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## ANALYSIS OF THE CAMBODIAN BAGNET ("DAI") FISHERY DATA

by

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*Photo on front cover:*

A row of 6 bagnet (Dai) units in the Tonle Sap River, Cambodia (*Photo N. van Zalinge*).

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## CONTENTS

INTRODUCTION .....	4
BACKGROUND .....	5
Material and methods .....	5
Sampling protocol .....	5
Taxonomy .....	5
Data base and software .....	6
SECTION 1: ANALYSES BASED ON ARTFISH RAW DATA .....	8
Taxonomy problems .....	9
Catch estimates problems .....	11
Identification of problems in raw data files .....	12
SECTION 2: FINAL RESULTS .....	13
SECTION 2: FINAL RESULTS .....	13
1- General features .....	13
1.1- Total catches .....	13
1.2- Catches of the 10 most important species .....	14
1.3- Trends among threatened species .....	14
2- Detailed features .....	15
Step 1: Selection of significant species .....	15
Step 2: Analysis of abundance patterns in time on 40 species .....	17
3- Catches and hydrology .....	21
3.1- Correlation between total catch and hydrology .....	22
3.2- Detailed trends for the 20 first groups .....	23
3.5- Analysis of long term trends .....	27
BIBLIOGRAPHY .....	33
ANNEX A Current Artfish Khmer names-Latin names conversion table .....	35
ANNEX B A function to lump multiple data files created by Artfish .....	39
ANNEX C Structure of Artfish ESTimates files and fields contents .....	43
ANNEX D Reference combined table used in final analyses .....	47
ANNEX E Seasonal abundance of the 35 most significant species .....	50

## INTRODUCTION

This report summarises general and detailed features of catches from the bagnet ("dai") fishery in Cambodia between 1995 and 1999, as monitored by the MRC/DoF/DANIDA Management of the Freshwater Capture Fisheries Project (MFCFP) in Phnom Penh.

A first analysis was performed in June 2000, based on data provided:

- by the MRC Hydrology Unit for hydrological data (2/6/00)
- by Ngor Pen Bun from MFCFP (30/5/00), following a manual compilation of annual statistical figures produced by the Project (Deap Loeung et al. 1998, van Zalinge & Nao Thuok 1999).

The results from this analysis are given in Section 1.

However, it appeared that:

- 1) provided water levels in Kampong Chhnang were not reliable, due to the change in the position of measuring gauges in 1957 and 1994 (Mekong Secretariat 1993, Lieng et al. 1995);
- 2) when recalculated from available raw data, catches figures significantly differ from those drawn from the MFCFP compilation.

This led to the Section 1 analysis based on basic raw data files generated by the Artfish software. Despite complications due to software structure which works on 493 different unit files, a unique data file was built. Analyses of these raw data pointed out the absence of 10,991 tons of fish in January 1998. This has been confirmed as a data loss by the project. This absence totally biases the annual figures, which led to the third section:

Section 2: analysis of a combined data file

This analysis is based on:

- raw data whenever available, supplemented by manual compilation of former figures for January 1998, October 1996 and the whole 2000 season).
- alternative hydrological data provided by the MFCFC project (two successive sets respectively sent by Ngor Peng Bun on 7/7/00 and N. van Zalinge on 25/7/00, which differ for 1982, 1998 and 1999); analyses below are based on the latter data set.

## BACKGROUND

## MATERIAL AND METHODS

### Sampling protocol

Sampling protocol (after Lieng et al 1995 and Thor Sensereivorth et al. 1999):

- no stratification by catch rate prior to 1996, then stratification into two groups according to the catch rate (low catches and high catches).

This was done after the October 1996 census to take into account the fact that the price of a dai concession can vary from 1 to 25 depending on its capture rate.

A detailed inter-annual analysis of catches should take this modification into account if i) this level of detail is required, ii) the precision level targeted is in accordance with the monitoring accuracy in the project implementation phase.

- stratification according to the moon phase:

Peak period of 4-6 days before the full moon, and low period consisting of the rest of the month

- random sampling of about 50% of dais
- estimation of catch per lift, and of the number of lifts per 24 hours. At least 10 hauls/dai/day are monitored (total catch recorded and sub-sampling for species identification and weights)

### Taxonomy

On the field, fish species or taxa are recorded under their Khmer name. This is transformed *a posteriori* into scientific names according to a correspondence table.

- This practical necessity however leads to some taxonomic problems. For instance the most abundant taxonomic group is that called Riel in Khmer (van Zalinge & Nao Thuok 1999). This corresponds to three species: *Henicorhynchus caudimaculatus*, *H. cryptopogon*, and *H. siamensis* (Rainboth 1996, p 111). In fact there is a differentiation in Khmer (Trey riel = *H. caudimaculatus*; Trey riel angkam = *H. cryptopogon*; Trey riel tob = *H. siamensis*) but this is not widely used by fishermen and not taken into account by fishery field surveyors. Furthermore:

- *H. siamensis* (de Beaufort 1927) is an invalid junior synonym of *Cirrhinus siamensis* (Sauvage 1881) according to Roberts (1997). Rainboth (1996) also states that "nearly all literature references to *Cirrhinus jullieni* actually refer to the species *H. siamensis*".

- *H. caudimaculatus* (Fowler 1934) also is an invalid synonym of *Cirrhinus caudimaculatus* (Fowler 1934) according to Roberts (1997).

Last, according to Roberts & Baird 1995, Roberts 1997, Baird et al. 2000, one of the most important species migrating in Southern Laos from Cambodia is *Cirrhinus lobatus* (Smith 1945). This species is not recorded in Rainboth (1996) and is absent from published species lists in Cambodia, even under its (invalid) synonym name *Henicorhynchus lobatus*.

- The Khmer-Latin names equivalence is also sometimes problematic as some Khmer names do not have known equivalent in scientific taxonomy (e.g.: Chhlang krobey, Kbal ruy, ), and the Khmer name given to a certain species can vary depending on the region (e.g.: Trey riel)

In the Current Artfish Khmer names-Latin names conversion table, the following taxonomic points, based on FishBase 1999, can be noted:

- *Barbichthys thynnoides* ("Phkakor") does not exist. Rainboth (1996) refers to "Pka kor" as *Cyclocheilichthys armatus*.

- *Systemus orphoides* (Valenciennes, 1842) is an invalid synonym of *Puntius orphoides* (Valenciennes, 1842) according to Kottelat et al. (1993)

- *Dangila spilopleura* (Smith, 1934) is a junior invalid synonym of *Labiobarbus siamensis* (Sauvage 1881) according to Roberts (1993)
- *Pangasius siamensis* (Steindachner, 1878) is an invalid junior synonym of *Pangasius macronema* (Bleeker, 1851) according to Roberts & Vidthayanon (1991)
- *Morulius chrysophekadion* (Bleeker 1850) is an invalid synonym of *Labeo chrysophekadion* (Bleeker 1850) according to Roberts (1989)
- *Monotreta cambodgiensis* (Chabanaud 1923) is an invalid junior synonym of *Tetraodon leiurus* (Bleeker, 1851) according to Kottelat et al. (1993)
- The correct spelling for "Kryptopterus cryptopterus" is "*Kryptopterus cryptopterus*"
- The correct spelling for "Pangasius larnaudiei" is "*Pangasius larnaudii*"
- The correct spelling for "Loptobarbus hoeveni" is "*Leptobarbus hoeveni*"
- The correct spelling for "Paralaubica typus" is "*Paralaubuca typus*"

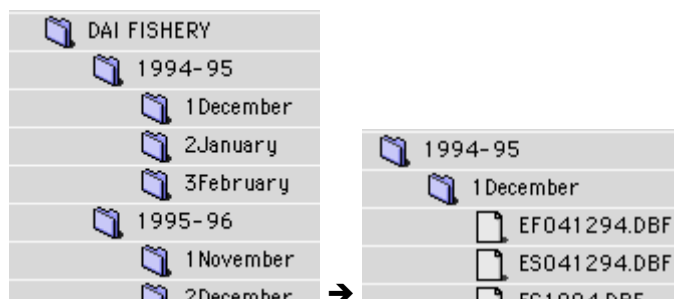
Annex A gives the table for Khmer and scientific names of fish as used in the Artfish software, and updated "correct" ones.

Another example of taxonomic problems encountered is the fish whose Khmer name is "Bong Lao". In the compilation of data provided by the Project (see section 1), this name is considered as meaning "*Pangasius krempfi*". However the name "Bong lao" is absent from raw data files. Assuming that the compilation was drawn from gathered raw data, the Khmer name used to identify *P. krempfi* in these raw data is unknown. Possibly "trey pra", given that "trey bong lao" is a synonym of "trey pra" in Khmer, according to Rainboth 1996 (the MRC reference taxonomy book). But according to the same author "trey pra" is also the Khmer name of *Pangasius djambal*, *Pangasionodon hypophthalmus*<sup>1</sup> and *Pangasius micronema*<sup>2</sup>. In the MFCFC compilation, the Khmer name "Prey tra" is considered as meaning "*Pangasius hypophthalmus*/sp." One can wonder what is the meaning of "/ sp", which other species fall under this category, and if *Pangasius krempfi* ("Bong Lao") is included too.

## Data base and software

Fishery data have been gathered in one or two sites in a single province<sup>3</sup> every month since end 1994. Data are handled through the ARTFISH software (for ARTisanal FISHeries", Stamatopoulos 1994, 1995), which caters for stratification in space and time, organisation of data into databases of primary statistics, and the derivation of total estimates for catch, fishing effort, prices and values.

Data are stored in multiple monthly small files under Dbase IV format; these unit files are ordered into successive folders following the Year, Month sequence:



<sup>1</sup> *Pangasionodon hypophthalmus* is an invalid synonym of *Pangasius hypophthalmus* (Sauvage 1878) according to Roberts & Vidthayanon (1991)

<sup>2</sup> *Pangasius micronema* is usually known as *Pangasius micronemus*, being called *P. micronema* in one taxonomic publication among nine only.

<sup>3</sup> In 1998-1999, the sampling site was split into two provinces: Kandal and Phnom Penh

The name codification for unit files is:

[Type of file (2 letters) / Landing site (2 digits) / Month (2 digits) / Year (2 digits)].dbf

Type of file:

EF= effort (fishing effort)

LN= landings (fishes landed)

ES= estimates (estimates of total catches)

Landing site: several codes corresponding to different landing sites

Example: EF250195.dbf= file about fishing effort, landing site n°25, January 95

Note:

Although all species or taxa met on the field are recorded on paper and typed, the Artfish software only keeps the 38 numerically most important ones, and indistinctly groups the other ones under the common name X-OTHERS (Sam Chin Ho 1999). Furthermore for a given landing, only 20 maximum species can be reported (Stamatopoulos 1994 p. 7). The new Windows-based version of the software (1997), which fixes that problem, is not used in Cambodia yet.

## SECTION 1: ANALYSES BASED ON ARTFISH RAW DATA

21/8/00

The analysis based on manually compiled figures being unsatisfactory when original raw data are available, we wished to analyse the exact content of the data base. Furthermore this data base created by the Artfish software has a particular structure made of  $\approx 120$  unit files ( 5 years x 12 months x 1 or 2 sites ) plus  $\approx 373$  intermediary files and folders. This is manageable by the original software only, and does not permit to perform any other analysis than those available in its options.

We therefore needed to make a single file of all data gathered, susceptible of being processed in different statistical softwares. An Access function was developed for this; its source code is given in Annex B. Then the content of unit Dbase files and the meaning of their different fields had to be understood. In the absence of detailed software documentation, this was a time consuming task. The result is given in Annex C.

Fusion of all dai fishery data files with the Fusion function

- for ES files → FusDaiES.dbf
- for EF files → FusDaiEF.dbf
- for LN files → FusDaiLN.dbf

Work on FusDaiES.dbf

Data sorted out on fields 1) L\_Bttype (boat type)

2) L\_Total

3) L\_Key

then all records different from <all boats> and <all gears> are suppressed. The resulting field is called FusDaiEScleared.dbf

Note: In FusDaiES.dbf and therefore in original files, fields L\_BTTYPE and L\_GRTYPE are not properly filled up as they include records of different nature:

L_BTTYPE	L_GRTYPE
<ALL BOATS>	<ALL GEARS>
DAI LP	DAI LP
DAI PP	DAI PP
DAI THOM LP	DAI THOM LP
DAI THOM PP	DAI THOM PP
DAI TOCH LP	DAI TOCH LP
DAI TOCH PP	DAI TOCH PP
BOAT DAI PP	LIFT NET PP
BOAT DAI LP	LIFT NET LP
HIGH CATCH	
DAI FISHERY	H-YIELD LP
DAI FISHERY	H-YIELD PP
DAI FISHERY	L-YIELD LP
DAI FISHERY	L-YIELD PP

Work on FusDaiEScleared.dbf

Note: when imported from Dbase into Excel, all numbers without digit are considered as text; they must be converted back in numbers by the CNUM function to be processed in formulas



## Taxonomy problems

On the previous file, a pivot table is run with the following query:

	L_YEAR	L_MONTH
L_TOTAL	Sum L_GC	
LIGNE	DONNÉES	

The result is a table of 78 various taxa names (and corresponding catches), which basically identifies mistakes or mistyping in terminology

* TOTAL *	CHHVEAT	KANTRANG PR	PROU/KRALANG
AMPIL TUM	CHRA KENG	KBAL RUY	PRUO/KRALANG
ANDAT CHHEK	CHRAKENG	KBORK	PRUOL/K LANG
ANDAT CHHKE	CHUN CHUKDAI	KES	RIEL
ARCH KOK	DANG KHTENG	KHLANG HAI	ROS/PHTUOK
B.AMPOAV	K-CH CHRAS	KHMAN	SANDAI
BAN AMPAOV	K-CH CHRAS	KHNANG VENG	SANGKORTPRAK
BANDAULAMPOV	K-CHHRUK	KROM	SL-RUSSEY
CH-CH DAI	K-CHRAMOS	KROS	SLAT
CH-LUONHMOAN	K-T-PRENG	LINH	SMOEU KANTUY
CH T PHLUK	KAEK	LOLOK SOR	SRAK KDAM
CH-TEASPHLUK	KAHE	PHKAKOR	SRAKA KDAM
CH.CHUOK-DAI	KAM CHRAMOS	PHTONG	TA AUN/KROMO
CHANHLUONH M	KAMPOUL BAI	PO	TA AUN/KROMO
CHEK	KAMPOULBAI	PRA	TRASORK
CHHDOR/DIEP	KAN TRORB	PRA IEV	X-OTHER
CHHKOK	KAN-PRENG	PRA KE	X-OTHERS
CHHLANG	KANH CHOS	PRAMA	
CHHMAR	KANH CHROUK	PREAM	
CHHPIN	KANH-CHRUUK	PROLOUNG/CHR	

Red: absent in the reference table

Purple: improper spelling

Other colours: non-standard name

After correction (based on the reference names table in Artfish), the resulting table is next:

* TOTAL *	CHUNH CHUKDAI	KBORK	PRAMA
AMPIL TUM	DANG KHTENG	KES	PREAM
ANDAT CHHKE	KANH CHANH CHRAS	KHLANG HAI	PROLOUNG/CHR
ARCH KOK	KANH CHROUK	KHMAN	PRUOL/ KRALANG
BANDOUL AMPAOV	KAMBUT CHRAMOS	KHNANG VENG	RIEL
CHANLUONH MOAN	KANTRANG PRENG	KROM	ROS/PHTUOK
CHAN TEAS PHLUK	KAEK	KROS	SANDAI
CHEK TUM	KAHE	LINH	SANGKAT PRAK
CHHDOR/DIEP	KAMPOUL BAI	LOLOK SOR	SLOEUK RUSSEY
CHHKOK	KAN TRORB	PHKAKOR	SLAT
CHHLANG	KANTRANG PRENG	PHTONG	SMOEU KANTUY
CHHMAR	KANH CHOS	PO	SRAKA KDAM
CHHPIN	KANH CHROUK	PRA	TA AUN/KRAMORM
CHHVAET	KANTRANG PRENG	PRA IEV	TRASORK
CHRA KENG	KBAL RUY	PRA KE	X-OTHERS

