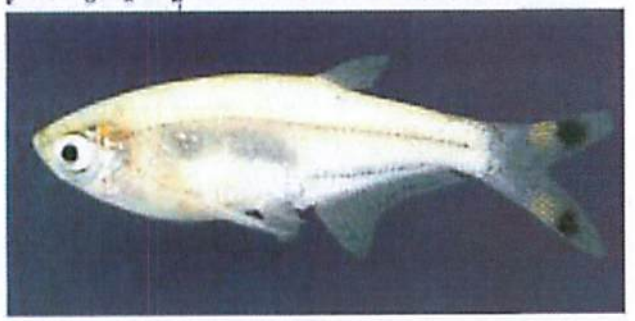


រូបទី១ ត្រីជន្លួញមាន់ *Coilia lindmani* (N/A)

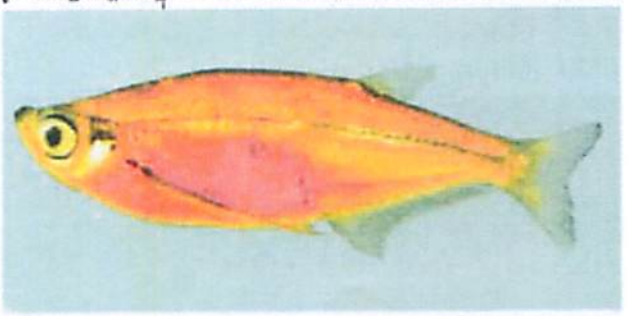


រូបទី៣ ត្រីជន្លួញមាន់ *Coilia macrognathos* (N/A)

រូបទី៥ ត្រីជន្លាសភ្នែក *Parachela maculicauda*



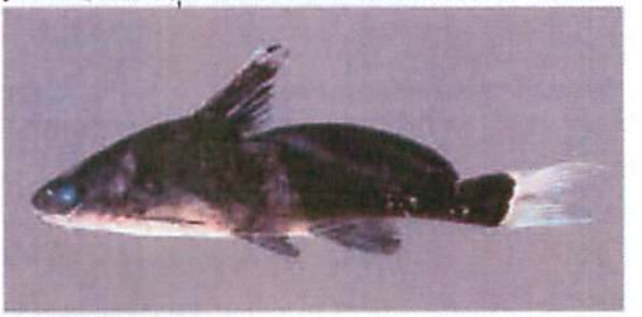
រូបទី៧ ត្រីជន្លាសភ្នែក *Parachela sp. cf.maculicauda* (N/A)



រូបទី៩ ត្រីជន្លាសភ្នែក *Parachela oxygastroides* (N/A)

រូបទី២ ត្រីជន្លាសភ្នែក *Parachela siamensis* (N/A)

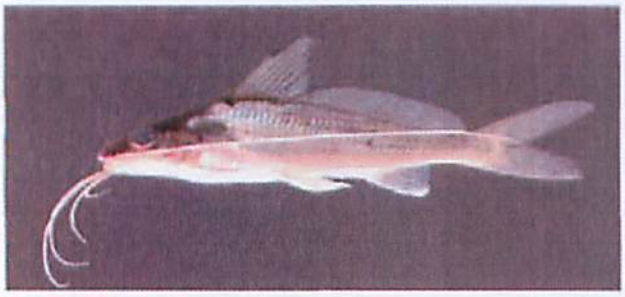
រូបទី៤ ត្រីជន្លាសភ្នែក *Parachela williamminae* (N/A)



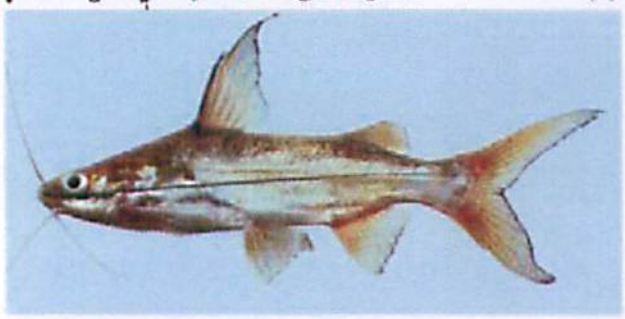
រូបទី៦ ត្រីចេកខ្ទុំ *Bagrichthys macracanthus* (3)

