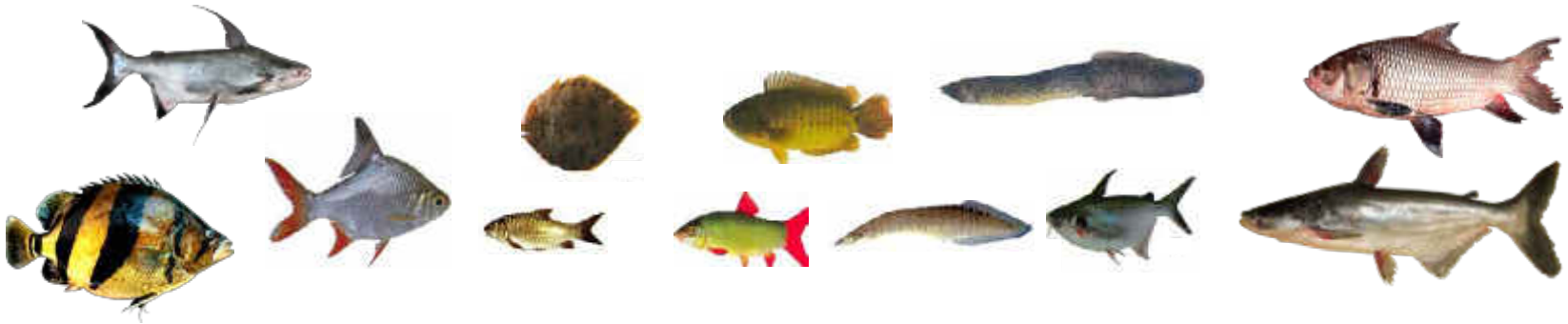
UNIVERSITÉ TOULOUSE III PAUL SABATIER

Fish diversity and sustainability in the flood-pulse system of the Lower Mekong Basin



Sovan Lek

UNICAM

Erasmus+

Maintaining productivity and incomes in the Tonle Sap fishery in the face of climate change (TLSCC)