**Note:** Cell in red correspond to fish absent from the reference table, to be checked. Furthermore several species present in the manual compilation are surprisingly not listed in this raw data base. These species are:

Present in raw data	Present in compiled data	Latin name
	AMBONG	
	ANDENG	Clarius sp.
	BONG LAO	Pangasius krempfi
	CHHLANG KROBEY	"Chhlang krobey"
	CHHLONH	Macrognathus siamensis
	DAMREY	Oxyeleotris marmorata
	KAMPHEANH	Trichogaster microlepis
	KAMPHLIEV	Kryptopterus cryptopterus
	KAMPOT	Monotreta cambodgiensis
	KAMPREAM	Polynemus multifilis
	KANH CHEAK SLA	Toxotes chatareus
	KANTHOR	Trichogaster pectoralis
	KAOK	Arius caelatus
KBORK		
	KHYA	Mystus wyckioides
	KRABEY	Bagarius bagarius
	KRANH	Anabas testudineus
	KRAY	Chitala ornata
LOLOK SOR		
	PASEE	Mekongina erythrospila
	PAVA	Labeo erythropterus
PRA IEV		
PRA KE		
PREAM		
	ROMEAS	Osphronemus exodon
	RUSCHEK	Acantopsis sp.
SMOEU KANTUY		
	THMOR	Gyrinocheilus pennocki

## Catch estimates problems

An automatic modification of names is made in file FusDaiEScleared.dbf (field L\_total)

Pivot table is run again:

L_YEAR	L_MONTH
<b>L_TOTAL</b>	<b>Sum L_GC</b>
<b>LIGNE</b>	<b>DONNÉES</b>

The monthly results are (\*Total\* = total estimated catches in kg):

L_YEAR	L_MONTH	* TOTAL *
1994	12	280061
1995	1	10699245
	2	7428480
	11	126412
	12	3634040
1996	1	9409512
	2	5747176
	3	1052672
	11	67871
	12	882248
1997	1	12336357
	2	1711260
	3	1829105
	11	92193
	12	989423

L_YEAR	L_MONTH	* TOTAL *
1998	2	1602246
	3	945098
	10	11665
	11	19344
	12	4941560
1999	1	3803275
	2	119802
	10	0
	11	0
	12	0
2000	1	0
	2	0
	3	0

When compared to the table provided by the MFCFP project for analysis on 30/5/00, differences are next:

Year	Month	Raw data	MFCFP compilation
1994	12	280	-
1995	1	10699	-
	2	7428	-
	11	126	128
	12	3634	386
1996	1	9410	5379
	2	5747	6968
	3	1053	1569
	10	-	8
	11	68	71
	12	882	363
1997	1	12336	10104
	2	1711	1581
	3	1829	3361
	11	92	91
	12	989	978

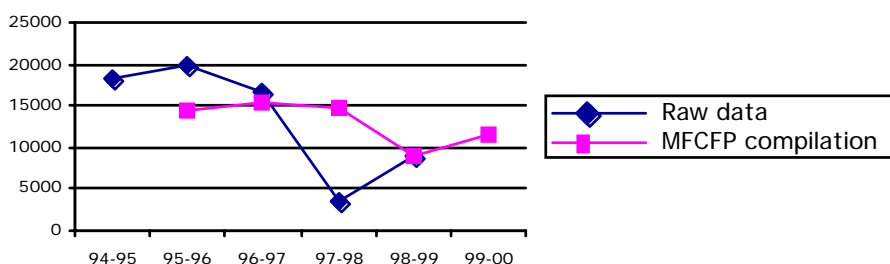
Year	Month	Raw data	MFCFP compilation
1998	1	-	10991
	2	1602	1602
	3	945	942
	10	12	12
	11	19	19
	12	4942	4941
1999	1	3803	3803
	2	120	119
	3	-	0
	10	-	49
	11	-	60
	12	-	1076
2000	1	-	9812
	2	-	336
	3	-	104

## Identification of problems in raw data files

The previous analysis points out:

- the absence of data for October 1996
- the absence of data for January 1998 in the Artfish data base. Ten thousand nine hundred ninety one tons of fishes are missing on an estimated annual catch of 14 600 tons.
- the divergent figures between raw and compiled data for December 1995, January and December 1996, March 1997
- the absence of data for 1999-2000 in the raw data set. Nets have been monitored (available LN\*\*.dbf files), but total effort figures are not available in files EF\*\*.dbf, and thus estimated total catches are not available in ES\*\*.dbf files.

These missing data in raw files totally bias annual trends: when seasonal raw and compiled figures are compared (season from October to March<sup>4</sup>), we have:



Following these remarks the analysis of raw data was not deepened and it was decided to analyse at last a file combining raw data whenever available, and manipulated compiled data alternatively. The resulting analysis is detailed in the next section.

<sup>4</sup> As a dai fishing season starts in October and stops in March the following year, the year was recoded to have coherent annual seasons (the reference year is that of the beginning of the season):

Field RecodYear: if month<10, then year=year-1; else year=year.

## SECTION 2: FINAL RESULTS

This analysis is based on raw data whenever available, supplemented (for missing data) by the re-assessed figures for October 1996, January 1998 and the whole 1999-2000 season.

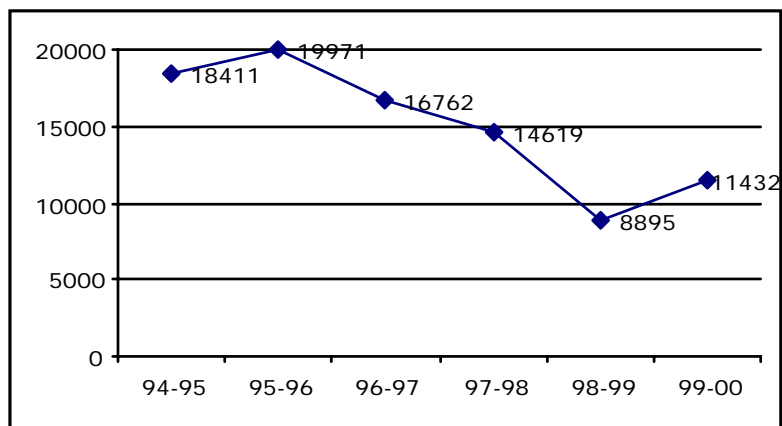
Corresponding reference file is "Combined.xls" given Annex D ; analyses files are in "Analyses.xls"

Note: Latin names used here are those usually used in the Artfish correspondence table, irrespective of synonymy modifications suggested in section "Material and methods"

In the raw data file "Ta Aun/Kramorm" and Ta Aun/Kromo" were considered as a single species and lumped.

### 1- GENERAL FEATURES

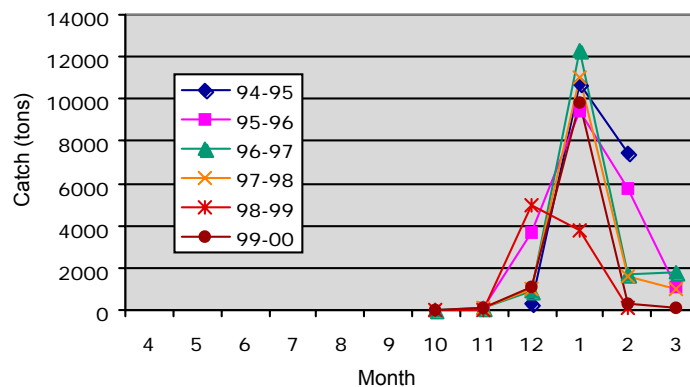
#### 1.1- Total catches



Although trends are similar, yearly total catches are significantly higher than those drawn from the manual compilation, reaching 20 000 tons instead of 15 500 tons (see p. 7).

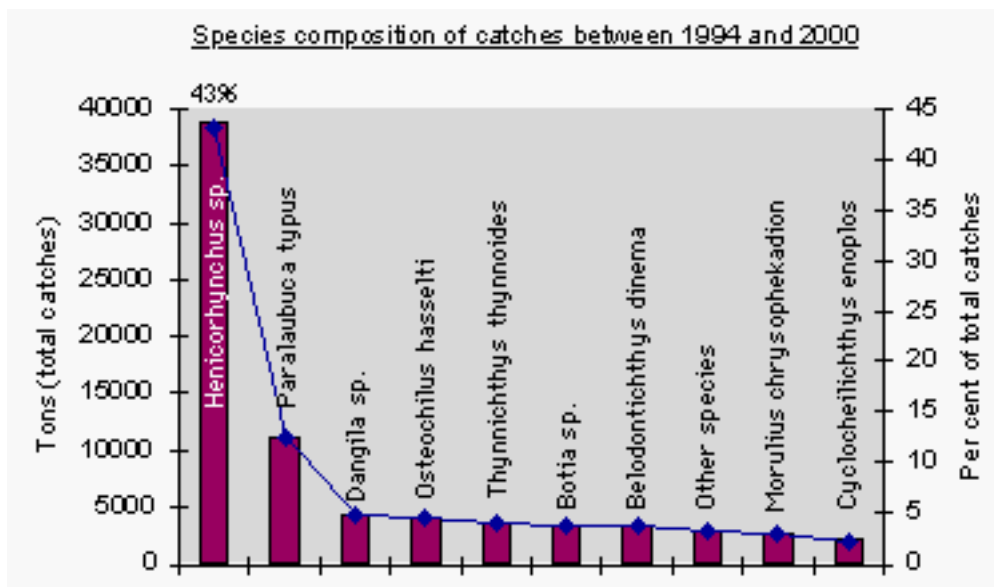
The monthly pattern is next:

Monthly distribution of dai catches



## 1.2- Catches of the 10 most important species

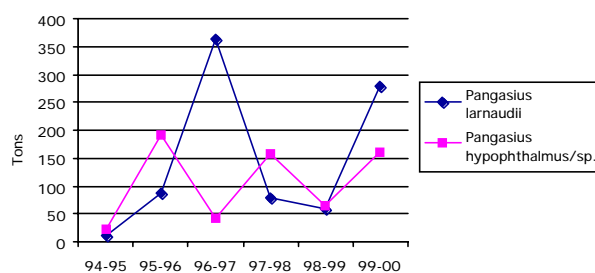
Latin name	Khmer name	Sum (tons)	Per cent
Henicorhynchus sp.	Riel	38843	43,1
Paralaubica typus	Sloek Russey	11089	12,3
Dangila sp.	Khngang Veng	4287	4,8
Osteochilus hasselti	Kros	4000	4,4
Thynnichthys thynnoides	Linh	3599	4,0
Botia sp.	Kanh Chrouk	3293	3,7
Belodontichthys dinema	Khlang Hai	3244	3,6
Other species	X-Others	2846	3,2
Morulius chrysophekadion	Kaek	2576	2,9
Cyclocheilichthys enoplos	Chhkok	2027	2,2



Remark: The mixed group of "other species" ranks eighth. Given that the Artfish software only keeps the 20 most abundant taxa, this means that the combination of species individually ranking below 20 make an important part of the total catch. This outlines the importance of diversity in the fishery.

## 1.3- Trends among threatened species

Two species are detailed here: *Pangasius larnaudii* and *Pangasius hypophthalmus*. *Pangasius krempfi*, present in the compiled data set and whose Khmer name ("Bong Lao") is absent from raw data, has not been considered.



Conclusion: there is no clear trend nor sign of decline for *Pangasius larnaudii* and *P. hypophthalmus* in the current data set based on the dai fishery catches from 1994 to 2000

## 2- DETAILED FEATURES

The original data table is a crossed table of abundances per fishing season and per species. Six years, 57 fish groups. A multivariate approach is relevant to detect global relationships between species, between years, and between both.

### Step 1: Selection of significant species

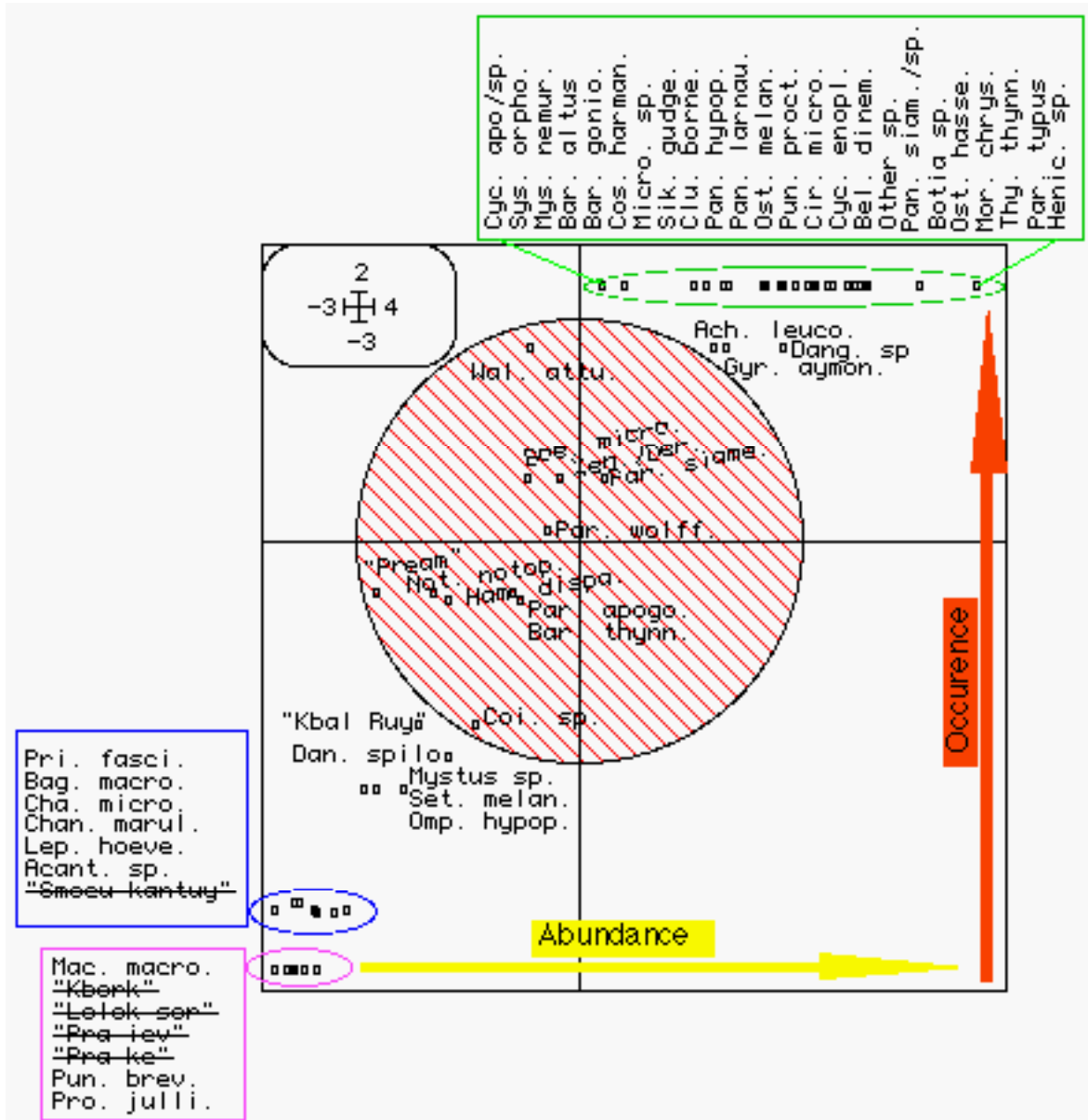
Some species are just met once or twice, in small quantities. Thus their number is not significant, they do not bear much quantitative information and they are represented by rows of (mostly) zeros, which biases the total inter-correlations. They must be removed prior to analyses. Several methods for "objectively" removing rare species from quantitative abundance analyses have been developed (Clifford & Stephenson 1975; Stephenson & Cook 1980). However with these methods indicator species occurring in particular conditions and most often in small numbers are also eliminated prior to analysis. A particular multivariate method was developed in order to eliminate quantitatively insignificant species but to keep ecologically significant indicator species (Baran 1995). This method consists in:

- log transformation of fishing seasons raw data [ $x \rightarrow \ln(x+1)$ ]
- performance of a centred-normalised Principal Component Analysis on the log-transformed table (first factorial axis only is saved)
- transformation of raw data into presence/absence data
- performance of a centred-normalised Principal Component Analysis on the presence/absence table (first factorial axis only is saved)
- biplotting of species according to their respective score on the two first factorial axes of the two analyses (ADE: Files Util: Paste files same row, .cnli files)
- elimination of species around the center of the factorial map.

