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)*.

CONTENTS

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*.
- *Systomus 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) in 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 "Kryptophterus cryptophterus" 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* "

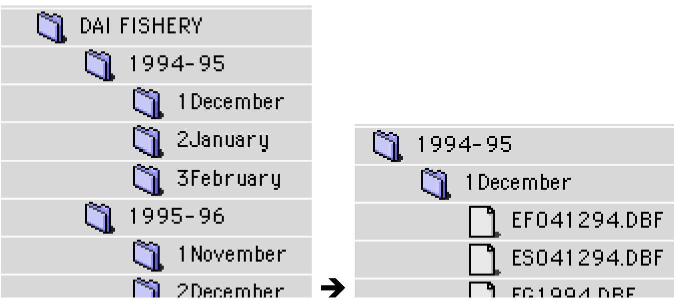
Annex A gives the table for Khmer and scientific names of fish as used in the Artfish software, and updated "correct" ones.

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*[1] and *Pangasius micronema*[2]. 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[3] 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:



[1] *Pangasionodon hypophthalmus* is an invalid synonym of *Pangasius hypophthalmus* (Sauvage 1878) according to Roberts & Vidthayanon (1991)
[2] *Pangasius micronema* is usually known as *Pangasius micronemus*, being called P. micronema in one taxonomic publication among nine only.
[3] 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 ≈ 120 unit files (5 years x 12 months x 1 or 2 sites) plus ≈ 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:

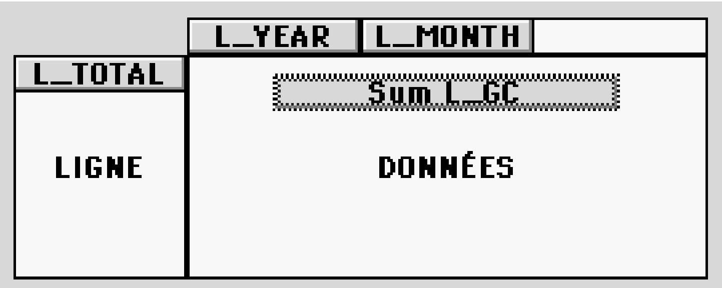
L_BTTYPE	L_GRTYPE
<ALL BOATS>	<ALL GEARS>
DAI LP	DAI LP
DAI PP	DAI PP
DAI THOM LP	DAI THOM LP
DAI THOM PP	DAI THOM PP
DAI TOCH LP	DAI TOCH LP
DAI TOCH PP	DAI TOCH PP
BOAT DAI PP	LIFT NET PP
BOAT DAI LP	LIFT NET LP
HIGH CATCH	
DAI FISHERY	H-YIELD LP
DAI FISHERY	H-YIELD PP
DAI FISHERY	L-YIELD LP
DAI FISHERY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



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/KROM0~~
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 CHRUK~~	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
	KAMPHLEANH	Trichogaster microlepis
	KAMPHLIEV	Kryptophterus cryptophterus
	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:

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:

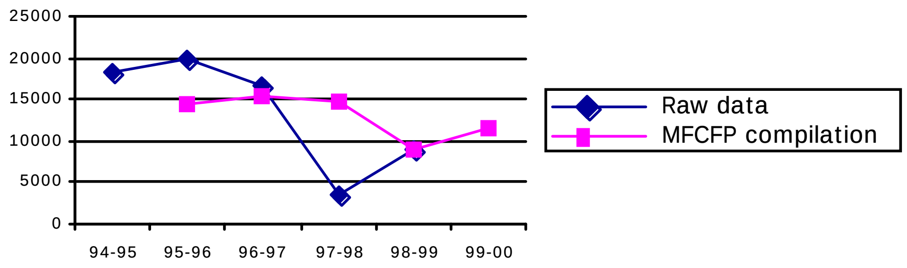
Year	Month	Raw data	MFCFP compilation
1994	12	280	-
1995	1	10699	-
	2	7428	-
	11	126	128
	12	3634	386
1996	1	9410	5379
	2	5747	6968
	3	1053	1569
	10	-	8
	11	68	71
	12	882	363
1997	1	12336	10104
	2	1711	1581
	3	1829	3361
	11	92	91
	12	989	978

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[4]), 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.

[4] 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

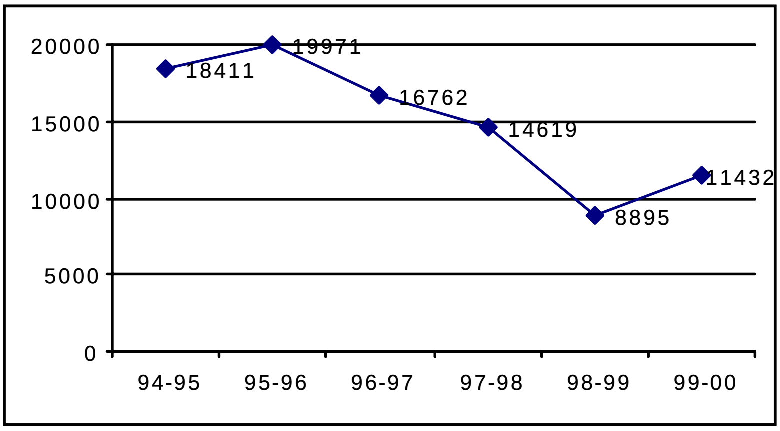
This analysis is based on raw data whenever available, supplemented (for missing data) by the re-assessed figures for October 1996, January 1998 and the whole 1999-2000 season.

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

<u>Note:</u> 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

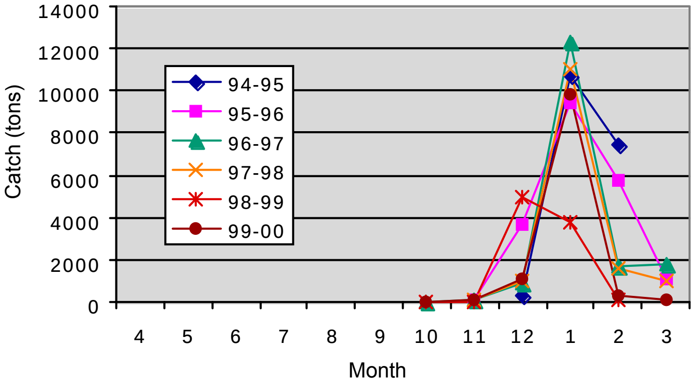
1.1- Total catches



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).

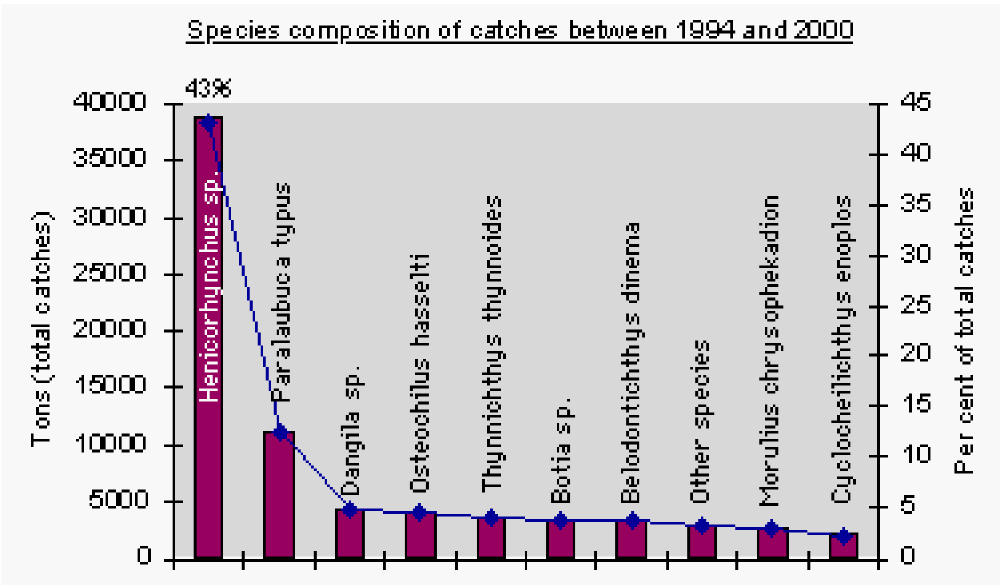
The monthly pattern is next:

<u>Monthly distribution of dai catches</u>



1.2- Catches of the 10 most important species

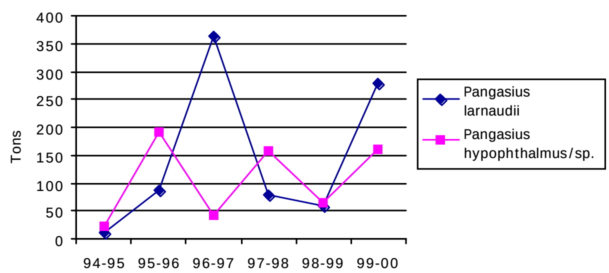
Latin name	Khmer name	Sum (tons)	Per cent
Henicorhynchus sp.	Riel	38843	43,1
Paralaubica typus	Sloeuk Russey	11089	12,3
Dangila sp.	Khnang Veng	4287	4,8
Osteochilus hasselti	Kros	4000	4,4
Thynnichthys thynnoides	Linh	3599	4,0
Botia sp.	Kanh Chrouk	3293	3,7
Belodontichthys dinema	Khlang Hai	3244	3,6
Other 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