រូបទី៨ ត្រីចេកខ្ទុំ *Bagrichthys obscurus* (3)

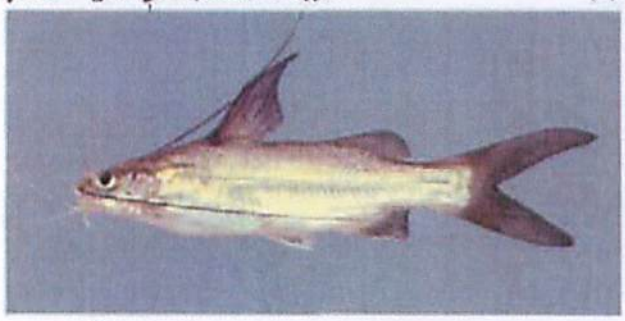
រូបទី១០ ត្រីឆ្លោក *Cyclocheilichthys enoplos* (1)



រូបទី១ ត្រីកញ្ជុះ *Mystus singaringan* (2)

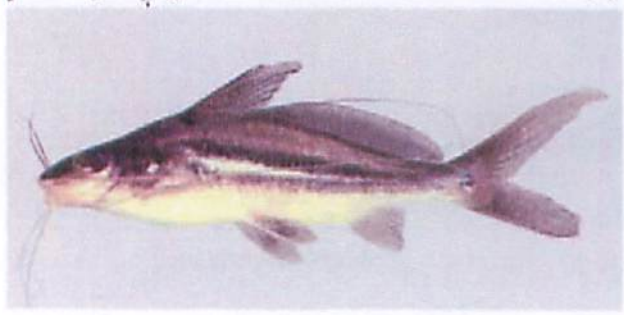


រូបទី៣ ត្រីកញ្ជុះ *Mystus wolffi* (2)



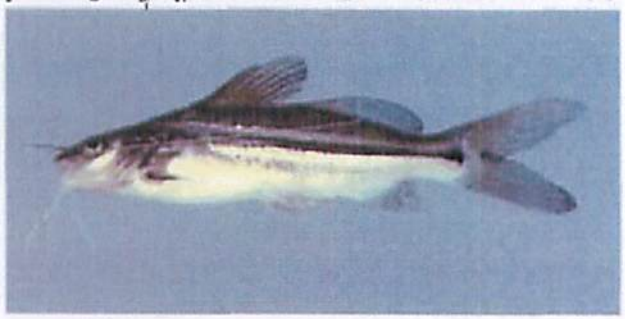
រូបទី៥ ត្រីកញ្ជុះ *Mystus sp. cf. wolffi* (2)

រូបទី៧ ត្រីកញ្ជុះថ្ម *Leiocassis siamensis* (2)

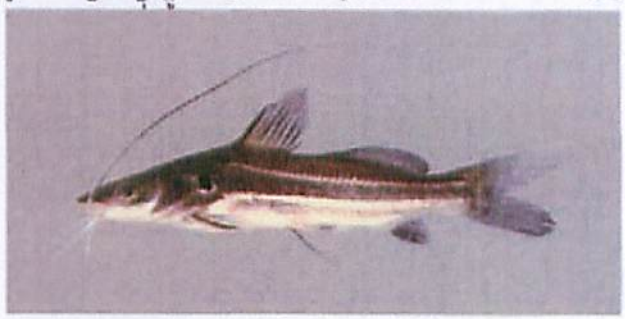


រូបទី៩ ត្រីកញ្ជុះពាយ *Mystus albolineutus* (2)

រូបទី២ ត្រីកញ្ជុះក្តោង *Heterobagrus bocourti* (2)