Following this technique, species with small abundance BUT particular spatial or temporal distribution are kept for further analysis, whereas species with low abundance and erratic presence are removed.

This method is applied to the dai fishery data set; the graphical analysis is displayed next page, and species to be removed accordingly are listed below:

Code	Species name in Khmer	Latin name	6 year catches (tons)	Percent of total catches	Occurrence in 6 years
"Kbal Ruy"	KBAL RUY	"Kbal ruy"	55	0,06	2
"Kbork"	KBORK	"Kbork"	1	0,00	1
"Lolok sor"	LOLOK SOR	"Lolok sor"	1	0,00	1
"Pra iev"	PRA IEV	"Pra iev"	0	0,00	1
"Pra ke"	PRA KE	"Pra ke"	33	0,04	1
"Pream"	PREAM	"Pream"	5	0,01	3
"Smoeu kantuy"	SMOEU KANTUY	"Smoeu kantuy"	0	0,00	1
Bar. thynn.	PHKAKOR	Barbichthys thynnoides	371	0,41	3
Boe. micro.	PRAMA	Boesemania microlepis	176	0,20	4
Coi. sp.	CHANLUONH MOAN	Coilia sp.	201	0,22	3
Ham. dispa.	KHMAN	Hampala dispar	11	0,01	3
Not. notop.	SLAT	Notopterus notopterus	9	0,01	3
Par. siame.	CHAN TEAS PHLUK	Parachela siamensis	612	0,68	4
Par. apogo.	KANH CHANH CHRAS	Parambassis apogoniodes	179	0,20	3
Par. wolff.	KANTRANG PRENG	Parambassis wolffi	141	0,16	4
Wal. attu.	SANDAI	Wallago attu	28	0,03	5
Xen./Der.	PHTONG	Xenentodon sp./Dermogenys sp.	103	0,11	4



Species included in the red circle have low abundance and erratic occurrence; they have to be removed prior to further quantitative analyses.

Smoeu kantuy, Kbork, Lolok sor, Pra iev and Pra ke are "rare" species which occurred only once or twice, in small number. They have been pointed out above as possible misidentifications or mistypings. Their rarity combined with a controversial name led to suppress them from the analysis. Idem for the species whose Khmer name is "Kbal ruy" and whose scientific name remains unknown.

Thus 17 species have been eliminated among 57, and 40 remain. From a strictly numerical point of view, a more drastic suppression of species could be made.



## Step 2: Analysis of abundance patterns in time on 40 species

In addition to the removal of insignificant species, some other selections and modifications have been made in the data table:

- removal of the 94-95 season corresponding to the Project early implementation period, and whose data are not considered as reliable by project leaders;
- removal of *Probarbus jullieni*, *Macrochirichthys macrochirus* and *Puntius brevis* which were present in 1994-1995 only
- removal of the "Other species" group, whose seasonal variation of abundance pattern is meaningless
- pooling of *Mystus nemurus* and *Mystus sp.* as a single taxon *Mystus spp.* (given that the original Khmer name for *M. nemurus* -Trey chhlang- also applies to *M. wycki* and to *Leiocassis stenomus*).

Thirty five taxa remain, for five fishing seasons. The corresponding table, given in Annex E, is analysed below.

### Analysis of raw abundance data

The original data table is a crossed table of abundances per year and per species. Five fishing seasons, 35 species. A multivariate analysis is relevant to detect global relationships between species, between years, and between both.

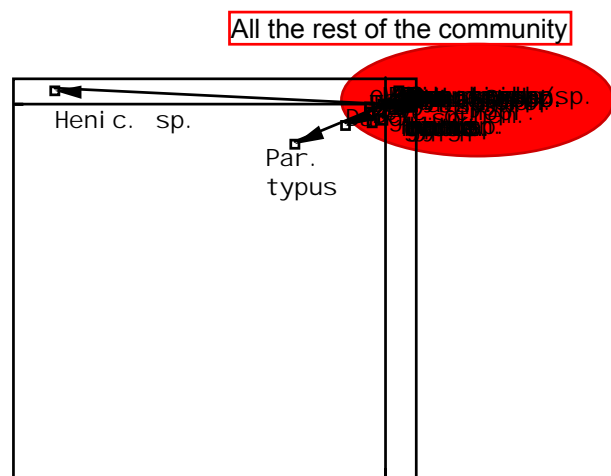
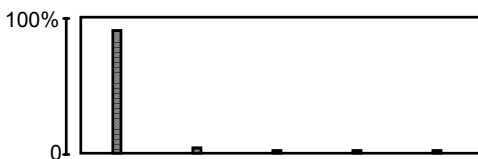
Performed analysis: non centred Principal Components Analysis.

PCA is relevant for abundance data, centring and normalising are not necessary (one common unit only).

The PCA on five variables-seasons will result in 5 principal component and thus 5 axes only. We detail below the three first axes.

### Analysis of axis 1 & 2

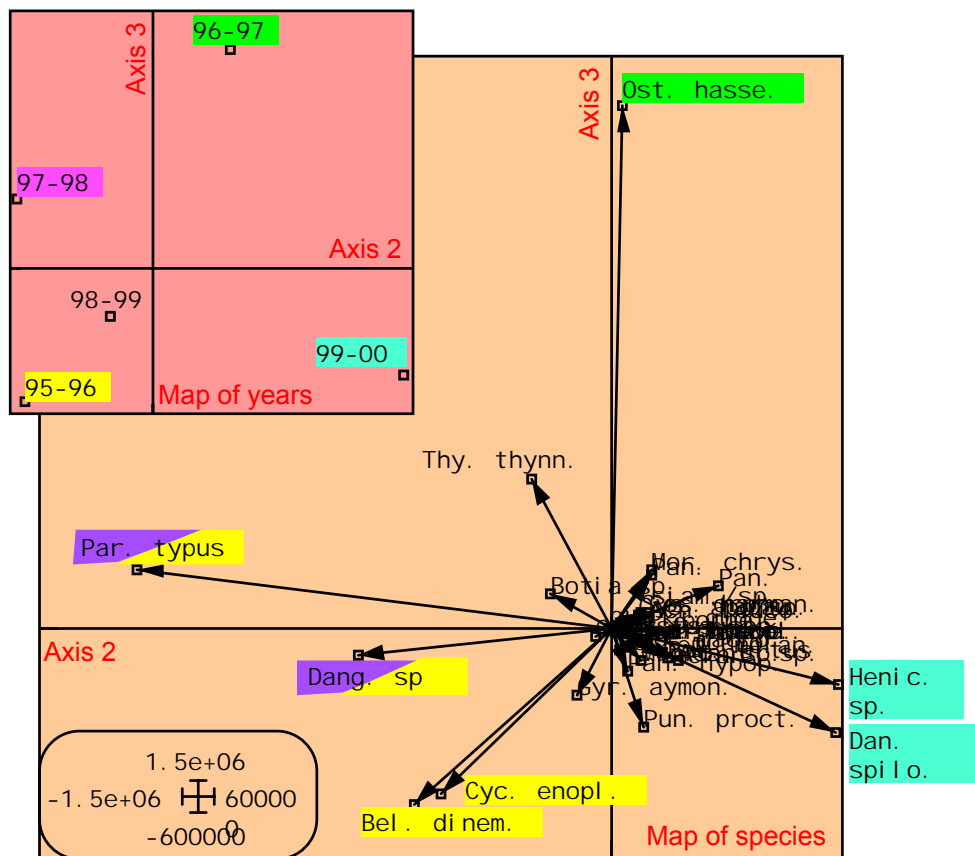
Eigenval.	Inertia
Axis 01	95.43%
Axis 02	2.10%
Axis 03	1.66%
Axis 04	0.06%



Interpretation:

Hyper-dominance of *Henicorhynchus sp.* and *Paralaubuca typus*, which mask all other species; a log-transformation of data must be performed for clarification of patterns.

## Analysis of axis 2 & 3



### Interpretation:

This analysis outlines the correlation between certain species and certain years (here is the same colour in both maps). Axis 1 above focused on total abundances, here axes 2 and 3 focus on relative abundances and particular distributions. The analysis points out the particular abundance of *Osteochilus hasselti* in 1996-1997, of *Cyclocheilichthys enoplos* and *Belodontichthys dinema* in 95-96, of *Dangila spilopleura* in 1999-2000, and of *Dangila sp.* and *Paralaubuca typus* both in 95-96 and 97-98

The major conclusion is that the distribution of years does not exhibit any structure which would attest a temporal evolution of the species composition; conversely the bulk of species, being located at the center of the map, does not exhibit significant inter-annual variability.

## Analysis on log-transformed abundance data

Transformation [  $x \rightarrow \ln(x+1)$  ] normalises data and reduces the variability (extremely high values are lowered, average values are not modified).

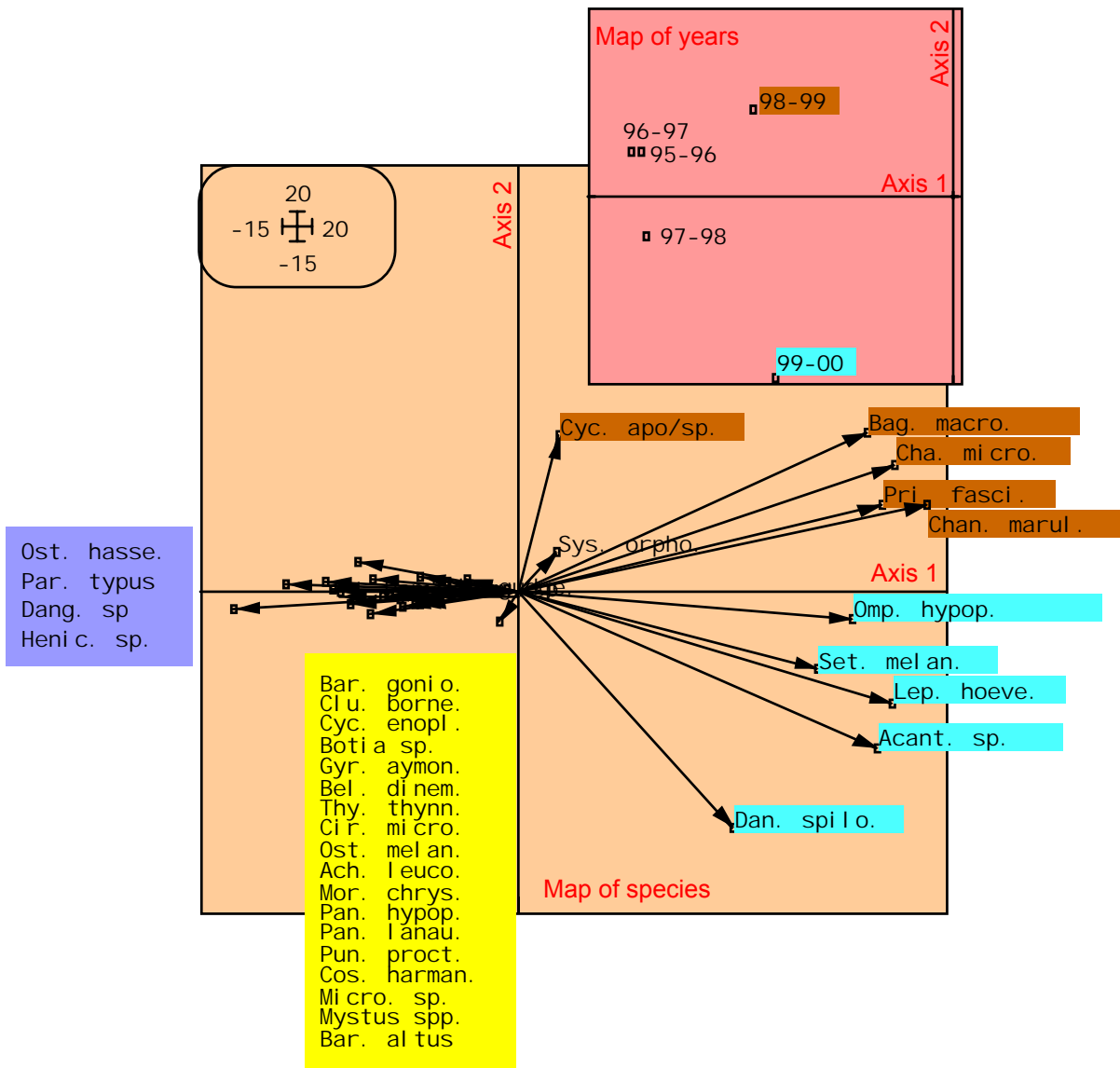
In the figure below, log-transformed abundances have been converted into a 4-levels colour chart, and species have been ordinated according to their score on the first axis of a non-centred non-normed PCA. The result is a visual chart of buffered abundances, in which minor species are also displayed although they might be two or three orders of magnitude less abundant than ultra-dominant species.

95-96	96-97	97-98	98-99	99-00	
Very abundant	Very abundant	Very abundant	Very abundant	Very abundant	Heni c. sp.
Very abundant	Very abundant	Very abundant	Very abundant	Very abundant	Par. typus
Very abundant	Very abundant	Very abundant	Very abundant	Very abundant	Dang. sp
Very abundant	Very abundant	Very abundant	Very abundant	Very abundant	Boti a sp.
Very abundant	Very abundant	Very abundant	Very abundant	Very abundant	Thy. thynn.
Very abundant	Abundant	Very abundant	Very abundant	Very abundant	Bel. di nem.
Very abundant	Very abundant	Very abundant	Very abundant	Very abundant	Mor. chrys.
Very abundant	Very abundant	Very abundant	Very abundant	Abundant	Ost. hasse.
Very abundant	Very abundant	Very abundant	Abundant	Very abundant	Pun. proct.
Very abundant	Abundant	Very abundant	Very abundant	Abundant	Cyc. enopl.
Abundant	Very abundant	Very abundant	Abundant	Very abundant	Pan. si am./sp.
Very abundant	Scarce	Very abundant	Very abundant	Very abundant	Gyr. aymon.
Abundant	Very abundant	Abundant	Abundant	Very abundant	Ost. mel an.
Very abundant	Very abundant	Very abundant	Scarce	Abundant	Ci r. mi cro.
Abundant	Very abundant	Abundant	Abundant	Very abundant	Pan. l anau.
Scarce	Abundant	Very abundant	Very abundant	Very abundant	Ach. l euco.
Very abundant	Abundant	Very abundant	Abundant	Very abundant	Pan. hypop.
Very abundant	Abundant	Very abundant	Abundant	Abundant	Cl u. borne.
Abundant	Abundant	Abundant	Scarce	Abundant	Si k. gudge.
Abundant	Scarce	Abundant	Abundant	Abundant	Mi cro. sp.
Abundant	Abundant	Abundant	Scarce	Abundant	Bar. goni o.
Scarce	Abundant	Scarce	Abundant	Abundant	Cos. harman.
Scarce	Scarce	Scarce	Scarce	Abundant	Bar. al tus
Scarce	Scarce	Abundant	Scarce	Scarce	Mystus spp.
Scarce	Abundant	Scarce	Scarce	Scarce	Sys. orpho.
Scarce	Abundant	Scarce	Scarce	Scarce	Cyc. apo/sp.
Absent	Absent	Very abundant	Absent	Very abundant	Dan. spi l o.
Absent	Absent	Absent	Scarce	Abundant	Set. mel an.
Absent	Absent	Absent	Scarce	Scarce	Omp. hypop.
Absent	Absent	Absent	Very abundant	Absent	Bag. macro.
Absent	Absent	Absent	Absent	Very abundant	Acant. sp.
Absent	Absent	Absent	Scarce	Absent	Cha. mi cro.
Absent	Absent	Absent	Absent	Scarce	Lep. hoeve.
Scarce	Absent	Absent	Absent	Absent	Pri. fasci.
Absent	Absent	Absent	Scarce	Absent	Chan. marul.