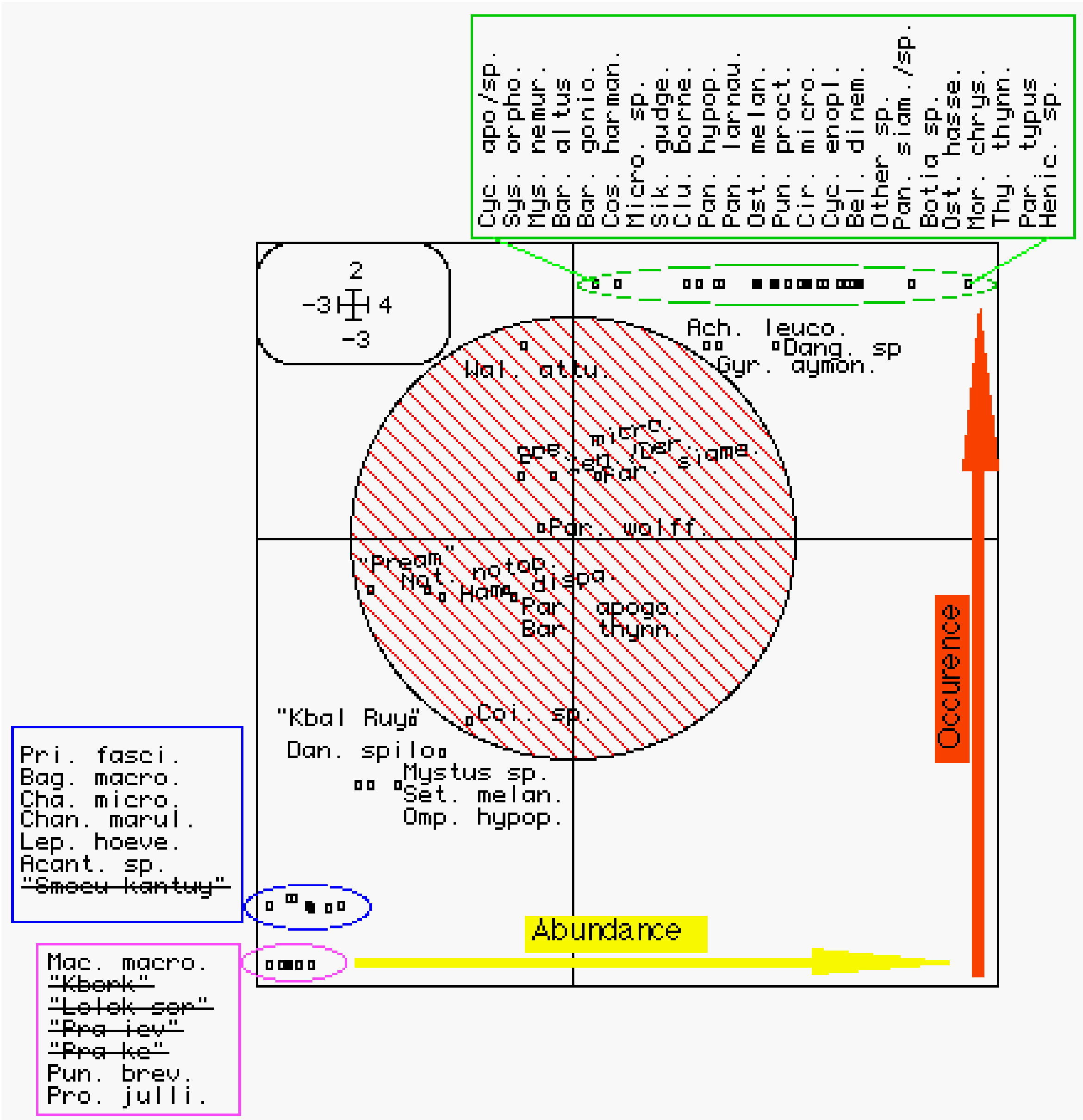
Some species are just met once or twice, in small quantities. Thus their number is not significant, they do not bear much quantitative information and they are represented by rows of (mostly) zeros, which biases the total inter-correlations. They must be removed prior to analyses. Several methods for "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 ➔ 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.

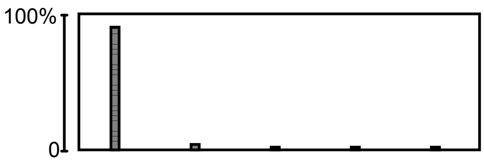
Performed analysis: non centred Principal Components Analysis.

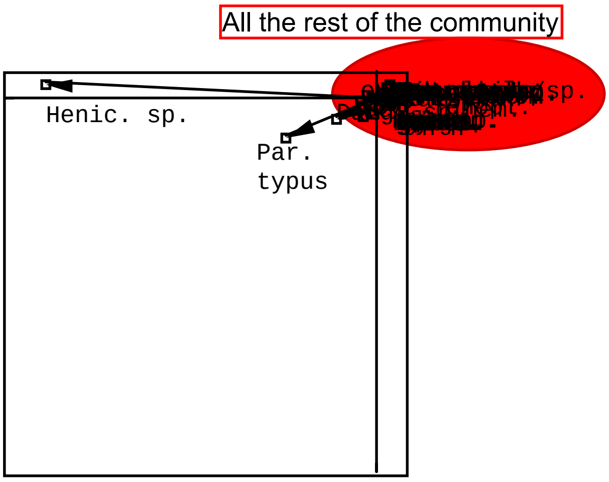
PCA is relevant for abundance data, centring and normalising are not necessary (one common unit only).

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

<u>Analysis of axis 1 & 2</u>

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

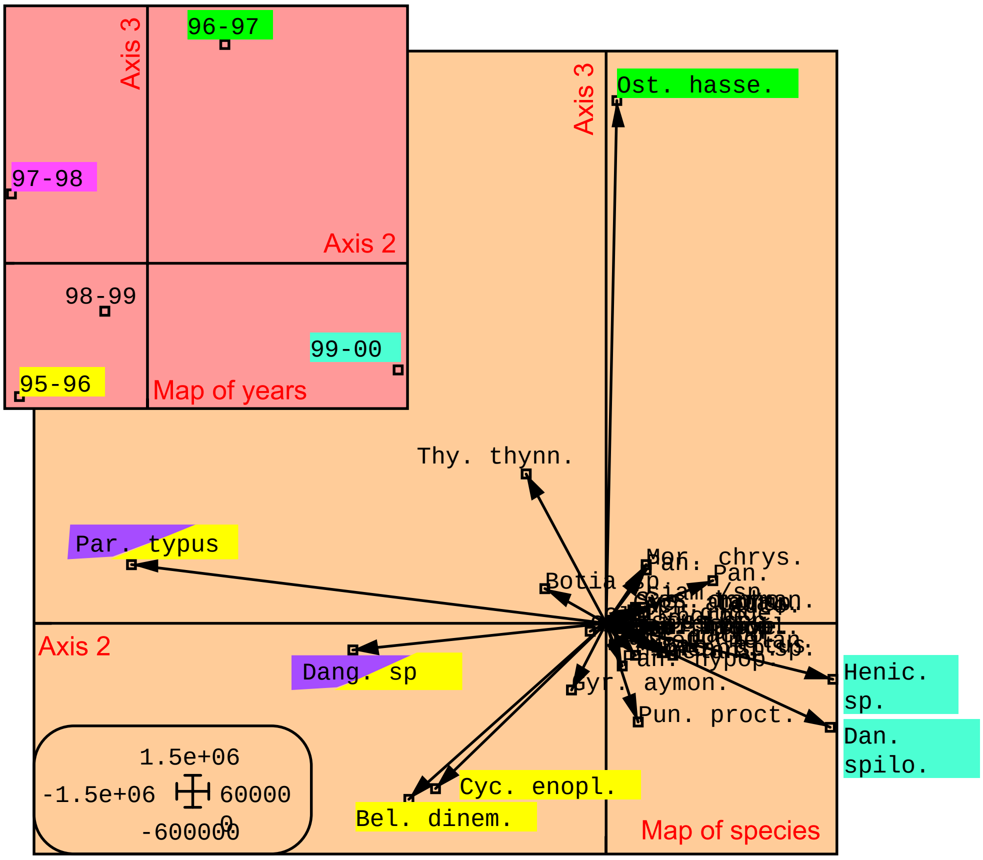




Interpretation:

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:

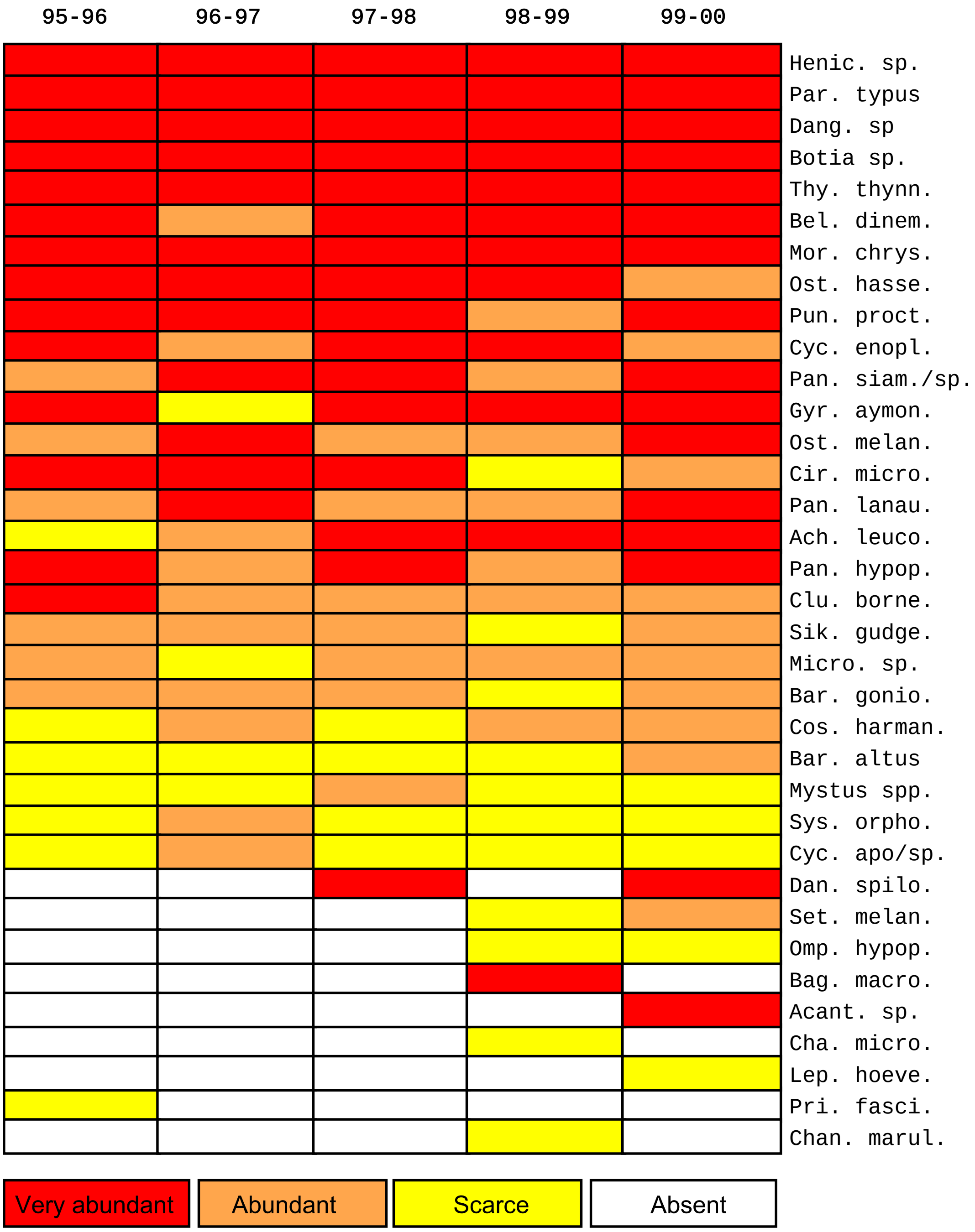
This analysis outlines the correlation between certain species and certain years (here is the same colour in both maps). Axis 1 above focused on total abundances, here axes 2 and 3 focus on relative abundances and particular distributions. The analysis points out the particular abundance of *Osteochilus 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.

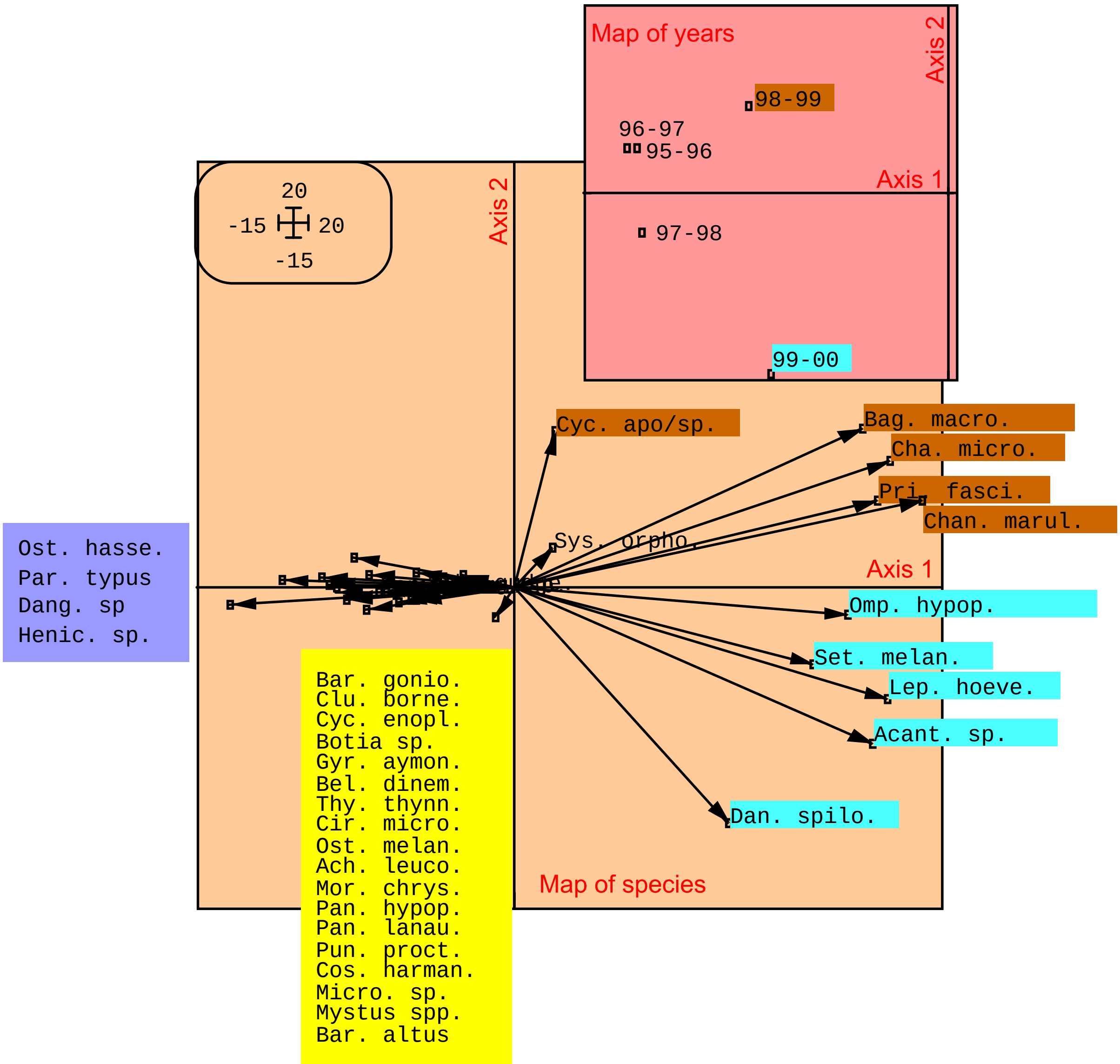
Analysis on log-transformed abundance data

Transformation [x ➔ 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.



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

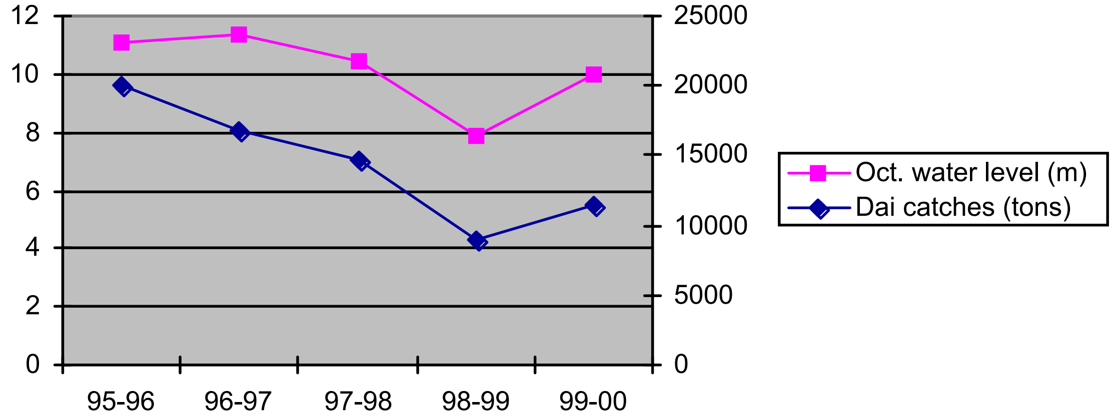
	MRC Hydrology Unit	Project data set 1	Project data set 2
1994	11,1	10,92	10,92
1995	11,1	11,1	11,1
1996	11,4	11,4	11,4
1997	10,4	10,4	10,4
1998	No data	10,4	7,9
1999	No data	7,9	10,0

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.