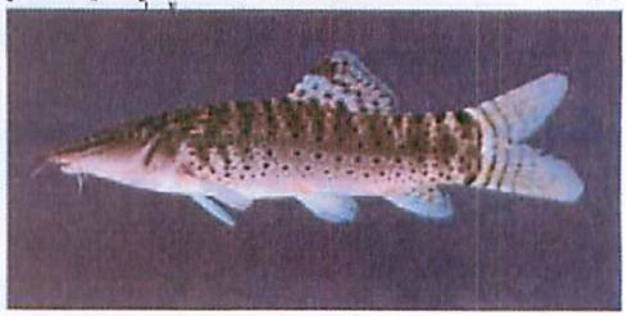


រូបទី៤ ត្រីកញ្ជុះឆ្នូត *Mystus atrifasciatus* (2)



រូបទី៦ ត្រីកញ្ជុះឆ្នូត *Mystus multiradiatus* (2)

រូបទី៨ ត្រីកញ្ជុះឆ្នូត *Mystus mysticetus* (2)



រូបទី១០ ត្រីកញ្ជ្រោក *Botia beauforti* (N/A)

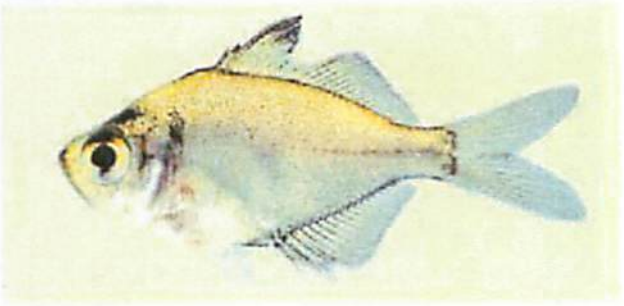
រូប៩១ ត្រីកញ្ជ្រុក *Botia morleti* (N/A)

រូប៩៣ ត្រីកញ្ជ្រុកឆ្នូត *Botia helodes* (2)

រូប៩៥ ត្រីកញ្ជ្រុកឈើង *Botia lecontei* (2)

រូប៩៧ ត្រីកញ្ជ្រុកក្រហម *Botia modesta* (2)

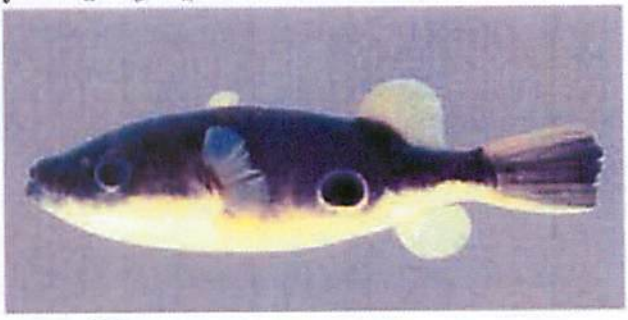
រូប៩៩ ត្រីកញ្ជ្រោងធំ *Parambassis apogonoides*(N/A)



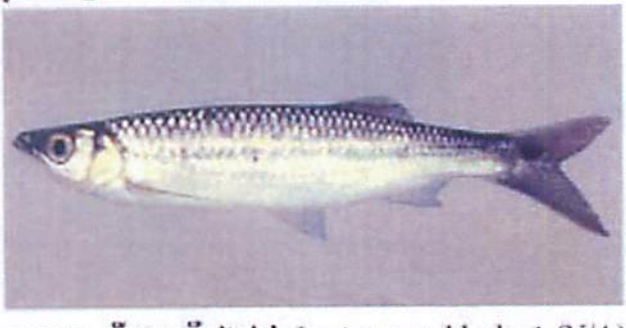
រូប៩២ ត្រីកញ្ជ្រោងសុទ្ធ *Pseudambassis notatus* (N/A)

រូប៩៤ ត្រីកញ្ឆាក់ស្លា *Toxotes chatareus* (2)

រូប៩៦ ត្រីកញ្ឆាក់ស្លា *Toxotes microlepis* (2)