Very abundant	Abundant	Scarce	Absent
---------------	----------	--------	--------

Non-normed non-centred PCA on log-transformed data gives the following result:



Interpretation:

This analysis points out the relative abundance of five minor species in the 98-99 season, as well of that of five other minor ones in 99-2000. However this correlation is weak.

However the major conclusion is the absence of strong temporal structure among this assemblage, in other words the lack of inter-annual variability in the species composition of dai catches between 1995 and 2000. This conclusion is recurrent in all analyses and, according to this data set focussing on the 35 most significant species only, the hypothesis of an evolution of the species composition these last five years in the dai fishery can therefore be refuted.

### 3- CATCHES AND HYDROLOGY

#### Hydrological data

We have successively been provided three hydrological data sets to be matched with fishery data (Kampong Chhnang zone, close to the major dai fishery zone).

The first set was provided by the MRC Hydrology Unit (2/6/00). However due to the unreliability of these data (Mekong Secretariat 1993, Lieng et al. 1995), we have been successively provided two other data sets

- by Ngor Pen Bun on 7/7/00 (project data set 1)
- by N. van Zalinge on 25/7/00 (project data set 2)

For the period corresponding to that of fishery data, the three files exhibit the following differences:

*Average peak water level data for the Tonle Sap at K. Chhnang*

	MRC Hydrology Unit	Project data set 1	Project data set 2
1994	11,1	10,92	10,92
1995	11,1	11,1	11,1
1996	11,4	11,4	11,4
1997	10,4	10,4	10,4
1998	No data	10,4	7,9
1999	No data	7,9	10,0

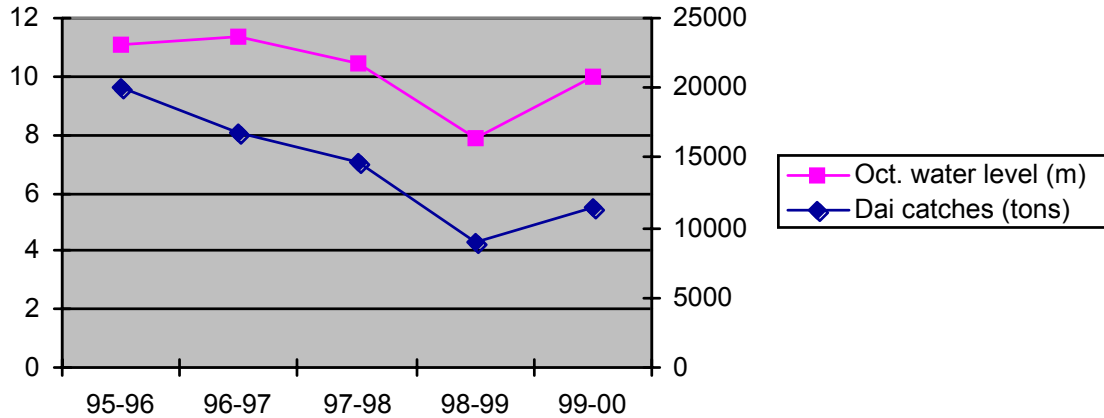
It appears that:

- according to the Project, the MRC data cannot be used because the position of measuring gauge in Kampong Chhnang has changed in 1994 (op. cit.), which led the Project to rely on alternative local hydrological sources;
- the two data sets provided by the project, supposedly from the same local source, are not similar
- the difference between these data sets and the MRC data is tiny.

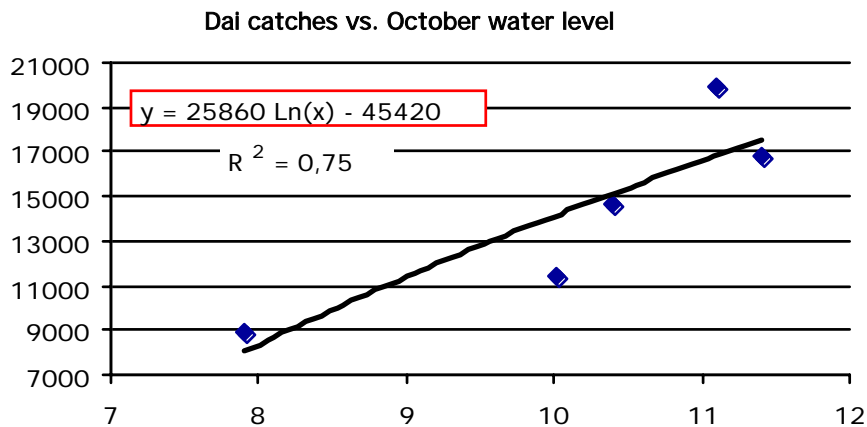
Incidentally, we have been provided the Kampong Chhnang alternative hydrological data set entitled "Hydrological observation book" and corresponding to the new gauge height, but measurements only cover the October 99 - February 2000 period.

In absence of evidence and of MRC data for 98-99, it was decided to base the following catches-hydrological levels on the second Project hydrology data set.

### 3.1- Correlation between total catch and hydrology



Previous works on this relationship (see Section 1) showed that the most appropriate was not a linear but a log relationship, as biological responses to environmental variations are not linear, but asymptotic. The logarithmic curve better illustrates such responses.

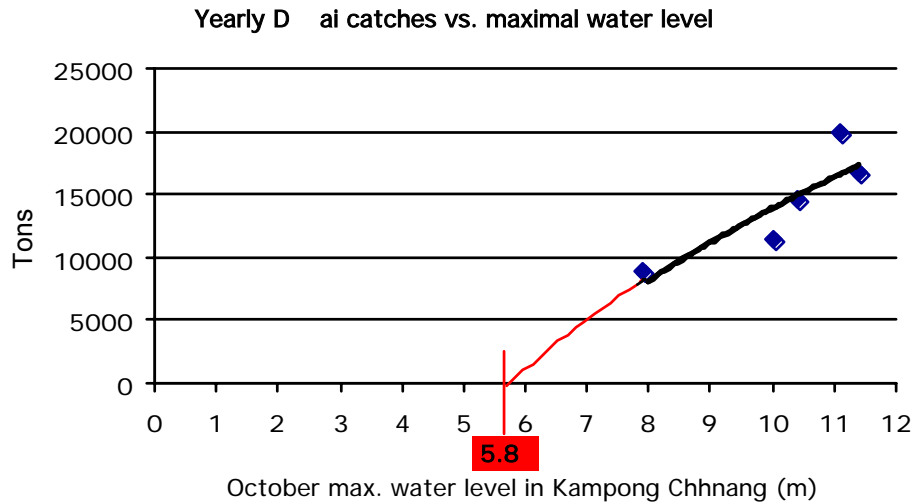


In that case, the equation is:

<b>Catches = 25860 . Ln (October water height) - 45420</b>	
Catches in kg	Kampong Chhnang average October height in meters

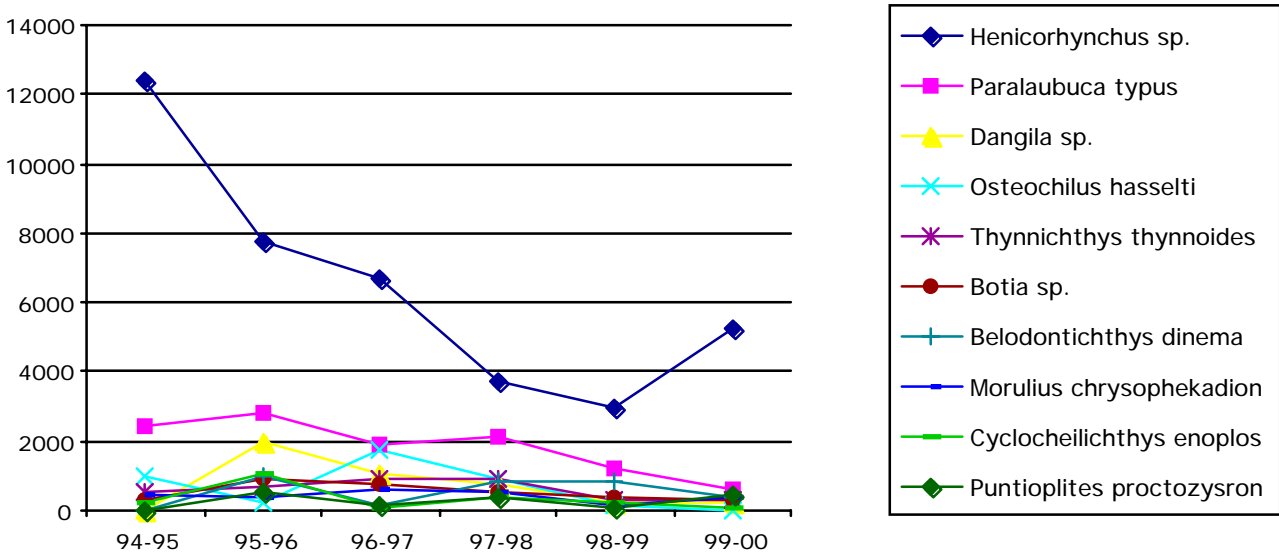
Therefore, nil catches corresponds to  
 $\text{Ln}(x) = 45420/25860 \Rightarrow x = \text{Exp}(1.756) = 5,79 \text{ m}$

This models predicts that the catch will be nil when the October water height does not exceed 5.8 m at the Kampong Chhnang gauge.
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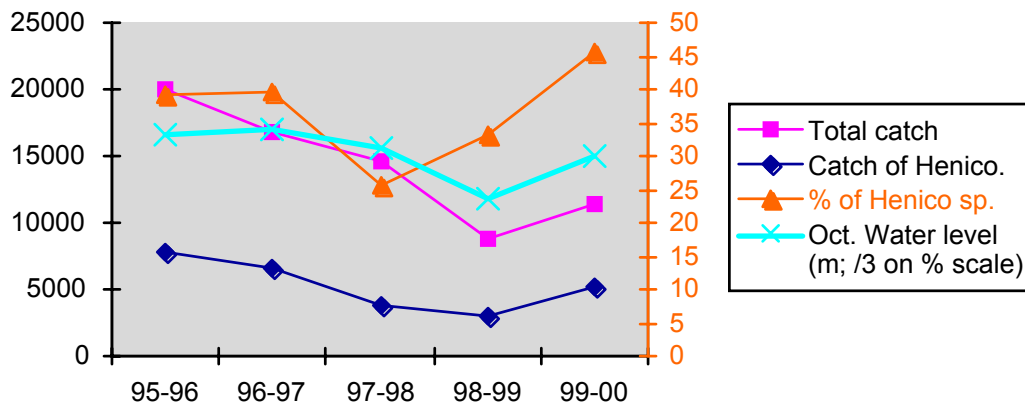
Compared to the average October water height of these five last years, this predicted nil catch would correspond to a reduction of the water height by 57% (but only a reduction of 27 % of the water level experienced two years ago).

### 3.2- Detailed trends for the 20 first groups

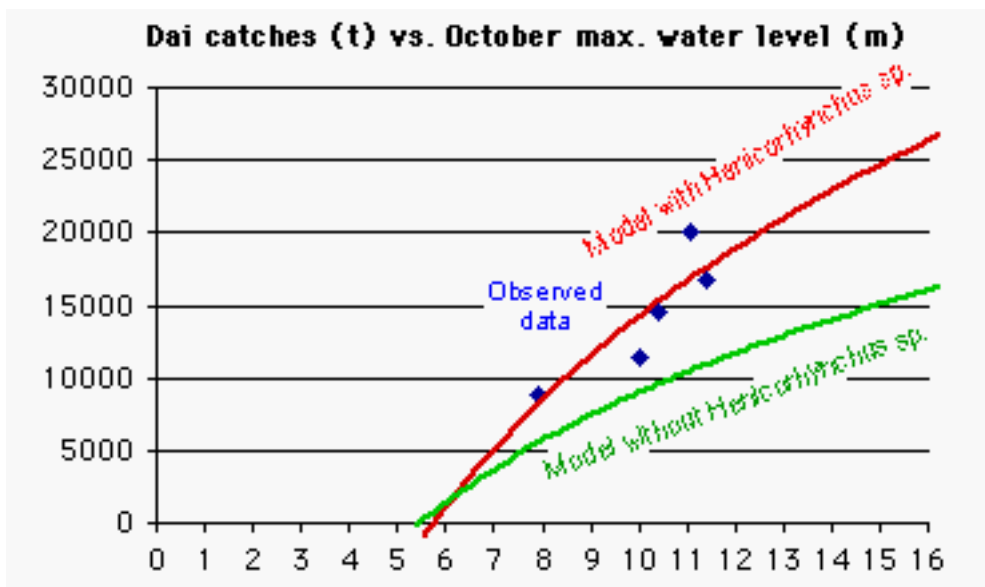


Conclusion: a major part of the excellent correlation between water levels and total catch is due to *Henicorhynchus sp.* only (*H. siamensis* and possibly *H. cryptopogon* and *H. caudimaculatus*, according to Rainboth 1996).

Incidentally, if *Henicorhynchus sp.* is always dominant in catches, its proportion in relation to total catches is variable and apparently not related to hydrological patterns:



The calculation of logarithmic equations linking catches and water heights allow to predict catches for different water levels. This is done below, taking *Henicorhynchus sp.* into account or not.



This visually confirms the importance of *Henicorhynchus sp.* in the accuracy of the model. The small number of data does not permit to calculate confidence intervals for these predictions (such a calculation is made under the assumption of data normal distribution, which cannot be tested here). It is to be noted that whether *Henicorhynchus* is taken into account or not, the critical threshold remains very similar.