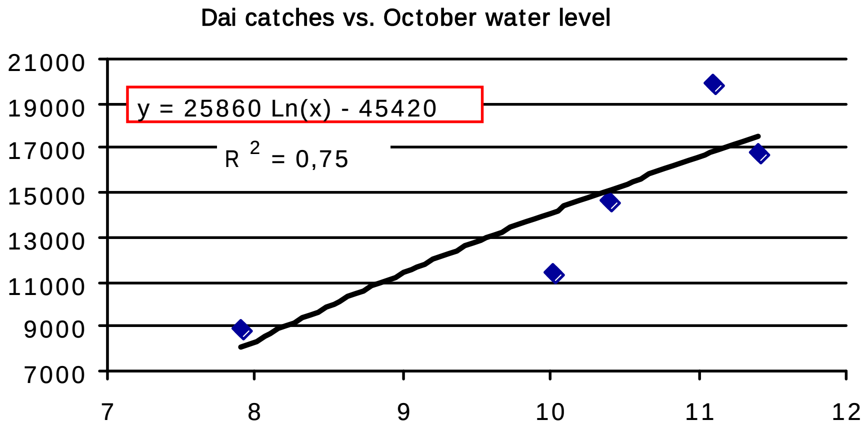
Incidentally, we have been provided the Kampong Chhnang alternative hydrological data set entitled "Hydrological observation book" and corresponding to the new gauge height, but measurements only cover the October 99 - February 2000 period.

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.

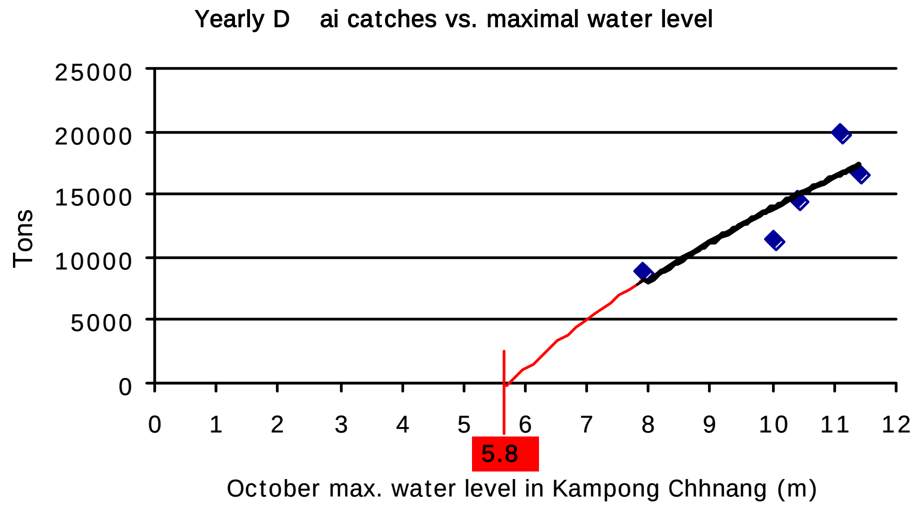


In that case, the equation is:

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

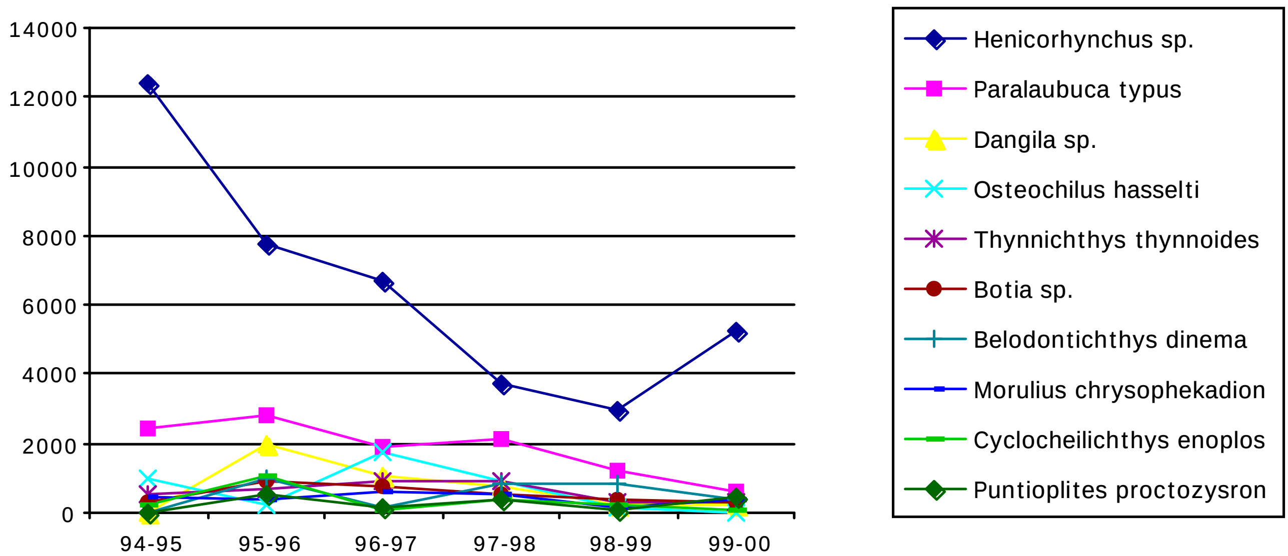
Therefore, nil catches corresponds to
Ln(x) = 45420/25860 => x = Exp(1.756) = 5,79 m

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.



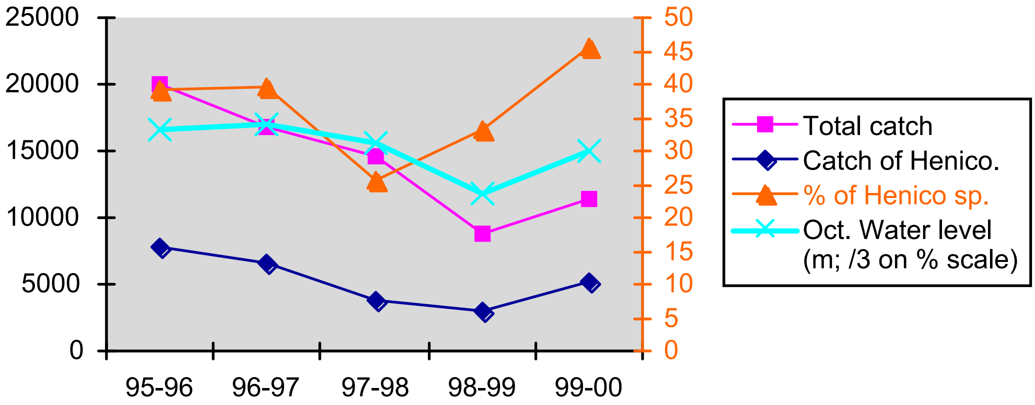
Compared to the average October water height of these five last years, this predicted nil catch would correspond to a reduction of the water height by 57% (but only a reduction of 27 % of the water level experienced two years ago).

3.2- Detailed trends for the 20 first groups

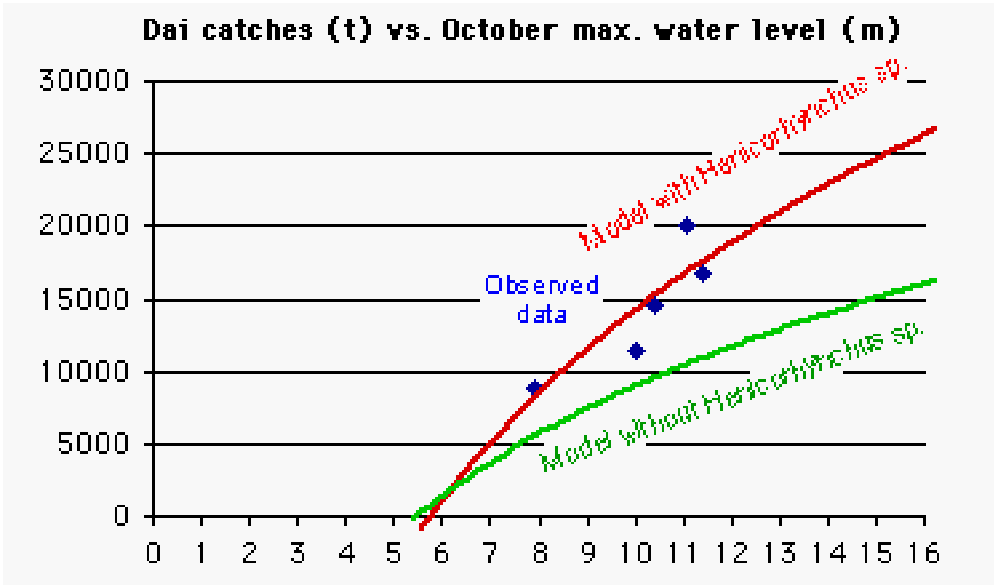


<u>Conclusion</u>: a major part of the excellent correlation between water levels and total catch is due to *Henicorhynchus sp.* only (*H. siamensis* and possibly *H.cryptopogon* and *H. caudimaculatus*, according to Rainboth 1996).