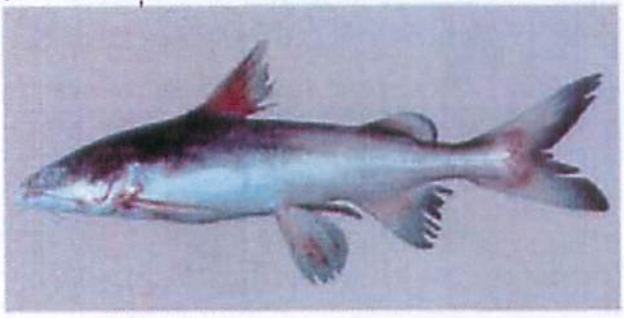


រូប៩៨ ត្រីកំពត *Monotreta barbata* (2)

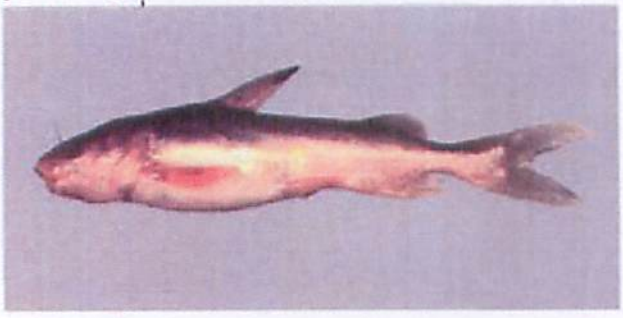


រូប១០០ ត្រីបង្គួយរឹងដងវ៉ា *Luciosoma bleekeri* (N/A)

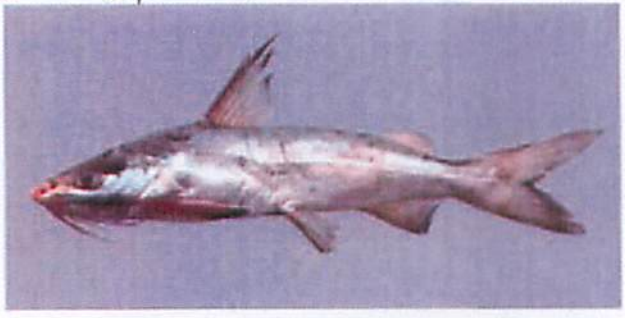
រូប១១១ ត្រីកួក *Batrachocephalus mino* (N/A)



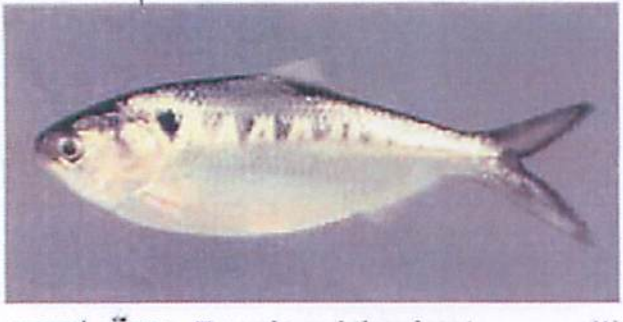
រូប១១៣ ត្រីកួក *Hemipimelodus bicolor* (N/A)



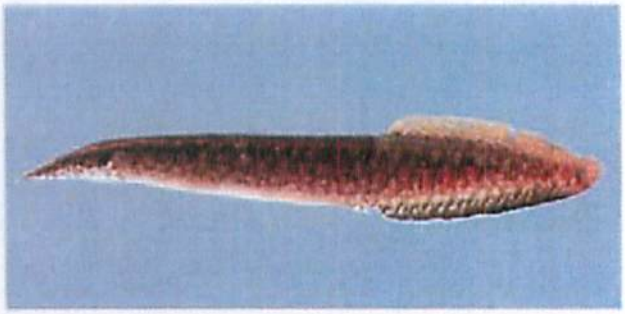
រូប១១៥ ត្រីកួក *Hemipimelodus borneensis* (N/A)



រូប១១៧ ត្រីកួក *Hemipimelodus intermedius* (N/A)



រូប១១៩ ត្រីក្បុក *Tenualosa thibaudeaui* (1)