As other species might have a longer life span than *Henicorhynchus*, they might not be correlated to the water level the same year but with the water level one or two years before. We checked this possibility by plotting Dai catches (without *Henicorhynchus*) as a function of the water level one or two years before:

In the case of Project data, the short time-series does not allow the proper calculation of this inter-annual relationship by removing the auto-correlations between years; We however give below the result of a linear forward stepwise regression on  $Catch_Y = f^1(L_Y; L_{Y-1}, L_{Y-2}, L_{Y-3})$ :

Note: this calculation is made on total catch data except *Henicorhynchus sp.*, to avoid a bias due to this dominant taxon whose response masks that of other species.



```

DEPENDENT VARIABLE    CATCH (without Henicorhynchus sp.)
PREDICTIVE VARIABLES: 1 CONSTANT; 2 LY; 3 LY-1, 4 LY-2, 5 LY-3
MINIMUM TOLERANCE FOR ENTRY INTO MODEL = 0.010000
[...]
STEP #      4 R= 0.777 RSQUARE= 0.604
VARIABLE          COEFFICIENT      STD ERROR  STD COEF  TOLERANCE      F      'P'
IN:
1 CONSTANT
2 WLY              1594.238      745.224    0.777    .1E+01      4.576    0.122
OUT:
PART. CORR
3 LY1              0.839         .          . 0.93760    4.757    0.161
4 LY2              -0.387        .          . 0.77780    0.353    0.613
5 LY3              -0.394        .          . 0.49608    0.368    0.606

```

THE SUBSET MODEL INCLUDES THE FOLLOWING PREDICTORS:

CONSTANT  
LY

```

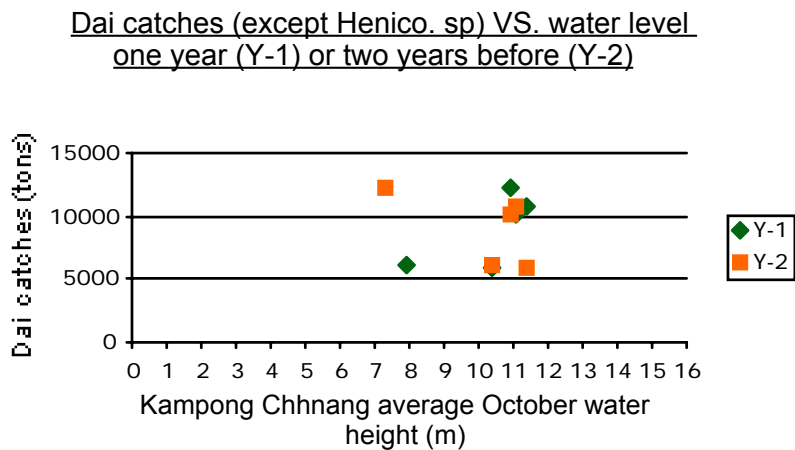
DEP VAR:  CATCH      N:      5  MULTIPLE R: 0.777  SQUARED MULTIPLE R: 0.604
ADJUSTED SQUARED MULTIPLE R: 0.472  STANDARD ERROR OF ESTIMATE: 2055.242

```

VARIABLE	COEFFICIENT	STD ERROR	STD COEF	TOLERANCE	T	P(2 TAIL)
CONSTANT	-7150.237	7630.024	0.000	.	-0.937	0.418
LY	1594.238	745.224	0.777	1.000	2.139	0.122

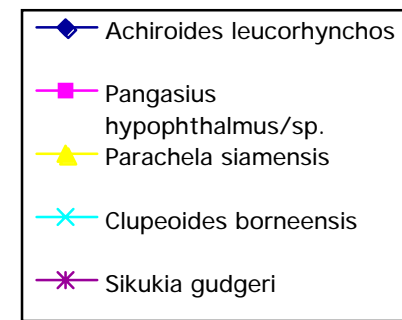
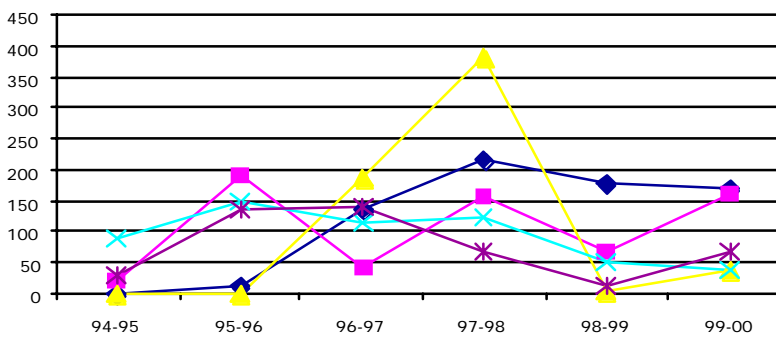
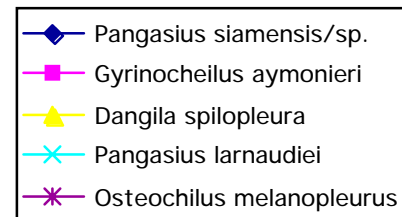
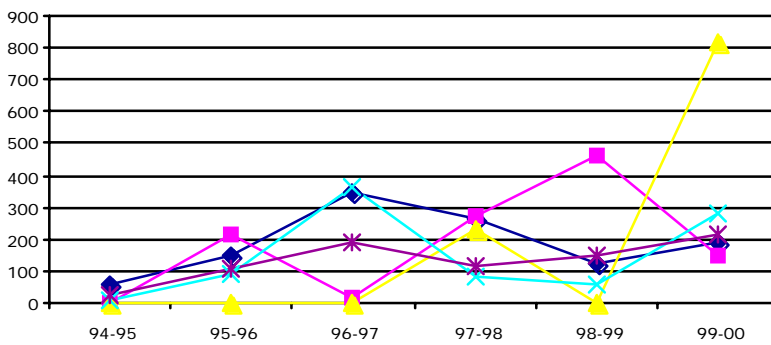
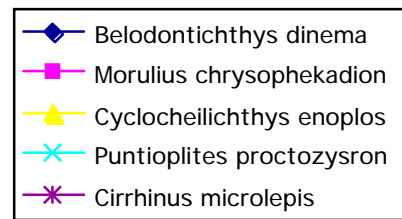
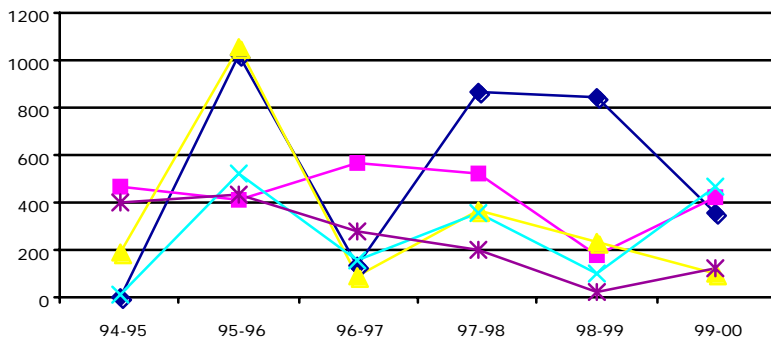
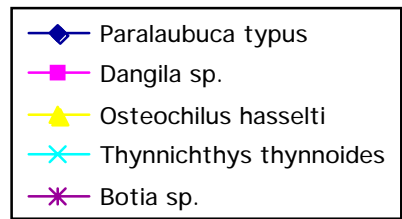
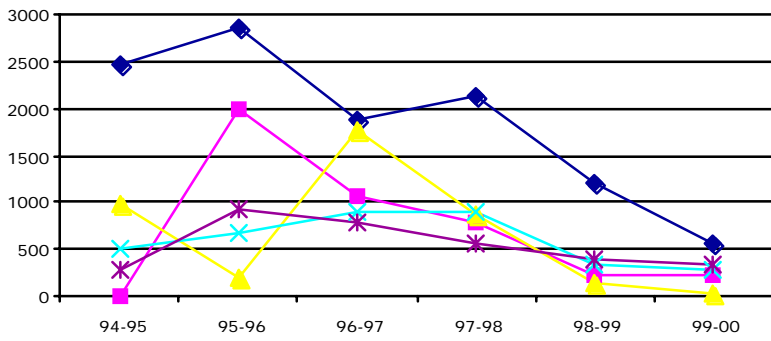
From this computation it can be concluded that the only significant linear correlation is between catches and the water level the same year. There is a slight and insignificant correlation between the catch and the water level one year before, and no correlation with previous years.

Given that we are not here within the theoretical limits of this linear statistical approach, we prefer plotting the catch as a function of the water level one or two years before (figure below).

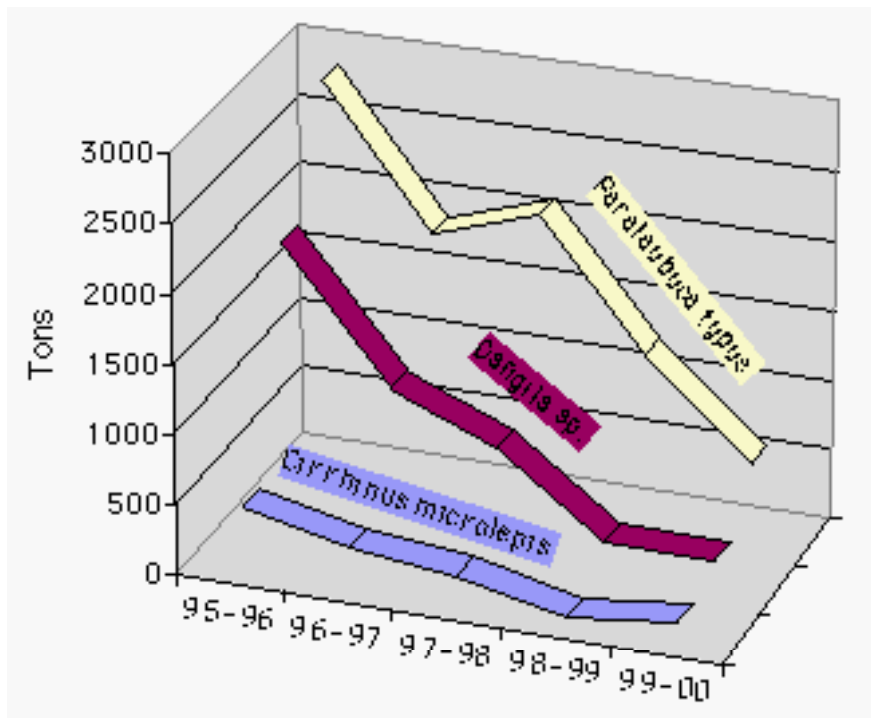


Conclusion: No visible relationship

Figures next page detail the evolution of catches for the 20 dominant species. Remaining species do not exhibit particular trends.



The figure below focuses on the three taxa which exhibit a clear trend of decline:



This analysis strongly suggests to consider the particular case of these three taxa via detailed studies or protection measures.

### 3.5- Analysis of long term trends

Knowing the October water height at a certain time, the model allows to calculate backwards the catch at this time.

The analysis below aims at:

- checking if there is a long term trend in water levels at Kampong Chhnang
- calculating backward the catch before 1965 and after 1965. This year is taken as a threshold because damming in the basin approximately started in 1965 (26 among the 29 major dams are 35 years old or less).

However many years of data are missing in Kampong Chhnang, due to historical reasons. In contrast, hydrological data have been continuously gathered since 1924. This leads to a reconstruction of missing hydrological data prior to retro-calculation of corresponding catches.

Here again the alternative is to work on data provided by the MRC Hydrology Unit, or by the MFCFC Project (on 25/7/00).

- MRC hydrological data: daily measurements, 52 years of data
- Project hydrological data: averaged monthly measurements, 59 years of data.

Differences between the two data sets are next:

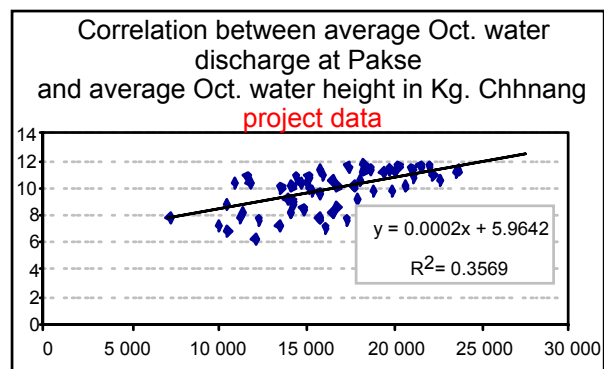
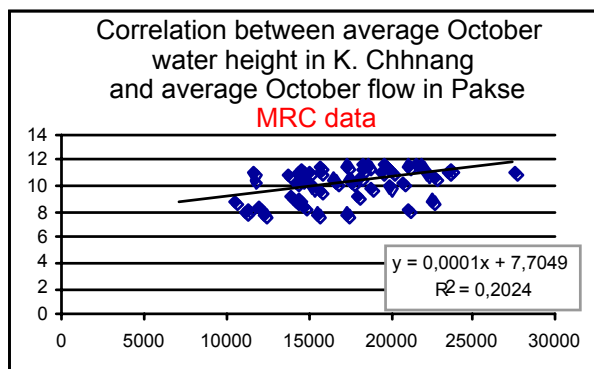
Year	Average Oct. water height in K Chhnang (source: MRC Hydrology Unit)	Average Oct. water height in K Chhnang (source: MFCFP, 25/7/00 )
1925	10,9	
1929	11,7	
1935	11,0	11,1
1936		10,4
1941		10,9
1945	11,3	
1946		11,7
1956		10,1
1961	11,1	
1962	10,6	
1963	8,8	
1964	8,8	
1970		9,02
1971	9,1	
1972		9,08
1985		8,13
1987		7,33
1988	8,4	6,28
1989		7,15
1990		8,16
1991		8,69
1992		6,85
1993		7,28
1994	11,1	10,92
1998		7,9
1999		10,02

The origin of MFCFC hydrological data missing at the MRC Hydrology Unit is not known. Surprisingly, some years present in MRC data are not present in the MFCFP data set.

Several attempts have been made to find the best possible correlation between the water flow at Pakse and the water level at K. Chhnang.

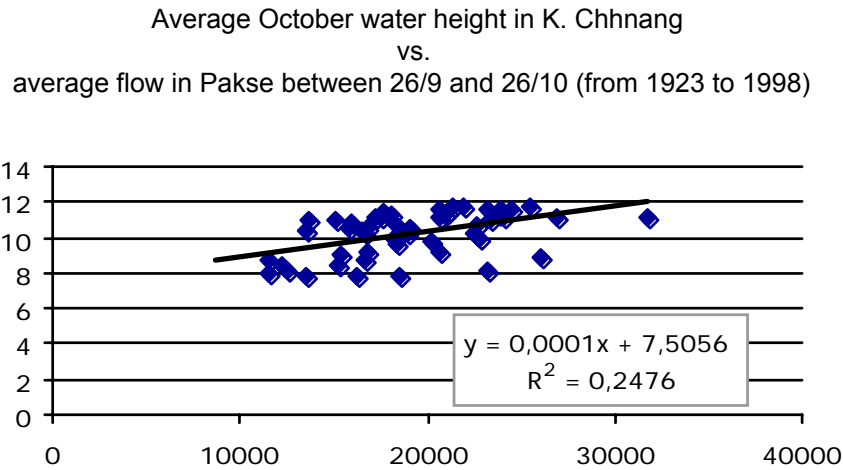
Note: this approach is not in agreement with standard methods to overcome missing data in hydrology, as Kampong Chhnang and Pakse are located along two different rivers. However in October the Mekong still flows into the Great Lake via the Tonle Sap River, so we considered the Tonle Sap level under influence of the Mekong flow.

Correlation between October water flow in Pakse and October water level in K. Chhnang



Conclusion: poor correlation, probably due to the distance between the two sites, and to the interference of other sub-basins between the two sites.

It has been suggested that the flood needed five days to come from Pakse to Phnom Penh (N. van Zalinge, pers. comm.); we therefore tried to correlate the "d" day water height in Kampong Chhnang to the "d-5" day flow in Pakse. Result, based on MRC data, is next:



Conclusion: insufficient correlation.

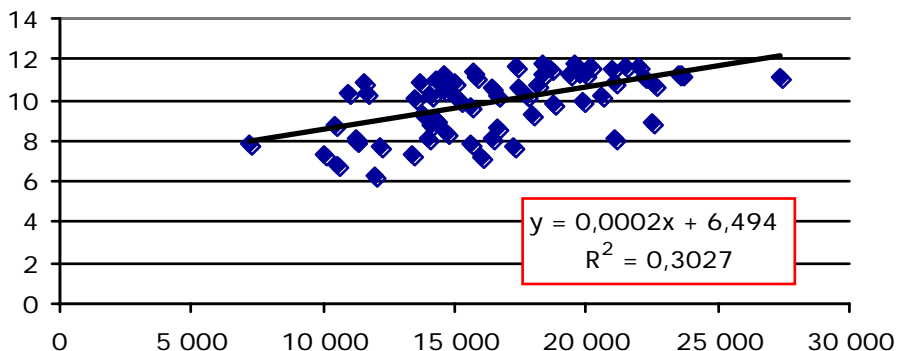
It has also been suggested

- to correlate October water heights in K. Chhnang with September average flow in Pakse, but i) the correlation is not different ( $R^2 = 0.360$  instead of  $0.357$ ) and ii) this is in contradiction with the time needed for the flow to come from Pakse to Phnom Penh (about five days only)
- to correlate October water heights in K. Chhnang with (September + October) average flow in Pakse, but i) although the correlation is better ( $R^2 = 0.706$  instead of  $0.357$ ) this manipulation is not justified by any hydrological reason, and ii) the improved correlation is probably an artefact due to the steeper slope of the relationship (September flows being lower than October ones, averaging the two months results in smaller values of flows, and therefore in a steeper slope when matched with the same water high values). This alternative has not been considered further.