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
$Catch_Y = f^n (L_Y; L_{Y-1}, L_{Y-2}, L_{Y-3})$:

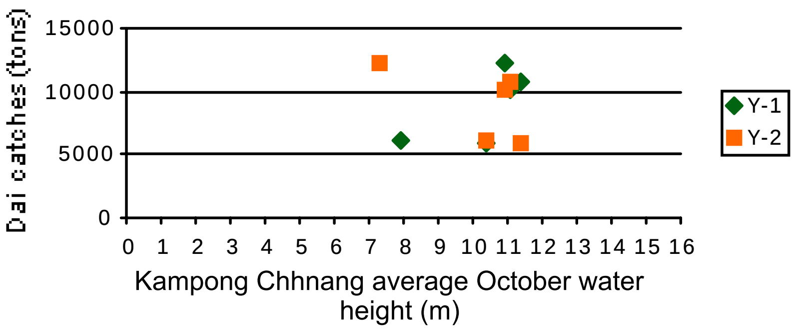
Note: this calculation is made on total catch data except *Henicorhynchus sp.*, to avoid a bias due to this dominant taxon whose response masks that of other species.

```
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.

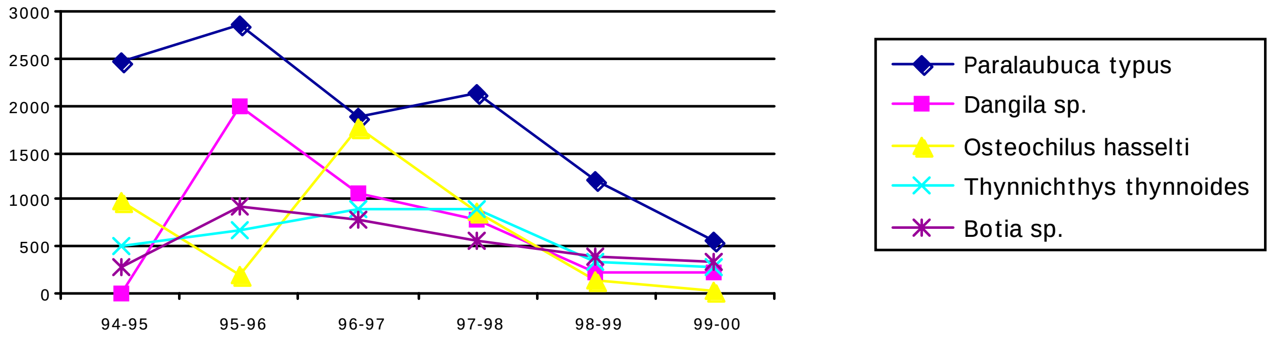
Given that we are not here within the theoretical limits of this linear statistical approach, we prefer plotting the catch as a function of the water level one or two years before (figure below).

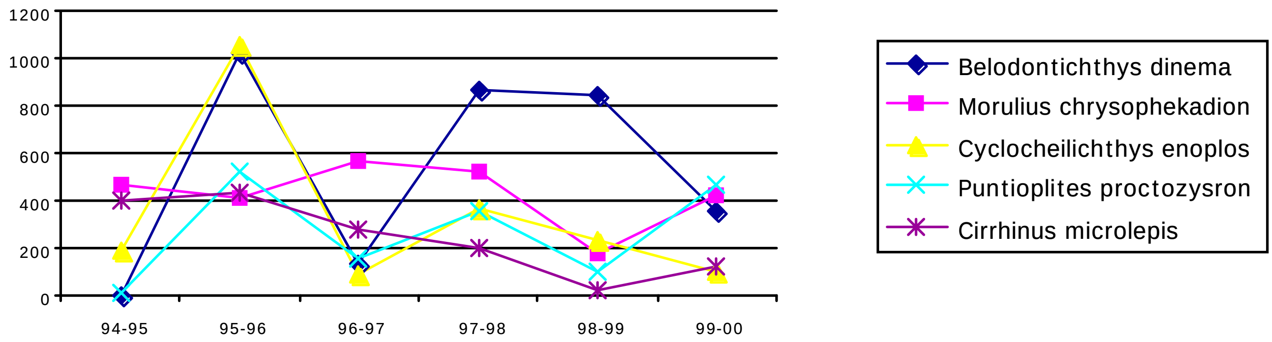
Dai catches (except Henico. sp) VS. water level one year (Y-1) or two years before (Y-2)

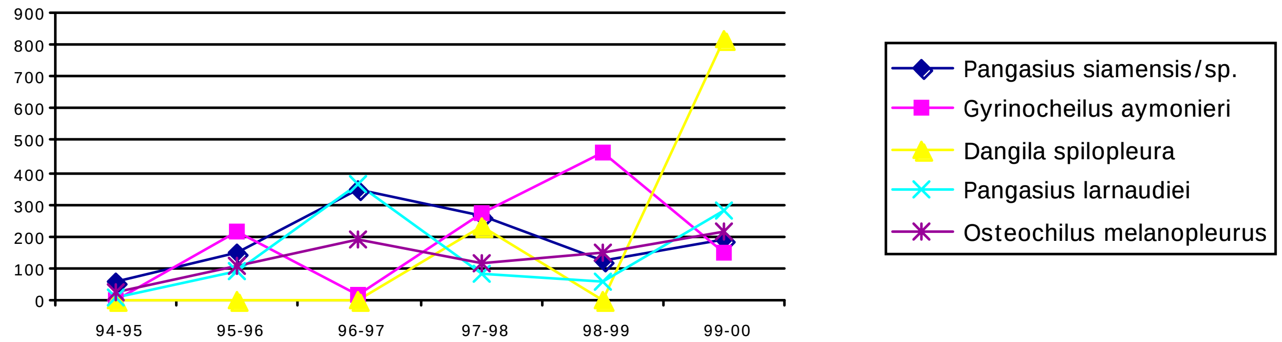


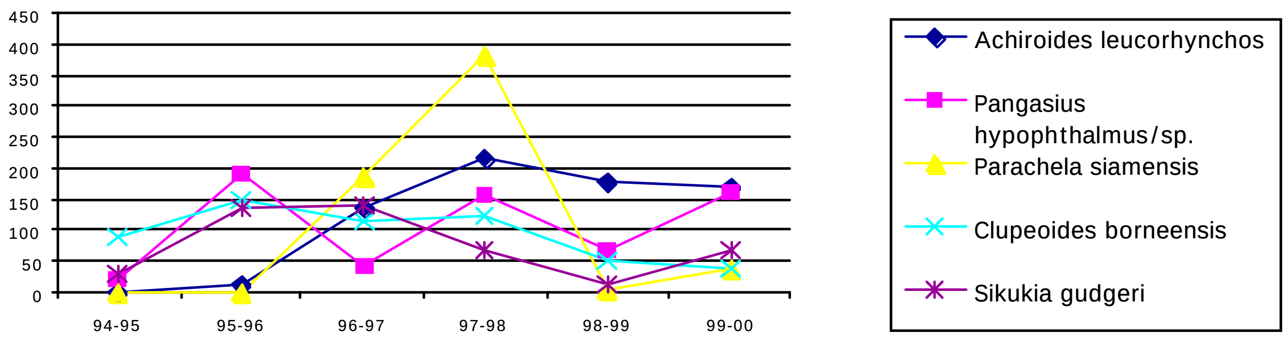
Conclusion: No visible relationship

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

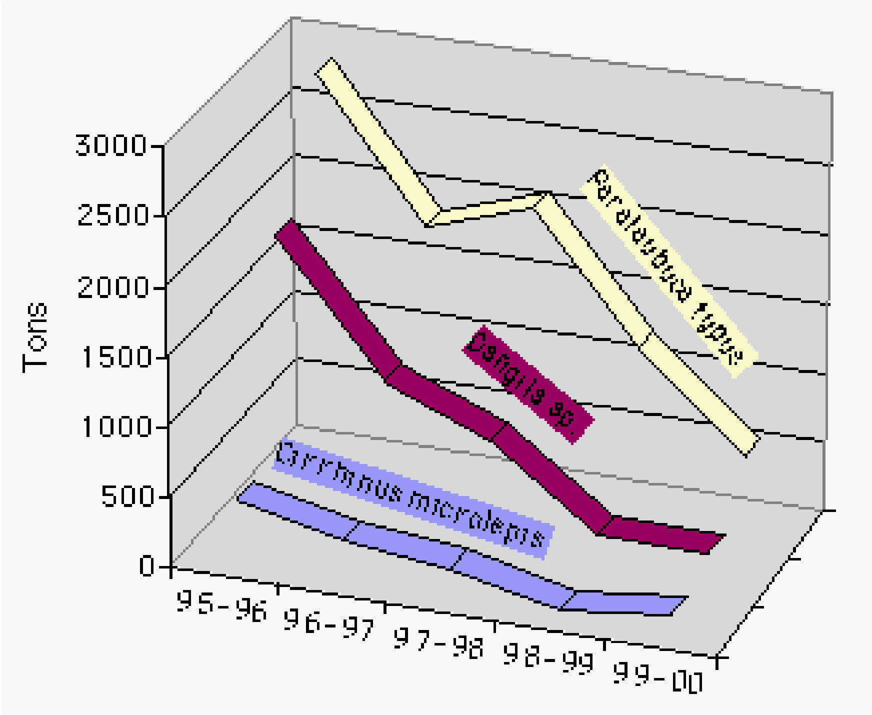

3000
2500
2000
1500
1000
500
0
94-95
95-96
96-97
97-98
98-99
99-00
Paralaubuca typus
Dangila sp.
Osteochilus hasselti
Thynnichthys thynnoides
Botia sp.


1200
1000
800
600
400
200
0
94-95
95-96
96-97
97-98
98-99
99-00
Belodontichthys dinema
Morulius chrysophekadion
Cyclocheilichthys enoplos
Puntioplites proctozysron
Cirrhinus microlepis


900
800
700
600
500
400
300
200
100
0
94-95
95-96
96-97
97-98
98-99
99-00
Pangasius siamensis/sp.
Gyrinocheilus aymonieri
Dangila spilopleura
Pangasius larnaudiei
Osteochilus melanopleurus


450
400
350
300
250
200
150
100
50
0
94-95
95-96
96-97
97-98
98-99
99-00
Achiroides leucorhynchos
Pangasius hypophthalmus/sp.
Parachela siamensis
Clupeoides borneensis
Sikukia gudgeri

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:

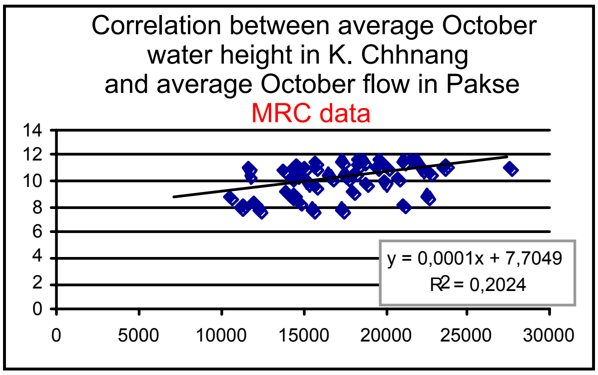
Year	Average Oct. water height in K Chhnang (source: MRC Hydrology Unit)	Average Oct. water height in K Chhnang (source: MFCFP, 25/7/00)
1925	10,9	
1929	11,7	
1935	11,0	11,1
1936		10,4
1941		10,9
1945	11,3	
1946		11,7
1956		10,1
1961	11,1	
1962	10,6	
1963	8,8	
1964	8,8	
1970		9,02
1971	9,1	
1972		9,08
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

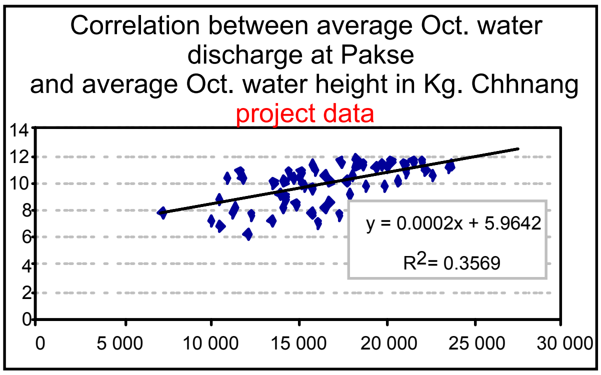
The origin of MFCFC hydrological data missing at the MRC Hydrology Unit is not known. Surprisingly, some years present in MRC data are not present in the MFCFP data set.

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

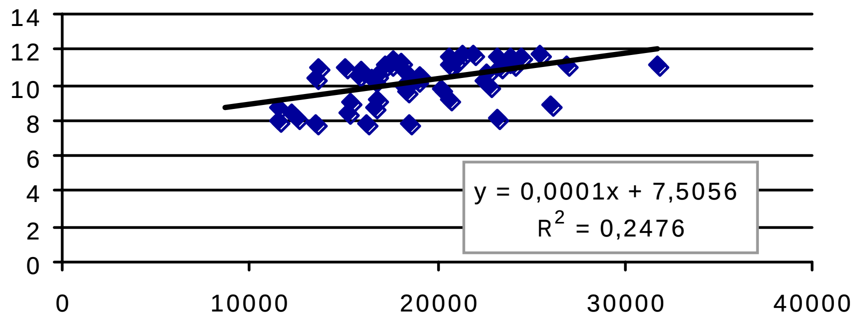




Conclusion: poor correlation, probably due to the distance between the two sites, and to the interference of other sub-basins between the two sites.

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:

Average October water height in K. Chhnang
vs.
average flow in Pakse between 26/9 and 26/10 (from 1923 to 1998)

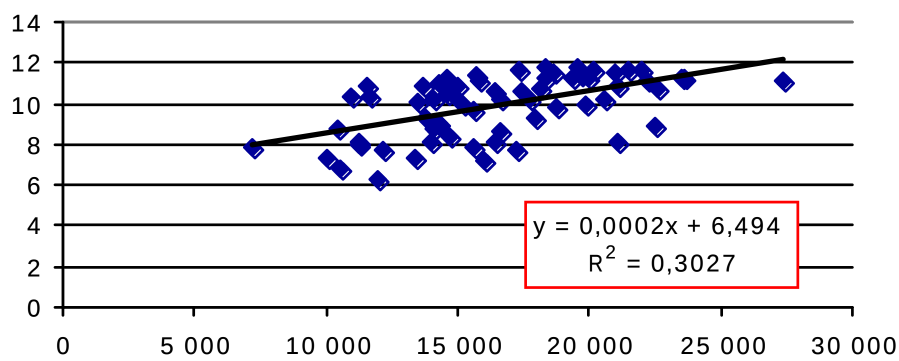


Conclusion: insufficient correlation.

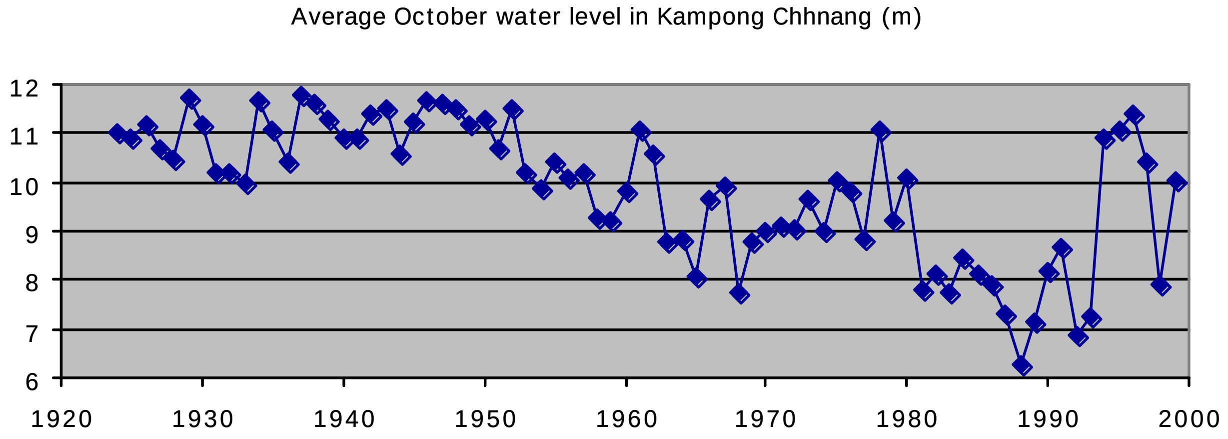
It has also been suggested
- to correlate October water heights in K. Chhnang with September average flow in Pakse, but i) the correlation is not different (R^2 = 0.360 instead of 0.357) and ii) this is in contradiction with the time needed for the flow to come from Pakse to Phnom Penh (about five days 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
(m3/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:



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.

<u>Examples:</u>
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

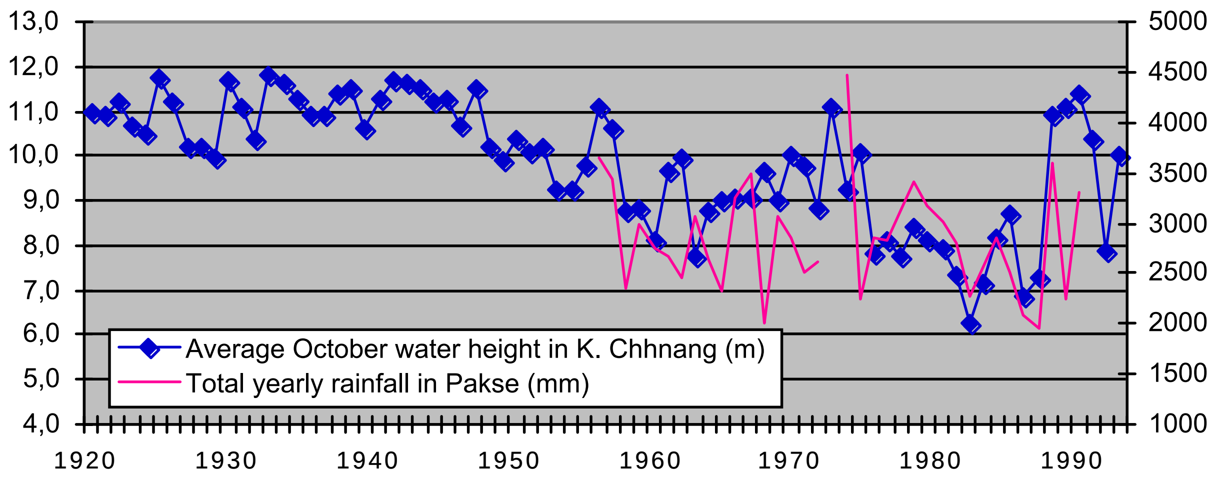
Note:
• Similar precipitation data files are not in the same format (e.g.: 040704.PTO and 040704.PTO below), the most common format being not easily usable without the original software.

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

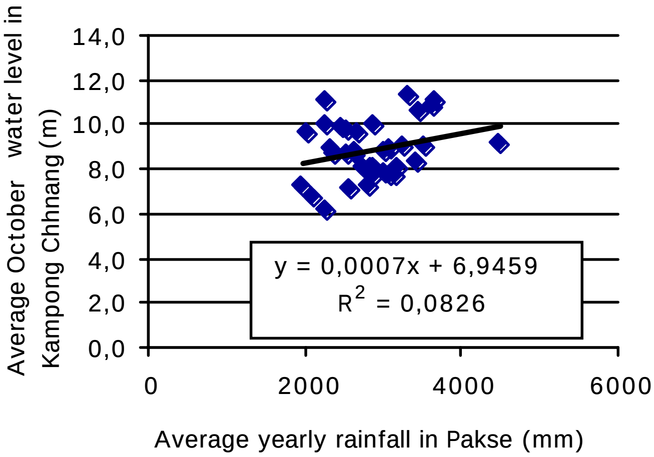
140703	PH3 1
01/06/1927	13.100
02/06/1927	6.000
03/06/1927	6.700
04/06/1927	2.900
05/06/1927	1.200
06/06/1927	0.000
07/06/1927	0.000
08/06/1927	1.000
09/06/1927	0.800

• 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:



Average October water level in Kampong Chhnang (m)
14,0