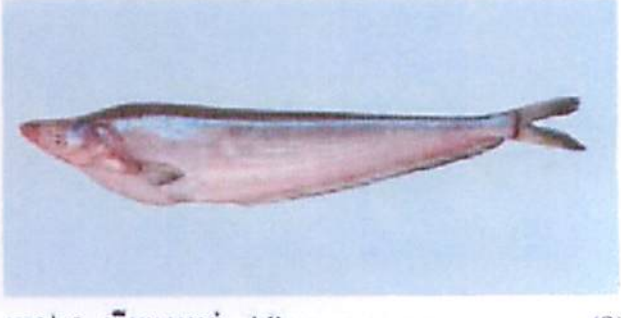


រូប១១២ ត្រីខ្ជែង *Macrognathus maculatus* (3)

រូប១១៤ ត្រីខ្ជែង *Macrognathus sp.* (3)

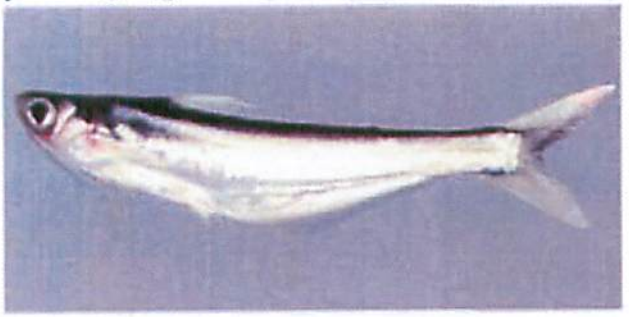
រូប១១៦ ត្រីខ្ជែង *Mastacembelus favus* (3)

រូប១១៨ ត្រីខ្ជែងផ្កា *Mastacembelus erythrotaenia* (3)

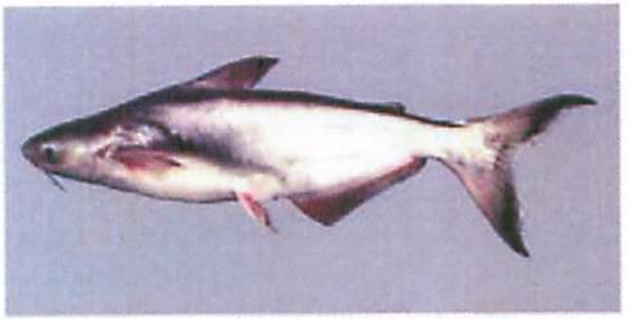


រូប១២០ ត្រីកេសប្រាក់ *Micronema apogon* (2)

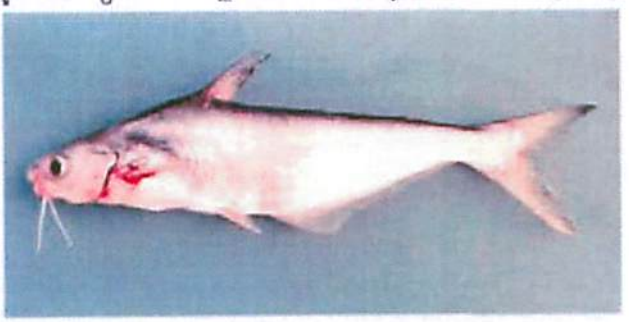
រូប១៥១ ត្រីឈ្បែត *Pangasius polyuranodon* (N/A)



រូប១៥៣ ត្រីឈ្បែត *Pangasius siamensis* (N/A)

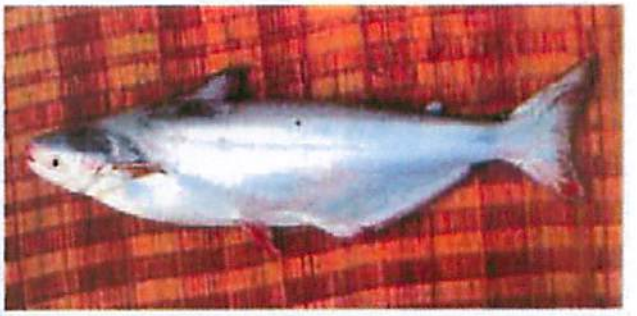


រូប១៥៥ ត្រីកែ *Pangasius conchophilus* (N/A)