Finally, the data set kept for the following analyses is that provided by the project, and whose missing data were supplemented by those of the MRC when available.

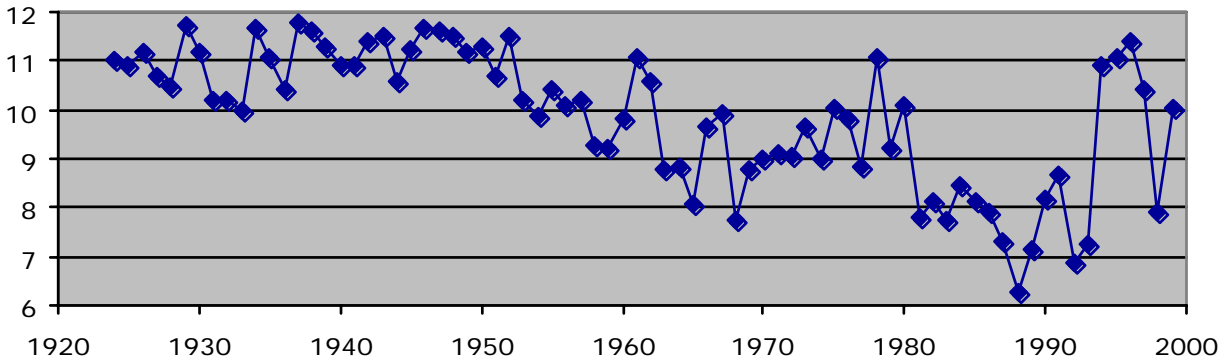
This data set is given in Annex G.

Final correlation between average October flow in Pakse  
(m<sup>3</sup>/s) and average water height in Kampong Chhnang (m)



From this (poor) relationship are calculated missing data in the Kampong Chhnang data set. This leads to the following long-term pattern of water height in Kampong Chhnang:

Average October water level in Kampong Chhnang (m)



Is this trend to flow reduction dependant of a similar trend in rainfall, or independent and therefore possibly related to damming?

In spite of a significant amount of time spent in sorting out available data, it has been impossible to find a rainfall time-series equivalent to that of water height. Most stations started measuring rainfall in the 60's. A few stations started earlier, but many years of data are missing.

Examples:

Phnom Penh

1963 → 1992 (29 years) but 15 missing years

Savannaketh

1927 → 1997 (70 years) but 42 years with missing months (complete years start in the 60's)

Pleiku

1927 → 1997 (70 years) but 26 missing years and 7 years with missing months

Tonkum

1923 → 1993 (70 years) but 26 missing years and 21 years with missing months

Note:

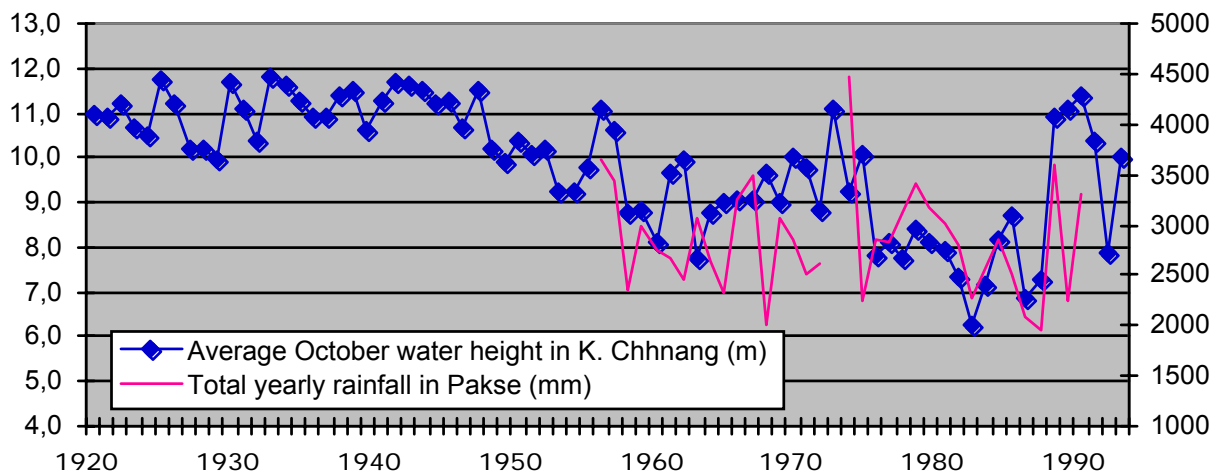
- Similar precipitation data files are not in the same format (e.g.: 040704.PTO and 040704.PTO below), the most common format being not easily usable without the original software.

Title : 140704 : KONTUM	Date :05/0
Site : KONTUM	
Type : Precipitation	
Units : mm	
Date : 01/02/1923 to 31/12/	Interval : [
Year :1923	
-----	
01 02 03 04	05 06
-----	
Jan -1? -1? -1? -1? -1? -1?	
Feb 0 0 0 0 0 0	
Mar 0 0 0 0 0 0	
Apr 0 0 4 5 0 0	
May 1 13 10 93 8 2	
Jun 24 19 14 0 5 26	

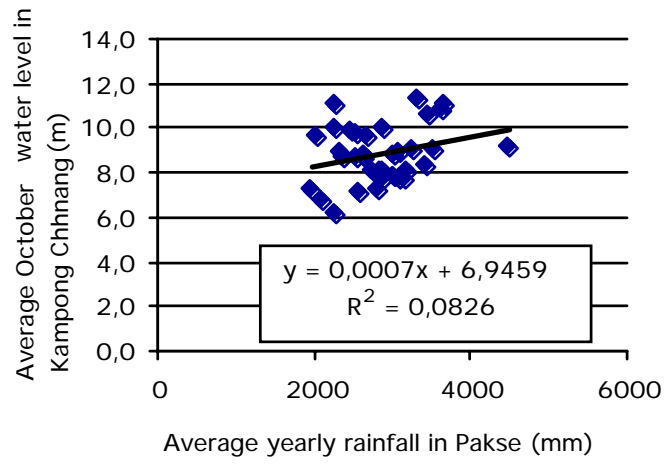
140703 PH3 1
01/06/1927 13.100
02/06/1927 6.000
03/06/1927 6.700
04/06/1927 2.900
05/06/1927 1.200
06/06/1927 0.000
07/06/1927 0.000
08/06/1927 1.000
09/06/1927 0.800

- several sums made in these rain data files are wrong  
 E.g.: daily precipitation in Savannaketh in March 1927 (file 160405.pto) : 2 + 4 mm = "7" mm  
 Monthly sums have sometimes been done, sometimes not.

Despite of these technical difficulties, we have selected a file with reasonably complete data (Rainfall in Pakse, from 1961 to 1998), and compared it with the trend in water height in Kampong Chhnang:



However the impossibility to compare with ante-1965 data does not allow any conclusion on the similar or different trend in rainfall patterns and water heights. Furthermore it must be pointed out that when quantified, the correlation between these two parameters is quasi-nil:





## BIBLIOGRAPHY

- Baird I. G., Flaherty M. S., Phylavanh B. 2000 Rythms of the river: lunar phases and small cyprinid migrations in the Mekong River. CESVI Project for environmental protection and community development in the Siphandone Wetland, Champassak Province, Lao PDR. 42 pp.
- Clifford (H.T.), Stephenson (W.) 1975 : An introduction to numerical classification ; Academic Press ; New-York.
- Deap Loeung 1999 The bagnet (Dai) fishery in the Tonle Sap River. Pp. 141-149 in van Zalinge & Nao Thuok (eds.): Present status of Cambodia's freshwater capture fisheries and management implications. Proceedings of the Annual meeting of the Department of Fisheries of the Ministry of Agriculture, Forestry and Fisheries, 19-21 January 1999. Mekong River Commission and Department of Fisheries, Phnom Penh, Cambodia.
- Deap Loeung, Ly Sina & N. van Zalinge 1998: Catch statistics of Cambodian Freshwater fisheries. MRC/DoF/DANIDA project for the management of freshwater capture fisheries of Cambodia. Phnom Penh.
- Eschmeyer W. N. (Ed.) 1998 Catalog of fishes. California Academy of Sciences
- Froese, R. and D. Pauly. Editors. 2000. FishBase. World Wide Web electronic publication. [www.fishbase.org](http://www.fishbase.org), 28 August 2000
- Kottelat, M., A.J. Whitten, S.N. Kartikasari and S. Wirjoatmodjo, 1993. Freshwater fishes of Western Indonesia and Sulawesi. Periplus Editions, Hong Kong. 221 p.
- Lieng S., Yim C., van Zalinge N. P. 1995 Freshwater fisheries of Cambodia, I: the bagnet (Dai) fishery in the Tonle Sap River. Asian Fisheries Science. 8 255-262
- Mekong Secretariat 1993 Development plan for the Tonle Sap and S Chakdomuk. Phase 1. Report by Orstom and the BCEOM for the Mekong Secretariat, Bangkok. 58 pp.
- Ngor Peng Bun 2000 Dai fisheries in the Tonle Sap River (review of the data census of 1996-1997) Presentation at the 2nd Mekong River Commission Fisheries Program technical symposium, Phnom Penh 13-14 December 1999. 9 pp.
- Rainboth W. J. 1996 Fishes of the Cambodian Mekong. FAO identification field guide for fishery purposes. Rome, FAO 265 pp.
- Roberts T. R., Baird I. G. 1995 Traditional fisheries and fish ecology on the Mekong River at Khone waterfalls in Southern Laos. Nat. Hist. Bull. Siam Soc. 43 219-262 33
- Roberts, T.R. and C. Vidthayanon, 1991. Systematic revision of the Asian catfish family Pangasiidae, with biological observations and descriptions of three new species. Proc. Acad. Nat. Sci. Philad. 143:97-144.
- Roberts, T.R., 1989. The freshwater fishes of Western Borneo (Kalimantan Barat, Indonesia). Mem. Calif. Acad. Sci. 14:210 p.
- Roberts, T.R., 1993. Systematic revision of the Southeast Asian cyprinid fish genus *Labiobarbus* (Teleostei: Cyprinidae). Raffles Bull. Zool. 41(2):315-329.
- Roberts, T.R., 1997. Systematic revision of three tropical Asian Labeon Cyprinid fish genus *Cirrhinus*, with descriptions of new species and biological observations on *C. lobatus*. Nat. Hist. Bull. Siam Soc. 45: 171-203.
- Sam Chin Ho 1999 The brush park (Samrah) fishery at the mouth of the Great Lake in Kompong Chhnang Province, Cambodia. Pp. 79-89 in van Zalinge & Nao Thuok (eds.): Present status of Cambodia's freshwater capture fisheries and management implications. Proceedings of the Annual meeting of the Department of Fisheries of the Ministry of Agriculture, Forestry and Fisheries, 19-21 January 1999. Mekong River Commission and Department of Fisheries, Phnom Penh, Cambodia.
- Stamatopoulos C. 1994 ARTFISH: a microcomputer system for the statistical monitoring of artisanal fisheries. Version 1. FAO Rome.
- Stamatopoulos C. 1995 Statistical monitoring of the freshwater capture fisheries in Cambodia. Mission report, field document n°3. DoF/MRC/DANIDA. Management of the freshwater capture fisheries of Cambodia project., Phnom Penh. 6pp.

Stephenson (W.), Cook (S.D.) 1980 : Elimination of species prior to cluster analysis ; Austr. J. Ecol. ; 5 ; 263-273.

Thor Sensereivorth, Diep Loeung, Nao Thuok 1999 Freshwater capture fisheries data collection in 1988. Pp. 40-53 in van Zalinge & Nao Thuok (eds.): Present status of Cambodia's freshwater capture fisheries and management implications. Proceedings of the Annual meeting of the Department of Fisheries of the Ministry of Agriculture, Forestry and Fisheries, 19-21 January 1999. Mekong River Commission and Department of Fisheries, Phnom Penh, Cambodia.

MRC 1994 Cambodia land cover atlas 1985/87 and 1992/93. Prepared by the Mekong Secretariat for Project CMB/92/005.

Van Zalinge N. P., Nao Thuok (Eds. ) 1999 Present status of Cambodia's freshwater capture fisheries and management implications. P. 11-20 in Proceedings of the Annual meeting of the Department of Fisheries of the Ministry of Agriculture, Forestry and Fisheries, 19-21 January 1999. Mekong River Commission and Department of Fisheries, Phnom Penh, Cambodia.

van Zalinge N., Nao Thuok, Touch Seang Tana, Deap Loeung 2000 Where there is water, there is fish? Cambodian fisheries issues in a Mekong River Basin perspective. p. 37-48. In M. Ahmed and P. Hirsch (eds.) Common property in the Mekong: issues of sustainability and subsistence. ICLARM Studies and Reviews 26, 67p.

**ANNEX A**  
**CURRENT ARTFISH KHMER NAMES-LATIN NAMES CONVERSION TABLE**

**In yellow:** to be modified

**In red:** non fish

ARTFISH TABLE	
Khmer name	Scientific Name
AMBONG	Fish Spp1
AMPIL TUM	<i>Systemus orphoides</i> (pg 104)
ANDAT CHHKE	<i>Achiroides leucorhynchus</i> (13,pg 221)
ANDENG	<i>Clarius</i> sp. (6,pg 162)
ARCH KOK	<i>Dangila spilopleura</i> (pg 110)
BANDOUL AMPAOV	<i>Clupeoides borneensis</i> (4, pg 59)
BANG KORNG	"Shrimp"
BONG LAO	<i>Pangasius krempfi</i> ( pg 155)
CHAN TEAS PHLUK	<i>Parachela siamensis</i> (4,pg 69)
CHANLUONH MOAN	<i>Coilia</i> sp. (2, pg 63)
CHEK TUM	<i>Bagrichthys macropterus</i> (2, pg 139)
CHHDOR/DIEP	<i>Channa micropeltes</i> (pg 220)
CHHKOK	<i>Cyclocheilichthys enoplos</i> (pg 88)
CHHLANG	<i>Mystus nemurus</i> (pg 143)
CHHLANG KROBEY	Fish Spp2
CHHLONH	<i>Macrogathus siamensis</i> (pg 179)
CHHMAR	<i>Setipinna melanochir</i> (2, pg 64)
CHHPIN	<i>Barbodes gonionotus</i> (pg 95)
CHHVAET	<i>Pangasius siamensis</i> /sp. (4, pg 155)
CHRA KENG	<i>Puntioplites proctozyron</i> (7, pg 93)
CHUNH CHUKDAI	<i>Gyrinocheilus aymonieri</i>
DAMREY	<i>Oxyeleotris marmorata</i> (pg 196)
DANG KHTENG	<i>Macrochirichthys macrochirus</i> (pg 67)
KAEK	<i>Morulus chrysophekadion</i> (pg 155)
KAHE	<i>Barbodes altus</i> (2, pg 95)
KAMBUT CHRAMOS	<i>Sikukia gudgeri</i> (pg 94)
KAMPEUS	<i>Gammaridae</i> ?
KAMPLEANH	<i>Trichogaster microlepis</i>
KAMPHLIEV	<i>Kryptophterus cryptophterus</i> (5, pg 146)
KAMPOT	<i>Monotreta cambodgiensis</i> (8, pg 225)
KAMPOUL BAI	<i>Cosmochilus harmandi</i> (pg 87)
KAMPREAM	<i>Polynemus multifilis</i> (4, pg 188)
KAN TRORB	<i>Pristolepis fasciata</i> (pg 191)
KANH CHANH CHRAS	<i>Parambassis apogoniodes</i> (2, pg 182)
KANH CHEAK SLA	<i>Toxotes chatareus</i> (2, 189)
KANH CHOS	<i>Mystus</i> sp. (11, pg 141)
KANH CHROUK	<i>Botia</i> sp. (8, pg 132)
KANTHOR	<i>Trichogaster pectoralis</i> (pg 216)
KANTRANG PRENG	<i>Parambassis wolffi</i> (pg 182)
KAOK	<i>Arius caelatus</i> (15, pg 164)
KBAL RUY	Fish Spp3
KES	<i>Micronema</i> sp. (3, pg148)