12,0
10,0
8,0
6,0
4,0
2,0
0,0
0
2000
4000
6000
y = 0,0007x + 6,9459
R2 = 0,0826
Average yearly rainfall in Pakse (mm)

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

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

Modified Khmer names-Latin names conversion table

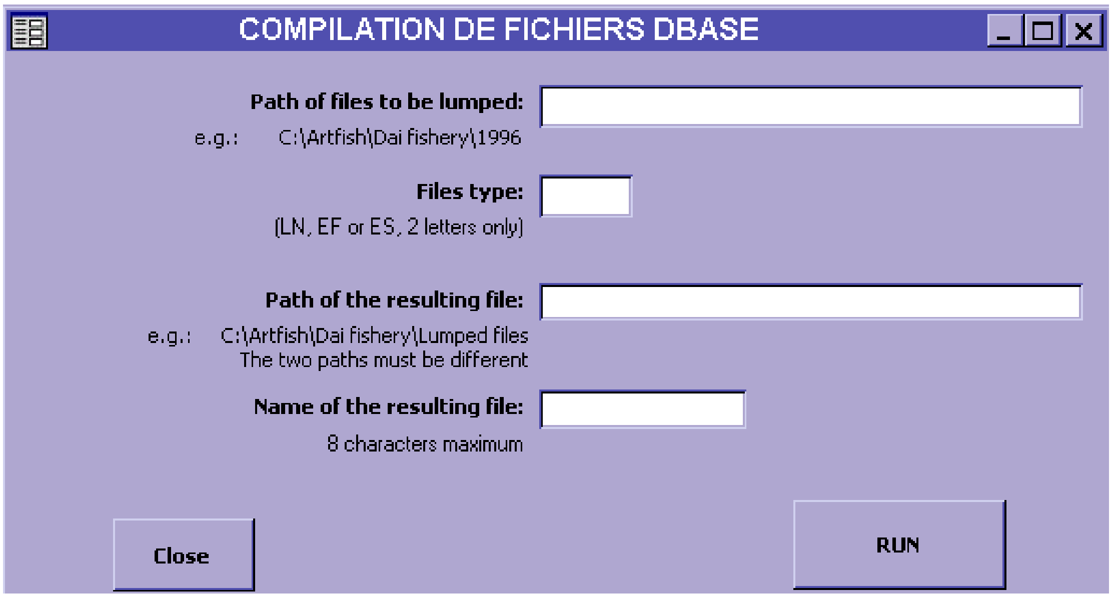
In yellow: modified
In red: to be modified

Scientific name	Species in Khmer	Code	Rainboth 1996
Acantopsis sp.	RUSCHEK	Acant. sp.	p. 136
Achiroides leucorhynchos	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
~~Barbichthys thynnoides~~	PHKAKOR	~~Bar. thynn.~~	
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
Labiobarbus siamensis	ARCH KOK	Lab. siam.	p. 110
"Ambong"	*AMBONG*	*"Ambong"*	
"Chhlang krobey"	*CHHLANG KROBEY*	*"Chhlang Krobey"*	
"Kbal ruy"	*KBAL RUY*	*"Kbal Ruy"*	
Gammaridae	*KAMPEUS*	*Gammar .*	
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
Kryptopterus cryptopterus	KAMPHLIEV	Kry. crypt.	n° 5 p. 146
Labeo erythropterus	PAVA	Leb. eryth.	p. 112
Leptobarbus hoeveni	PROLOUNG	Lop. hoeve.	p. 74
Macrobrachium	BANG KORNG	Macrob.	
Macrochirichthys macrochirus	DANG KHTENG	Mac. macro.	p. 67
Macrognathus siamensis	CHHLONH	Mac. siame.	p. 179
Mekongina erythrospila	PASEE	Mek. eryth.	p. 122
Micronema sp.	KES	Micro. sp.	n° 3 p.148
Tetraodon leiurus	KAMPOT	Tetr. leiu.	n° 8 p. 225
Labeo chrysophekadion	KAEK	Lab. chrys.	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

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

'utliser 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
```

```
            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

	Meaning	*Special case of dai fishery*
DOC	N° of the data page (per month)	
SEQ	?	Only "0"
LSITE	Landing site	2 landing sites
MNSTRAT	Landing minor stratum	Usually 2 minor identical strata identical to sites (redundancy)
DAY	N° of day of the month	
MONTH	N° of the month	
YEAR	Year	
RECORD	Number of the page (per day)	
RECNAME	Recorder name	
TIME	Time of sampling	Not used for dai fishery
BTTYPE	Boat type	only "DAI FISHERY"
GRTYPE	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
BTNO	Number of boats	For dai fishery, n° = "1" (not defined)
GRNO	Number of gears	Only "0" (not defined)
CREW	Number of fishermen	Number of workers
DUR	Total weight resulting from Effort	
BTREG	Sorted by species by the fishermen? (Y/N)	N = no
BTNAME	Boat name	Not defined
SKIPPER	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
GROUND	Fishing ground	Not defined
REMARK	Remark	Not defined
KEY	?	Not defined
NOSP	?	Nb of species +1 (for * TOTAL *)
TOTAL	?	Only "TOTAL"
TOTC	Total weight of the sample	= sum of CATCHxx for species xx
TOTV	Total value	= (TOTC x TOTP)
TOTP	Average? sample price (*1000 Riels)	
TOTN	Total number of individuals	= sum of NOFISHxx for species xx
EFF		
AVUSE		
BCPUE	Catch per Boat Unit effort	= GCPUE for dais
VBCPUE		
CVBCPUE		
BCPUE1		
BCPUE2		
GCPUE	Catch per Gear Unit effort	= BCPUE for dais
VGCPUE		
CVGCPUE		
GCPUE1		
GCPUE2		

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

Structure of Artfish Landing files and fields contents

	Meaning	*Special case of dai fishery*
DOC	N° of the data page (per month)	
SEQ	?	Only "0"
LSITE	Landing site	2 landing sites
MNSTRAT	Landing minor stratum	Usually 2 minor identical strata identical to sites (redundancy)
DAY	N° of day of the month	
MONTH	N° of the month	
YEAR	Year	
RECORD	Number of the page (per day)	
RECNAME	Recorder name	
TIME	Time of sampling	Not used for dai fishery
BTTYPE	Boat type	only "DAI FISHERY"
GRTYPE	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
BTNO	Number of boats	For dai fishery, n° = "1" (not defined)
GRNO	Number of gears	Only "0" (not defined)
CREW	Number of fishermen	Number of workers
DUR	Total weight resulting from Effort	
BTREG	Sorted by species by the fishermen? (Y/N)	N = no
BTNAME	Boat name	Not defined
SKIPPER	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
GROUND	Fishing ground	Not defined
REMARK	Remark	Not defined
KEY	?	Not defined
NOSP	?	Nb of species +1 (for * TOTAL *)
TOTAL	?	Only "TOTAL"