រូប១៥៧ ត្រីក្រាកណ្តុរ *Helicophagus waandersi* (1)

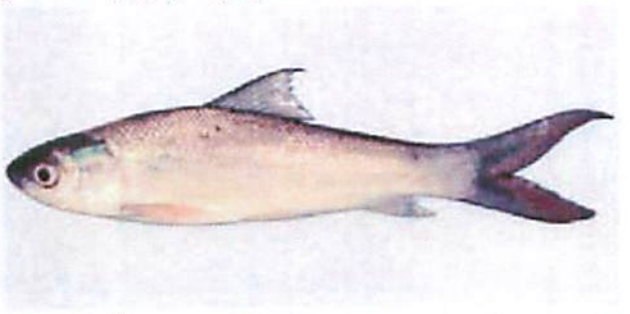
រូប១៥៩ ត្រីក្រាខ្មៅ *Pangasius bocourti* (1)



រូប១៥២ ត្រីក្រាប៊ុងម្សារ *Pangasius krempfi* (N/A)

រូប១៥៤ ត្រីប្រម៉ា *Boesemania microlepis* (1)

រូប១៥៦ ត្រីព្រលូង/ច្រឡឹង *Leptobarbus hoeveni* (3)

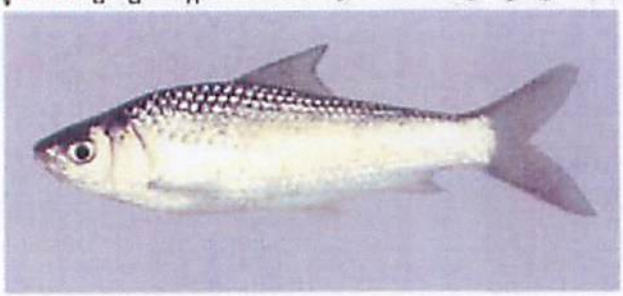


រូប១៥៨ ត្រី ព្រួល/ក្រឡង់ *Cirrhinus microlepis* (1)

រូប១៦០ ត្រីចាំរាំមុខមូយ *Labeo erythropterus* (N/A)

រូប១៦១ ត្រីរៀល *Henicorhynchus caudimaculatus* (1)

រូប១៦៣ត្រីរៀលអង្គាម*Henicorhynchus cryptopogon*(1)



រូប១៦៥ ត្រីរៀលសុប *Henicorhynchus siamensis* (1)

រូប១៦៧ត្រីអង្គត់ប្រាក់ *Scaphognathops bandanensis* (2)

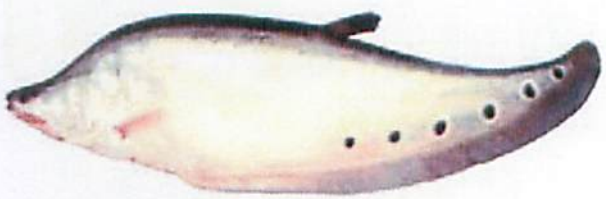
រូប១៦៩ ត្រីឆ្ពោ *Channa micropeltes* (2)

រូប១៦២ ត្រីវ៉ស់ *Channa striata* (2)

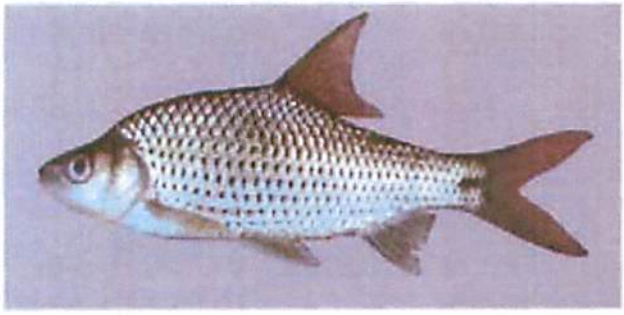
រូប១៦៤ ត្រីកញ្ឆេនជើយ *Channa lucius* (2)

រូប១៦៦ ត្រីក្បាង *Channa gachua* (1)