KHLANG HAI	<i>Belodontichthys dinema</i> (pg 145)
KHMAN	<i>Hampala dispar</i> (2, pg 101)
KHNANG VENG	<i>Dangila</i> sp. (pg 110)
KHYA	<i>Mystus wyckioides</i> (pg 144)
KRABEY	<i>Bagarius bagarius</i> (5, pg160)
KRANH	<i>Anabas testudineus</i> (pg 214)
KRAY	<i>Chitala ornata</i> (3, pg 56)
KROM	<i>Osteochilus melanopleurus</i> (pg 117)
KROS	<i>Osteochilus hasselti</i> (4, pg 116)
LINH	<i>Thynnichthys thynnoides</i> (pg 105)
<b>PASEE</b>	<b><i>Mekongina erythrospila</i> (pg 122)</b>
PAVA	<i>Labeo erythropterus</i>
PHKAKOR	<i>Barbichthys thynnoides</i>
PHTONG	<i>Xenentodon</i> spg/ <i>Dermogenys</i> spg(pg 172)
PO	<i>Pangasius larnaudiei</i> (pg 155)
PRA	<i>Pangasius hypophthalmus</i> /sp. (4, pg 152)
PRAMA	<i>Boesemania microlepis</i> (pg 188)
PROLOUNG	<i>Loptobarbus hoeveni</i> (pg 74)
PRUOL/ KRALANG	<i>Cirrhinus microlepis</i> (pg 107)
RIEL	<i>Henicorhynchus</i> sp. (3, pg 111)
ROMEAS	<i>Osphronemus exodon</i> (pg 218)
ROS/PHTUOK	<i>Channa marulius</i> (pg 219)
RUSCHEK	<i>Acantopsis</i> spg (pg 136)
SANDAI	<i>Wallago attu</i> (pg 151)
SANGKAT PRAK	<i>Puntius brevis</i> (1,pg 89;3, pg 102)
SLAT	<i>Notopterus notopterus</i> (pg 56)
SLOEUK RUSSEY	<i>Paralaubica typus</i> (7, pg 67)
SRAKA KDAM	<i>Cyclocheilichthys apogon</i> /sp. (pg 87)
TA AUN/KRAMORM	<i>Ompok hypophthalmus</i> (4, pg 149)
THMOR	<i>Gyrinocheilus pennocki</i>
TRASORK	<i>Probarbus jullieni</i>
X-OTHERS	Other species

### Modified Khmer names-Latin names conversion table

**In yellow:** modified

**In red:** to be modified

Scientific name	Species in Khmer	Code	Rainboth 1996
Acantopsis sp.	RUSCHEK	Acant. sp.	p. 136
Achiroides leucorhynchus	ANDAT CHHKE	Ach. leuco.	n° 13 p. 221
Anabas testudineus	KRANH	Ana. testu.	p. 214
Arius caelatus	KAOK	Ari. caela.	n° 15 p. 164
Bagarius bagarius	KRABEY	Bag. bagar.	n° 5 p.160
Bagrichthys macropterus	CHEK TUM	Bag. macro.	n° 2 p. 139
<b>Barbichthys thynnoides</b>	PHKAKOR	<b>Bar. thynn.</b>	
Barbodes altus	KAHE	Bar. altus	n° 2 p. 95
Barbodes gonionotus	CHHPIN	Bar. gonio.	p. 95
Belodontichthys dinema	KHLANG HAI	Bel. dinem.	p. 145
Boesemania microlepis	PRAMA	Boe. micro.	p. 188
Botia sp.	KANH CHROUK	Botia sp.	n° 8 p. 132
Channa marulius	ROS/PHTUOK	Chan. marul.	p. 219
Channa micropeltes	CHHDOR/DIEP	Cha. micro.	p. 220
Chitala ornata	KRAY	Chi. ornat.	n° 3 p. 56
Cirrhinus microlepis	PRUOL/ KRALANG	Cir. micro.	p. 107
Clarius sp.	ANDENG	Clarius sp.	n° 6 p. 162
Clupeoides borneensis	BANDOUL AMPAOV	Clu. borne.	n° 4 p. 59
Coilia sp.	CHANLUONH MOAN	Coi. sp.	n° 2 p. 63
Cosmochilus harmandi	KAMPOUL BAI	Cos. harman.	p. 87
Cyclocheilichthys apogon/sp.	SRAKA KDAM	Cyc. apo/sp.	p. 87
Cyclocheilichthys enoplos	CHHKOK	Cyc. enopl.	p. 88
Dangila sp.	KHNANG VENG	Dang. sp	p. 110
<b>Labiobarbus siamensis</b>	ARCH KOK	<b>Lab. siam.</b>	p. 110
<i>"Ambong"</i>	<i>AMBONG</i>	<i>"Ambong"</i>	
<i>"Chhlang krobey"</i>	<i>CHHLANG KROBEY</i>	<i>"Chhlang Krobey"</i>	
<i>"Kbal ruy"</i>	<i>KBAL RUY</i>	<i>"Kbal Ruy"</i>	
<i>Gammaridae</i>	<i>KAMPEUS</i>	<i>Gammar .</i>	
Gyrinocheilus aymonieri	CHUNH CHUKDAI	Gyr. aymon.	p. 138
Gyrinocheilus pennocki	THMOR	Gyr. penno.	p. 138
Hampala dispar	KHMAN	Ham. dispa.	n° 2 p. 101
Henicorhynchus sp.	RIEL	Henic. sp.	n° 3 p. 111
<b>Kryptopterus kryptopterus</b>	KAMPHLIEV	<b>Kry. crypt.</b>	n° 5 p. 146
Labeo erythropterus	PAVA	Leb. eryth.	p. 112
<b>Leptobarbus hoeveni</b>	PROLOUNG	<b>Lop. hoeve.</b>	p. 74
Macrobrachium	BANG KORNG	Macrob.	
Macrochirichthys macrochirus	DANG KHTENG	Mac. macro.	p. 67
Macrogonathus siamensis	CHHLONH	Mac. siame.	p. 179
Mekongina erythrospila	PASEE	Mek. eryth.	p. 122
Micronema sp.	KES	Micro. sp.	n° 3 p.148
<b>Tetraodon leiurus</b>	KAMPOT	<b>Tetr. leiu.</b>	n° 8 p. 225
<b>Labeo chrysophekadion</b>	KAEK	<b>Lab. chrys.</b>	p. 155
Mystus nemurus	CHHLANG	Mys. nemur.	p. 143
Mystus sp.	KANH CHOS	Mystus sp.	n° 11 p. 141
Mystus wyckioides	KHYA	Mys. wycki.	p. 144

<i>Notopterus notopterus</i>	SLAT	Not. notop.	p. 56
<i>Ompok hypophthalmus</i>	TA AUN/KRAMORM	Omp. hypop.	n° 4 p. 149
<i>Osphronemus exodon</i>	ROMEAS	Osp. exodo.	p. 218
<i>Osteochilus hasselti</i>	KROS	Ost. hasse.	n° 4 p. 116
<i>Osteochilus melanopleurus</i>	KROM	Ost. melan.	p. 117
Other species	X-OTHERS	Other sp.	
<i>Oxyeleotris marmorata</i>	DAMREY	Oxy. marmo.	p. 196
<i>Pangasius hypophthalmus</i> /sp.	PRA	Pan. hypop.	n° 4 p. 152
<i>Pangasius krempfi</i>	BONG LAO	Pan. kremp.	p. 155
<i>Pangasius larnaudii</i>	PO	Pan. lanau.	p. 155
<i>Pangasius macronema</i> /sp.	CHHVAET	Pan. macr./sp.	n° 4 p. 155
<i>Parachela siamensis</i>	CHAN TEAS PHLUK	Par. siame.	n° 4 p. 69
<i>Paralauca typus</i>	SLOEUK RUSSEY	Par. typus	n° 7 p. 67
<i>Parambassis apogoniodes</i>	KANH CHANH CHRAS	Par. apogo.	n° 2 p. 182
<i>Parambassis wolffi</i>	KANTRANG PRENG	Par. wolff.	p. 182
<i>Polynemus multifilis</i>	KAMPREAM	Pol. multi.	n° 4 p. 188
<i>Pristolepis fasciata</i>	KAN TRORB	Pri. fasci.	p. 191
<i>Probarbus jullieni</i>	TRASORK	Pro. julli.	p. 83
<i>Puntioplites proctozysron</i>	CHRA KENG	Pun. proct.	n° 7 p. 93
<i>Puntius brevis</i>	SANGKAT PRAK	Pun. brev.	n° 1 p. 89; 3 p. 102
<i>Setipinna melanochir</i>	CHHMAR	Set. melan.	n° 2 p. 64
<i>Sikukia gudgeri</i>	KAMBUT CHRAMOS	Sik. gudge.	p. 94
<i>Puntius orphoides</i>	AMPIL TUM	Pun. orpho.	p. 104
<i>Thynnichthys thynnoides</i>	LINH	Thy. thynn.	p. 105
<i>Toxotes chatareus</i>	KANH CHEAK SLA	Tox. chata.	n° 2 p. 189
<i>Trichogaster microlepis</i>	KAMPHEANH	Tri. micro.	p. 216
<i>Trichogaster pectoralis</i>	KANTHOR	Tri. pecto.	p. 216
<i>Wallago attu</i>	SANDAI	Wal. attu.	p. 151
<i>Xenentodon</i> sp./ <i>Dermogenys</i> sp.	PHTONG	Xen./Der.	p. 172

## ANNEX B

### A FUNCTION TO LUMP MULTIPLE DATA FILES CREATED BY ARTFISH

This function lumps together the individual files generated by the Artfish software and ordinated by year/month/province. These different files having different names are lumped as a single file, which allows further statistical analyses. The function has been written in Visual Basic for Access 2000. The interface window is :

The source code is next:

```
Option Compare Database
Private Sub Fusion_Click()
Dim NomTable, NomChFich, NomFichiers, DossierF, TableFusion As String
Dim Instruction, PremièreT As String
Dim fs, s
Dim Tabledef As Tabledef
Dim MaBase As Database
Dim PreTable As Boolean
Dim i, j, Fin As Integer

Set MaBase = CurrentDb()
PreTable = True

Set fs = Application.FileSearch
With fs
    .NewSearch
    .lookin = SourceDbf.Value
    'Parcourt aussi les sous repertoires
    .SearchSubFolders = True
    .FileName = Forms!SyntDbf!TypeDbf & " " & "*.dbf"
    .Execute
    'Compte le nombre de fichiers Dbase existants dans le repertoire
    'et les sous repertoires
    If .FoundFiles.Count > 0 Then
        MsgBox "There were " & .FoundFiles.Count & " file(s) found."
```

```

For i = 1 To .FoundFiles.Count
  MsgBox .FoundFiles(i)
  If i = 1 Then
'suppression de toutes les tables de la base
    With MaBase
'Compte le nombre de tables existantes dans la base de données
      Fin = .TableDefs.Count - 1
      j = 0
      Do While j <= Fin
'Exclu les tables systèmes
        If .TableDefs(j).Name Like "MSys*" Then
          j = j + 1
        Else
'suppression de la table trouvée
          .TableDefs.Delete (.TableDefs(j).Name)
          Fin = Fin - 1
        End If
      Loop
      .TableDefs.Refresh
'suppression effectuée
    End With
  End If
'Importe dans Access les tables Dbase en les renommant au format Tablex (x étant un numéro)
  NomTable = "Table" & i
'Recherche du nom et du chemin complet du fichier à importer
  NomChFich = .FoundFiles(i)
'Recupération du nom du fichier uniquement
  NomFichierS = GetNameFileImport(.FoundFiles(i))
'Recupère le chemin complet dans lequel se trouve le fichier à importer
  DossierF = GetPathImport(.FoundFiles(i))
'Importe la table Dbase dans la base Ms Access 97
  DoCmd.TransferDatabase acImport, "dbase III", DossierF, acTable, _
    NomFichierS, NomTable, 0

'Création de la structure de la table fusion par rapport à la première table
  If i = 1 Then
'creation de la table "Fusion"
    DoCmd.TransferDatabase acImport, "dbase III", DossierF, acTable, _
      NomFichierS, "TFusion", -1
  End If
Next i

'utiliser les tables de la base pour la fusion
'la fusion est faite dans la 1ère table
  With MaBase
    .TableDefs.Refresh
    Fin = .TableDefs.Count - 1
    Debug.Print Fin
    j = 0
    Do While j <= Fin
'Passe sur les tables systèmes sans recuperer le contenu
      If .TableDefs(j).Name Like "MSys*" Then
        j = j + 1
      Else
'Copie les enregistrements de la table courante
'dans la table de fusion
        If .TableDefs(j).Name <> "TFusion" Then
          Instruction = "INSERT INTO " & "TFusion" & " " & " _
            & "SELECT * FROM " & .TableDefs(j).Name & " ;"
          MaBase.Execute Instruction
        End If
      End If
    End With
  End With

```



```

        j = j + 1
    End If
    Loop
End With
MaBase.TableDefs.Refresh
'Exporter la table fusion au format Dbase
'Dans tous les cas la table de fusion se nomme "fusion.dbf"
DoCmd.TransferDatabase acExport, "dbase III", Forms!SyntDbf!Destinatdbf,
acTable, _
    "TFusion", Forms!SyntDbf!NomFichSy, 0
    MsgBox "Succesful lumping in the directory: " & Destinatdbf.Value & "
under the name: " & Forms!SyntDbf!NomFichSy
    Else
        MsgBox "There were no files found."
    End If
End With
MaBase.Close
End Sub
Private Sub Fermer_Click()
On Error GoTo Err_Fermer_Click

    DoCmd.Close

Exit_Fermer_Click:
    Exit Sub

Err_Fermer_Click:
    MsgBox Err.Description
    Resume Exit_Fermer_Click

End Sub

Function GetPathImport(PathFich) As String
' Cette fonction recherche le chemin du fichier trouvé

    Dim CpteLongFich As Integer

    For CpteLongFich = Len(PathFich) To 1 Step -1
        If Mid$(PathFich, CpteLongFich, 1) = "\" Then
            Exit For
        End If
    Next CpteLongFich

    GetPathImport = Left$(PathFich, CpteLongFich - 1)

End Function

Function GetNameFileImport(SourceFich) As String
' Cette fonction recupère le nom fichier trouvé

    Dim intFich As Integer, LongChemin As Integer
    LongChemin = Len(SourceFich)
    For intFich = Len(SourceFich) To 1 Step -1
        If Mid$(SourceFich, intFich, 1) = "\" Then
            Exit For
        End If
    Next intFich

    GetNameFileImport = Right$(SourceFich, LongChemin - intFich)

End Function