TOTC	Total weight of the sample	= sum of CATCHxx for species xx
TOTV	Total value	= (TOTC x TOTP)
TOTP	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)
TOTN	Total number of individuals	= sum of NOFISHxx for species xx
SPC01	Rank of this species in the species table	
SPN01	Species name (khmer)	
CATCH01	Weight of this species (kg)	
VALUE01	= value of the catch = CATCHxPRICE	
PRICE01	Value (x1000 riels) per kg	
NOFISH01	Number of individuals of that species	
SPC02		
SPN02		
CATCH02		
VALUE02		
PRICE02		

NOFISH02		
…		
SPC19		
SPN19		
CATCH19		
VALUE19		
PRICE19		
NOFISH19		
SPC20		
SPN20		
CATCH20		
VALUE20		
PRICE20		
NOFISH20		

ANNEX D
REFERENCE COMBINED TABLE USED IN FINAL ANALYSES

Year	94	95	95	95	95	96	96	96	96	96	96	97	97	97	97	97	98	98	98	98	98	98	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	95-96	95-96	96-97	96-97	96-97	96-97	96-97	96-97	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
Latin name	**Dec.94**	**Jan.95**	**Feb.95**	**Nov.95**	**Dec.95**	**Jan.96**	**Feb.96**	**Mar.96**	**Oct.96**	**Nov.96**	**Dec.96**	**Jan.97**	**Feb.97**	**Mar.97**	**Nov.97**	**Dec.97**	**Jan.98**	**Feb.98**	**Mar.98**	**Oct.98**	**Nov.98**	**Dec.98**	**Jan.99**	**Feb.99**	**Oct.99**	**Nov.99**	**Dec.99**	**Jan.00**	**Feb.00**	**Mar.00**
Systomus orphoides	482	0	0	1101	347	314	220	2203	43	0	885	92654	460	0	0	839	0	811	0	193	0	22	676	19	0	231	1313	0	4	0
Achiroides leucorhynchos	0	0	0	1346	0	9911	3519	0	53	2122	37165	80807	15233	0	2412	10780	145045	8308	50090	1637	3106	148104	14551	8905	4835	4749	32215	111546	13794	4529
Dangila spilopleura	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25220	137782	18195	48767	0	0	0	0	0	3378	2460	63567	703700	29000	17863
Clupeoides borneensis	531	10812	76513	0	1459	56551	75123	15268	57	1336	1405	83705	15422	11706	0	7201	99707	6282	9735	372	456	36483	12605	1921	3541	1725	2112	12709	15528	1978
Parachela siamensis	0	0	0	0	0	0	0	0	82	0	2035	185020	0	0	370	6152	354592	7931	14271	0	44	1308	3628	3	28	42	0	36815	96	4
Coilia sp.	0	1816	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	66	388	53755	17618	1287	1309	1225	9950	111280	2296	4
Bagrichthys macropterus	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	32	401	143363	16418	2048	0	0	0	0	0	0
Channa micropeltes	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2928	0	0	0	0	0	0	0	0
Cyclocheilichthys enoplos	37519	70465	83942	26411	519557	431405	59817	17272	31	5719	57958	19321	3075	0	7281	88240	241473	11933	15878	661	1590	100952	126537	1392	1663	3026	55270	33391	3929	1036
Mystus nemurus	381	0	11143	0	309	0	2373	2203	2	30	7882	268	843	0	4782	23303	26569	589	95	60	150	9950	10489	4	777	1127	5045	2635	427	323
Setipinna melanochir	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	25	190	3236	2019	273	162	419	3707	96224	1530	797
Barbodes gonionotus	1109	0	0	12036	99398	299	6831	2203	11	5976	32002	1932	77	0	5561	37026	13731	2536	0	581	582	21874	5204	144	2335	1651	19820	10484	760	0
Pangasius siamensis/sp.	1013	55479	0	1608	12093	108460	21154	1969	151	465	15445	320428	11216	0	2127	32965	222951	3215	5009	115	279	110467	11503	3882	480	1194	46251	138760	5298	1638
Puntioplites proctozysron	5011	655	0	16919	393580	46863	63253	6608	49	7669	91054	51315	4912	0	7576	90937	244498	7177	3875	1237	1445	95313	5808	510	1523	2845	67177	391155	3107	606
Gyrinocheilus aymonieri	0	0	0	3	1889	197280	17027	1544	10	208	3755	7075	4488	3475	140	3343	256003	11018	2457	135	503	305459	153014	3498	209	678	3401	139654	4183	183
Macrochirichthys macrochirus	5143	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
Morulius chrysophekadion	16821	420480	34171	2448	217834	127003	56237	9922	246	5808	31469	523959	9326	0	3012	41595	444000	9830	21926	408	306	138944	42263	1071	2346	4576	62773	329801	15302	2365
Barbodes altus	699	9461	0	37	6181	4478	6330	3314	3	18	1971	4399	1684	0	458	6070	5000	778	0	63	24	8998	2735	26	36	422	13222	119468	1004	88
Parambassis apogoniodes	0	0	0	0	900	35250	0	257	11	376	5112	6749	2108	6036	0	1863	116591	2328	1796	0	0	0	0	0	0	0	0	0	0	0