រូប១៦៨ ត្រីក្រាយ *Chitala blanci* (3)



រូប១៧០ ត្រីក្រាយ *Chitala ornata* (3)



រូប១៨១ ត្រីស្រែកាក្តាម *Cyclocheilichthys apogon* (2)

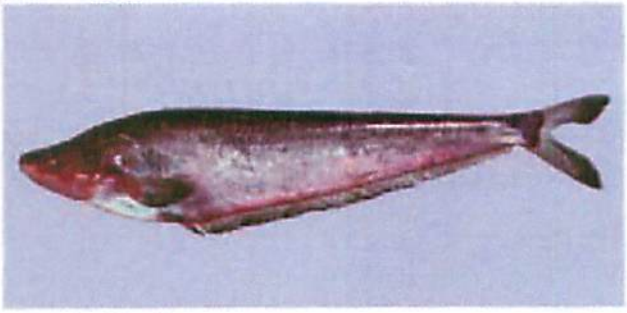
រូប១៨៣ ត្រីស្រែកាក្តាម *Cyclocheilichthys amatus?* (2)

រូប១៨៥ ត្រីស្រែកាក្តាម *Cyclocheilichthys amatus?* (2)

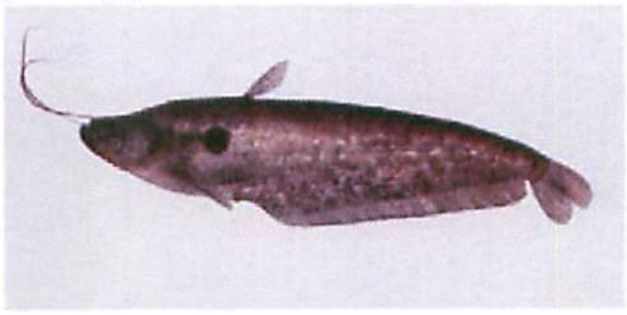
រូប១៨៧ ត្រីស្រែកាក្តាម *Cyclocheilichthys lagleri* (2)

រូប១៨៨ ត្រីស្រែកាក្តាម *Cyclocheilichthys repasson?* (2)

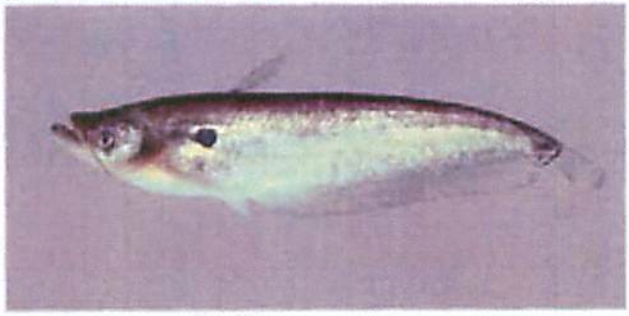
រូប១៨២ ត្រីស្រែកាក្តាម *Cyclocheilichthys repasson ?*(2)



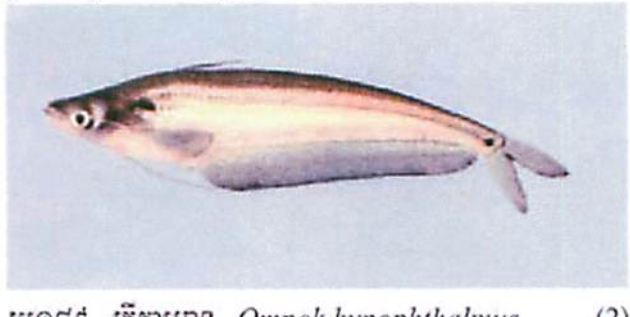
រូប១៨៤ ត្រីក្រម៉ម *Hemisilurus mekongensis* (N/A)



រូប១៨៦ ត្រីតាអោន *Ompok bimaculatus* ???? (N/A)



រូប១៩១ត្រីតាអោនរឺក្រម៉ម *Ompok bimaculatus??*(N/A)



រូប១៨៩ ត្រីតាអោន *Ompok hypophthalmus* (2)