```



**ANNEX C**  
**STRUCTURE OF ARTFISH ESTIMATES FILES AND FIELDS CONTENTS**

	<i>Meaning</i>	<i>Special case of dai fishery</i>
<b>DOC</b>	N° of the data page (per month)	
<b>SEQ</b>	?	Only "0"
<b>LSITE</b>	Landing site	2 landing sites
<b>MNSTRAT</b>	Landing minor stratum	Usually 2 minor identical strata identical to sites (redundancy)
<b>DAY</b>	N° of day of the month	
<b>MONTH</b>	N° of the month	
<b>YEAR</b>	Year	
<b>RECORD</b>	Number of the page (per day)	
<b>RECNAME</b>	Recorder name	
<b>TIME</b>	Time of sampling	Not used for dai fishery
<b>BTTYPE</b>	Boat type	only "DAI FISHERY"
<b>GRTYPE</b>	Gear type	4 categories of variable duration: L-YIELD LP = Low Yield Low period H-YIELD LP = High Yield Low period L-YIELD PP = Low Yield Peak Period H-YIELD PP = High Yield Peak Period
<b>BTNO</b>	Number of boats	For dai fishery, n° = "1" (not defined)
<b>GRNO</b>	Number of gears	Only "0" (not defined)
<b>CREW</b>	Number of fishermen	Number of workers
<b>DUR</b>	Total weight resulting from Effort	
<b>BTREG</b>	Sorted by species by the fishermen? (Y/N)	N = no
<b>BTNAME</b>	Boat name	Not defined
<b>SKIPPER</b>	Name of skipper OR No of dai unit/no of row	N° of row (=dai) / Letter of unit in a row ex: 12E = dai n° 12, 5th bagnet
<b>GROUND</b>	Fishing ground	Not defined
<b>REMARK</b>	Remark	Not defined
<b>KEY</b>	?	Not defined
<b>NOSP</b>	?	Nb of species +1 (for * TOTAL *)
<b>TOTAL</b>	?	Only "TOTAL"
<b>TOTC</b>	Total weight of the sample	= sum of CATCHxx for species xx
<b>TOTV</b>	Total value	= (TOTC x TOTP)
<b>TOTP</b>	Average? sample price (*1000 Riels)	
<b>TOTN</b>	Total number of individuals	= sum of NOFISHxx for species xx
<b>EFF</b>		
<b>AVUSE</b>		
<b>BCPUE</b>	Catch per Boat Unit effort	= GCPUE for dais
<b>VBCPUE</b>		
<b>CVBCPUE</b>		
<b>BCPUE1</b>		
<b>BCPUE2</b>		
<b>GCPUE</b>	Catch per Gear Unit effort	= BCPUE for dais
<b>VGCPUE</b>		
<b>CVGCPUE</b>		
<b>GCPUE1</b>		
<b>GCPUE2</b>		

<b>PERC</b>		
<b>PERV</b>		
<b>BAC</b>	Boat Activity Coefficient (in %) per boat	= GAC for Dais
<b>BAC1</b>	Boat Activity Coefficient (in %) -lower limit	= GAC1 for Dais
<b>BAC2</b>	Boat Activity Coefficient (in %) -upper limit	= GAC2 for Dais
<b>BEFF</b>	Boats estimated effort	= GEFF for Dais
<b>BEFF1</b>	Boats estimated effort -lower limit 95%	= GEFF1 for Dais
<b>BEFF2</b>	Boats estimated effort -upper limit 95%	= GEFF2 for Dais
<b>VBEFF</b>		
<b>CVBEFF</b>	Variation coefficient of Boat Effort	= CVGEFF for Dais
<b>GAC</b>	Activity (in %) per Gear	= BAC for Dais
<b>GAC1</b>	Gear activity (in %) -lower limit	= BAC1 for Dais
<b>GAC2</b>	Gear activity (in %) -upper limit	= BAC2 for Dais
<b>BC</b>	Boat Catch?	
<b>VBC</b>		
<b>CVBC</b>	Variation coefficient of Boat Catch?	= CVGC for Dais
<b>BC1</b>	Boat Catch? (in %) -lower limit	= GC1 for Dais
<b>BC2</b>	Boat Catch? (in %) -upper limit	= GC2 for Dais
<b>BV</b>	Boat Value?	= GV for Dais
<b>BV1</b>	Boat Value? (in %) -lower limit	= GV1 for Dais
<b>BV2</b>	Boat Value? (in %) -upper limit	= GV2 for Dais
<b>BP</b>		
<b>GEFF</b>	Gears estimated effort	= BEFF for Dais
<b>GEFF1</b>	Gears estimated effort -lower limit 95%	= BEFF1 for Dais
<b>GEFF2</b>	Gears estimated effort -upper limit 95%	= BEFF2 for Dais
<b>VGEFF</b>		
<b>CVGEFF</b>	Variation coefficient of Gear Effort	= CVBEFF for Dais
<b>GC</b>	Estimated catch for Gears ("Gear Catch")	= BC for Dais
<b>GC1</b>	Lower limit at 95% of GC	= BC1 for Dais
<b>GC2</b>	Upper limit at 95% of GC	= BC2 for Dais
<b>GV</b>	(Estimated value)	= BV for Dais
<b>GV1</b>	Lower limit at 95% of GV	= BV1 for Dais
<b>GV2</b>	Upper limit at 95% of GV	= BV2 for Dais
<b>VGC</b>		
<b>CVGC</b>	Variation coefficient of GC	= CVBC for Dais
<b>BFRM</b>	Nb of boats from Frame	= GFRM for Dais
<b>GFRM</b>	Nb of gears from Frame	= BFRM for Dais
<b>NOCALD</b>		
<b>NOWRKD</b>		
<b>BVARFRM</b>	Observed/Frame sample ratio for Boats	=GVARFRM for Dais
<b>GVARFRM</b>	Observed/Frame sample ratio for Gears	=BVARFRM for Dais
<b>PERCB</b>		
<b>PERVB</b>		
<b>PERCG</b>		
<b>PERVG</b>		

### Structure of Artfish Landing files and fields contents

	<i>Meaning</i>	<i>Special case of dai fishery</i>
<b>DOC</b>	N° of the data page (per month)	
<b>SEQ</b>	?	Only "0"
<b>LSITE</b>	Landing site	2 landing sites
<b>MNSTRAT</b>	Landing minor stratum	Usually 2 minor identical strata identical to sites (redundancy)
<b>DAY</b>	N° of day of the month	
<b>MONTH</b>	N° of the month	
<b>YEAR</b>	Year	
<b>RECORD</b>	Number of the page (per day)	
<b>RECNAME</b>	Recorder name	
<b>TIME</b>	Time of sampling	Not used for dai fishery
<b>BTTYPE</b>	Boat type	only "DAI FISHERY"
<b>GRTYPE</b>	Gear type	4 categories of variable duration: L-YIELD LP = Low Yield Low period H-YIELD LP = High Yield Low period L-YIELD PP = Low Yield Peak Period H-YIELD PP = High Yield Peak Period
<b>BTNO</b>	Number of boats	For dai fishery, n° = "1" (not defined)
<b>GRNO</b>	Number of gears	Only "0" (not defined)
<b>CREW</b>	Number of fishermen	Number of workers
<b>DUR</b>	Total weight resulting from Effort	
<b>BTREG</b>	Sorted by species by the fishermen? (Y/N)	N = no
<b>BTNAME</b>	Boat name	Not defined
<b>SKIPPER</b>	Name of skipper OR No of dai unit/no of row	N° of row (=dai) / Letter of unit in a row  ex: 12E = dai n° 12, 5th bagnet
<b>GROUND</b>	Fishing ground	Not defined
<b>REMARK</b>	Remark	Not defined
<b>KEY</b>	?	Not defined
<b>NOSP</b>	?	Nb of species +1 (for * TOTAL *)
<b>TOTAL</b>	?	Only "TOTAL"
<b>TOTC</b>	Total weight of the sample	= sum of CATCHxx for species xx
<b>TOTV</b>	Total value	= (TOTC x TOTP)
<b>TOTP</b>	Average? sample price (*1000 Riels)	? Sort of average price probably weighted by the importance of the catch or the number of individuals (or variance of prices for this species)
<b>TOTN</b>	Total number of individuals	= sum of NOFISHxx for species xx
<b>SPC01</b>	Rank of this species in the species table	
<b>SPN01</b>	Species name (khmer)	
<b>CATCH01</b>	Weight of this species (kg)	
<b>VALUE01</b>	= value of the catch = CATCHxPRICE	
<b>PRICE01</b>	Value (x1000 riels) per kg	
<b>NOFISH01</b>	Number of individuals of that species	
<b>SPC02</b>		
<b>SPN02</b>		
<b>CATCH02</b>		
<b>VALUE02</b>		
<b>PRICE02</b>		

<b>NOFISH02</b>		
...		
<b>SPC19</b>		
<b>SPN19</b>		
<b>CATCH19</b>		
<b>VALUE19</b>		
<b>PRICE19</b>		
<b>NOFISH19</b>		
<b>SPC20</b>		
<b>SPN20</b>		
<b>CATCH20</b>		
<b>VALUE20</b>		
<b>PRICE20</b>		
<b>NOFISH20</b>		







Year 94 95 95 95 96 96 96 96 96 96 96 97 97 97 97 97 97 98 98 98 98 98 98 99 99 99 99 99 99 0 0 0  
 Month 12 1 2 11 12 1 2 3 10 11 12 1 2 3 11 12 1 2 3 10 11 12 1 2 10 11 12 1 2 3  
 Season 94-95 94-95 94-95 95-96 95-96 95-96 96-97 96-97 96-97 96-97 96-97 97-98 97-98 97-98 97-98 97-98 97-98 98-99 98-99 98-99 98-99 98-99 99-00 99-00 99-00 99-00 99-00 99-00 99-00 99-00 99-00

Xenitodon sp./Dermogenys sp.	0	0	0	0	0	1	0	3103	0	0	0	0	2043	54160	1499	2646	56	1	18384	3985	11	258	187	1057	8513	4007	3316						
Pangasius lamaudii	10184	0	0	701	53436	15840	13924	4519	142	1532	88125	271147	3678	0	4608	14382	44127	3577	12003	159	425	51938	6788	110	1052	3088	62490	209148	3441	309			
Pangasius phtthalmus/sp.	5431	16819	0	10019	108406	30940	30296	12609	15	2862	21570	13792	5262	0	11604	54726	76869	284	580	1049	497	1637	2636	49490	101214	6527	231	0	0				
"Pra iev"	48	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
"Pra ke"	2890	29983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Boesemania microlepis	0	0	0	0	0	0	0	0	0	0	199	0	0	849	774	23503	0	567	132	68	147951	435	672	299	173	65	773	0	0	0			
"Pream"	0	0	0	6	0	0	0	0	107	190	2944	1972	0	0	129	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Leptobarbus hoeveni	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0		
Cirrhinus microlepis	4317	142963	251083	18383	285057	18272	99388	14581	136	11558	87023	165191	4695	7316	15435	30651	38831	90399	27124	154	400	10629	15940	312	347	2780	18497	101981	932	0	0		
Hemicorhynchus sp.	54718	8834115	5543132	1091	732180	2671023	3673552	714164	3799	1673	70529	4543363	512755	1534253	4920	168350	2098013	1078608	418111	1113	1027	1083423	1824014	57259	4437	4637	189133	4889508	100861	38892	0		
Channa marulius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Acantopsis sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Wallago attu	0	0	0	183	103	0	0	0	0	0	695	0	0	0	1214	6453	6101	0	11530	89	30	40	0	79	135	7	257	0	0	0	1051	0	
Puntius brevis	289	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Notopterus notopterus	0	0	0	2204	0	0	0	0	0	94	430	0	0	0	617	1200	0	0	3969	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Paraibaucba typus	31302	1562164	866161	2313	35770	2369812	356394	82946	884	1430	11643	1197731	614696	46276	835	40907	1945643	72850	61526	49	511	673896	524659	17952	1752	2589	33407	454149	61330	17894	0	0	
"Smoeu kantuy"	0	0	0	0	335	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyclocheilichthys apogon/sp.	121	0	0	0	5278	1218	81	0	36	0	1889	79690	1630	0	387	9381	0	189	0	0	0	2000	2941	4	0	2	0	0	1	0	0	0	
Ompok hypophthalmus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	39	110	788	73	5	84	4	2958	0	5	0	0	0	0
Probarbus jullieni	844	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Other species	13620	244855	37142	5280	63039	230554	339605	22301	166	2246	27696	307855	29794	7865	5251	58745	459767	32258	45270	1705	2114	327845	139384	7516	3528	0	105160	309393	12546	3267	0	0	

**ANNEX E**  
**SEASONAL ABUNDANCE OF THE 35 MOST SIGNIFICANT SPECIES**

Code	Latin name	95-96	96-97	97-98	98-99	99-00	Sum 5 years (tons)	Occurrences 5 years
Acant. sp.	Acantopsis sp.	0	0	0	0	153	<b>153</b>	<b>1</b>
Ach. leuco.	Achiroides leucorhynchos	15	135	217	176	172	<b>715</b>	<b>5</b>
Bag. macro.	Bagrichthys macropterus	0	0	0	162	0	<b>162</b>	<b>1</b>
Bar. altus	Barbodes altus	20	8	12	12	134	<b>187</b>	<b>5</b>
Bar. gonio.	Barbodes gonionotus	121	40	59	28	35	<b>283</b>	<b>5</b>
Bel. dinem.	Belodontichthys dinema	1022	136	872	850	361	<b>3241</b>	<b>5</b>
Botia sp.	Botia sp.	931	799	569	393	331	<b>3023</b>	<b>5</b>
Chan. marul.	Channa marulius	0	0	0	0,03	0	<b>0,03</b>	<b>1</b>
Cha. micro.	Channa micropeltes	0	0	0	3	0	<b>3</b>	<b>1</b>
Cir. micro.	Cirrhinus microlepis	436	276	202	27	125	<b>1066</b>	<b>5</b>
Clu. borne.	Clupeoides borneensis	148	114	123	52	38	<b>474</b>	<b>5</b>
Cos. harman.	Cosmochilus harmandi	17	126	16	40	39	<b>238</b>	<b>5</b>
Cyc. apo/sp.	Cyclocheilichthys apogon/sp.	7	83	10	5	0,003	<b>105</b>	<b>5</b>
Cyc. enopl.	Cyclocheilichthys enoplos	1054	86	365	231	98	<b>1835</b>	<b>5</b>
Dang. sp	Dangila sp.	2000	1077	776	219	215	<b>4287</b>	<b>5</b>
Dan. spilo.	Dangila spilopleura	0	0	230	0	820	<b>1050</b>	<b>2</b>
Gyr. aymon.	Gyrinocheilus aymonieri	218	19	273	463	148	<b>1121</b>	<b>5</b>
Henic. sp.	Henicorhynchus sp.	7792	6666	3758	2967	5228	<b>26411</b>	<b>5</b>
Lep. hoeve.	Leptobarbus hoeveni	0	0	0	0	13	<b>13</b>	<b>1</b>
Micro. sp.	Micronema sp.	84	29	32	97	98	<b>338</b>	<b>5</b>
Mor. chrys.	Morulus chrysophekadion	413	571	520	183	417	<b>2105</b>	<b>5</b>
Mystus spp.	Mystus spp.	5	9	55	24	15	<b>108</b>	<b>5</b>
Omp. hypop.	Ompok hypophthalmus	0	0	0	1	3	<b>4</b>	<b>2</b>
Ost. hasse.	Osteochilus hasselti	202	1753	878	151	38	<b>3021</b>	<b>5</b>
Ost. melan.	Osteochilus melanopleurus	109	186	114	145	217	<b>771</b>	<b>5</b>
Pan. hypop.	Pangasius hypophthalmus/sp.	192	44	157	66	162	<b>620</b>	<b>5</b>
Pan. lanau.	Pangasius larnaudiei	88	365	79	59	280	<b>871</b>	<b>5</b>
Pan. siam./sp.	Pangasius siamensis/sp.	145	348	266	126	194	<b>1079</b>	<b>5</b>
Par. typus	Paralaubuca typus	2847	1873	2122	1217	571	<b>8630</b>	<b>5</b>
Pri. fasci.	Pristolepis fasciata	0,6	0	0	0	0	<b>1</b>	<b>1</b>
Pun. proct.	Puntioplites proctozysron	527	155	354	104	466	<b>1607</b>	<b>5</b>
Set. melan.	Setipinna melanochir	0	0	0	6	103	<b>109</b>	<b>2</b>
Sik. gudge.	Sikukia gudgeri	138	140	69	13	67	<b>427</b>	<b>5</b>
Sys. orpho.	Systemus orphoides	4,2	94	1,7	0,9	1,5	<b>102</b>	<b>5</b>
Thy. thynn.	Thynnichthys thynnoides	676	897	900	336	275	<b>3084</b>	<b>5</b>
	<b>Sum 5 years (tons)</b>	<b>19213</b>	<b>16027</b>	<b>13030</b>	<b>8158</b>	<b>10815</b>		
	<b>Occurrences 5 years</b>	<b>27</b>	<b>26</b>	<b>27</b>	<b>31</b>	<b>31</b>		