Sikukia gudgeri	10442	15872	3714	2	26009	97743	12935	1029	59	0	15232	107795	17018	0	221	13589	55000	500	189	0	414	7993	4911	57	80	21	883	64947	640	11
Cosmochilus harmandi	3826	0	0	216	9787	1760	4944	0	52	0	15768	109788	230	0	296	11907	0	618	2930	0	42	5767	33506	917	31	452	8567	29763	569	0
Pristolepis fasciata	0	0	0	0	607	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
Mystus sp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	69	84	2681	619	2	294	406	3786	53	132	40
Botia sp.	4413	171172	94342	0	41301	378775	471244	39487	373	335	4271	670687	93437	29632	569	12725	496122	38986	20981	121	252	233703	155023	3500	922	1197	21631	284356	19807	3502
Parambassis wolffi	506	2902	0	0	5000	33218	15009	5517	1	40	187	1769	153	366	0	258	75619	0	0	0	0	0	0	0	0	0	0	0	0	0

"Kbal ruy"	0	0	0	0	0	0	0	0	16	98	25	12068	19513	732	0	65	22481	0	0	0	0	0	0	0	0	0	0	0	0	0
"Kbork"	675	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
Micronema sp.	820	81994	0	5418	52393	13469	9087	3314	12	1124	7223	18282	77	1829	1400	5226	22481	0	2552	241	59	74432	21795	294	233	547	22918	73627	24	380
Belodontichthys dinema	3407	0	0	5579	32456	984310	0	0	47	6009	67009	38315	24804	0	3017	76333	789963	1711	662	848	1349	657428	188739	1565	2823	4657	55968	293941	3360	0
Hampala dispar	0	0	0	0	0	0	0	0	1	1242	540	0	0	0	1234	2323	0	0	3402	0	0	11	2149	0	0	0	0	0	0	0
Dangila sp.	0	0	0	283	810071	999617	183079	6519	475	2025	6811	1058721	8796	0	14	21152	612106	40491	102638	201	412	80768	137481	66	211	206	8219	198483	7621	570
Osteochilus melanopleurus	18281	7358	0	12829	46474	22498	23234	4406	64	5603	85519	94168	690	0	6288	21389	74661	4354	7183	386	1179	52870	90078	175	7415	2186	49191	157169	841	0
Osteochilus hasselti	41672	542736	394452	0	25743	62387	68901	44805	864	0	64043	1316319	200931	170473	106	59926	697986	93076	26935	14	120	88492	61756	925	20	170	12433	21997	2832	200
Thynnichthys thynnoides	2556	479249	33428	0	46883	462118	133459	33685	405	145	971	817421	69214	8963	0	11099	833812	34387	20603	127	157	176092	156449	2849	77	1275	9544	249290	11718	2916
"Lolok sor"	965	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
Barbichthys thynnoides	0	0	0	0	0	0	0	0	45	7	13127	58620	33174	0	0	9056	245963	4543	0	0	67	1684	4760	63	0	0	0	0	0	0

Year	94	95	95	95	95	96	96	96	96	96	96	97	97	97	97	97	98	98	98	98	98	98	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	95-96	95-96	96-97	96-97	96-97	96-97	96-97	96-97	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
Xenentodon sp./Dermogenys sp.	0	0	0	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 larnaudii	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 hypo-phthalmus/sp.	5431	16819	0	10019	108406	30940	30296	12609	15	2862	21570	13792	5262	0	11604	54726	76869	13146	284	580	1049	61258	2633	497	1637	2636	49490	101214	6527	231
"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	0	849	774	23503	0	567	132	68	147951	435	672	299	173	65	773	0	0
"Pream"	0	0	0	6	0	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
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	470	3687	8382	216	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
Henicorhynchus sp.	54718	6834115	5543132	1091	732180	2671023	3673552	714164	3799	1673	70529	4543363	512755	1534253	4920	158350	2098013	1078608	418111	1113	1027	1083423	1824014	57259	4437	4637	189133	4889508	100861	38992
Channa marulius	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	15	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	262	722	31049	118116	2366	11
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	1051
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
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
Paralaubuca 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
"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
Cyclocheilichthys apogon/sp.	121	0	0	0	5278	1218	81	0	36	0	1889	79690	1630	0	0	387	9381	0	189	0	0	2000	2941	4	0	2	0	0	1	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
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
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

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