Chea Ratha


Seng Ratha


Chan Bunyeth


Ngor Peng Bun

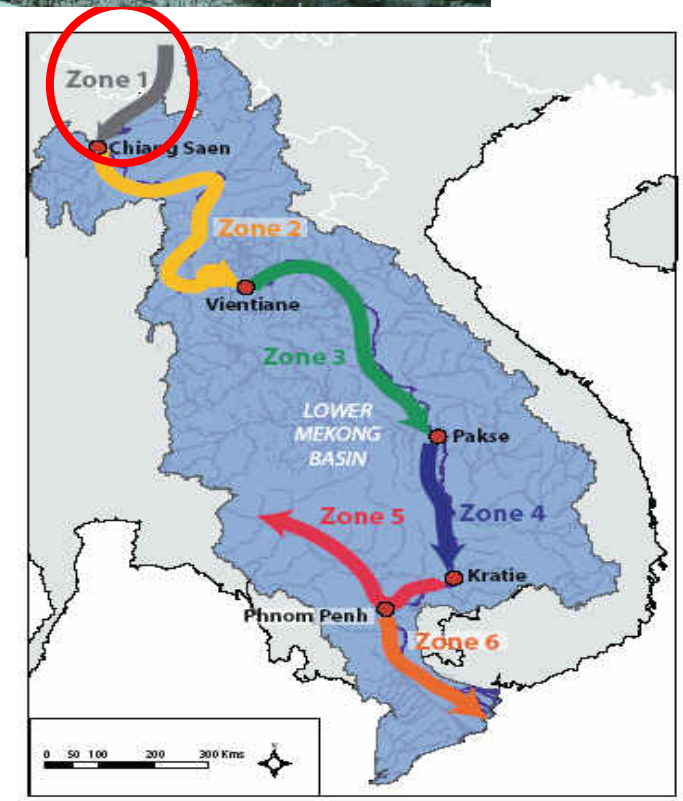

Heng Kong


Sor Ratha

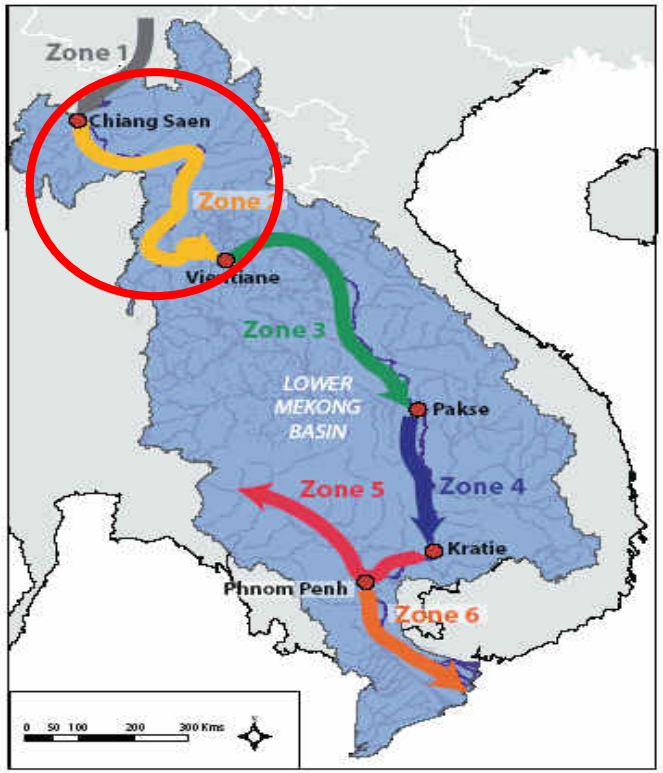
- Length: **4,909 km**, 10th in the world
- Total drainage area: **795,000 km2**
- Large-scale seasonal flooding, creating huge surfaces of floodplains: **70,000 km2**

(Cambodia: Approx. **60%)**

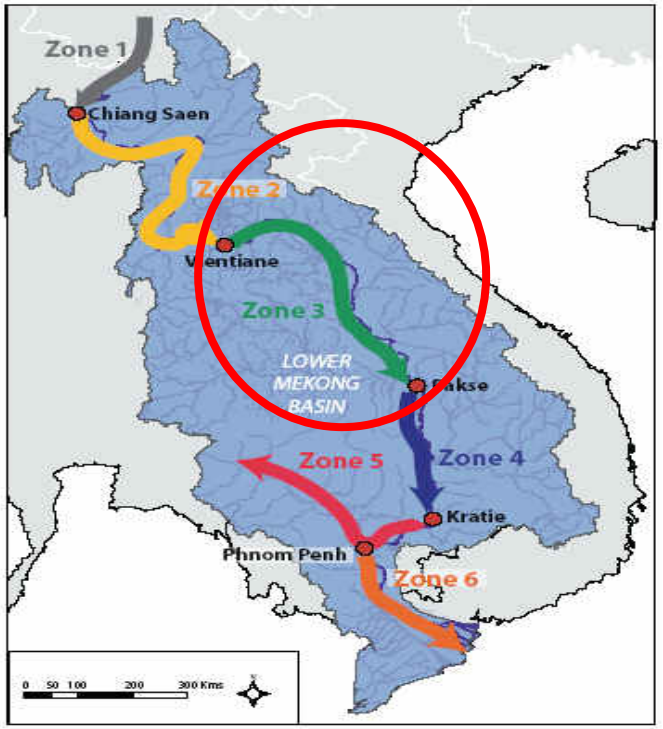
The Mekong River in the high mountains or headwaters in China to Chiang Saen in Thailand.



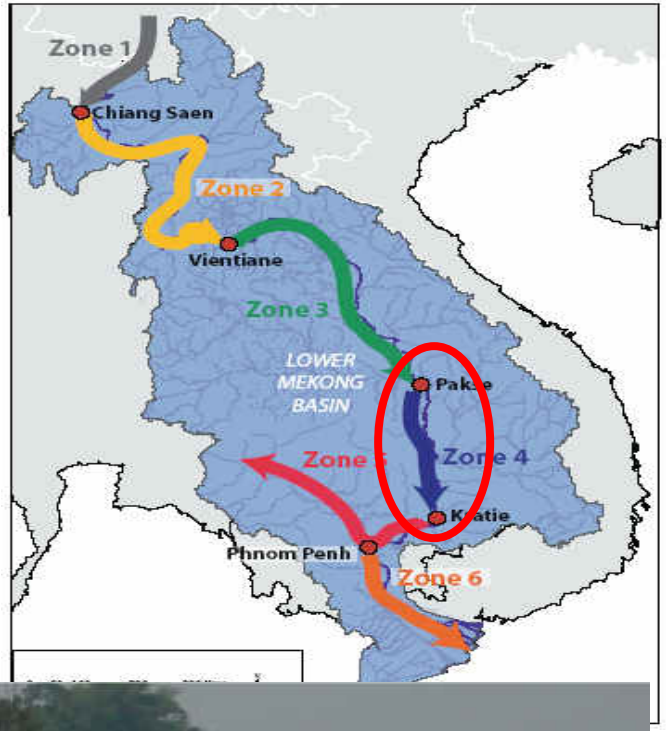
Low mountain or upland river in steep narrow valley Chiang Saen in Thailand and Vientiane in Lao PDR



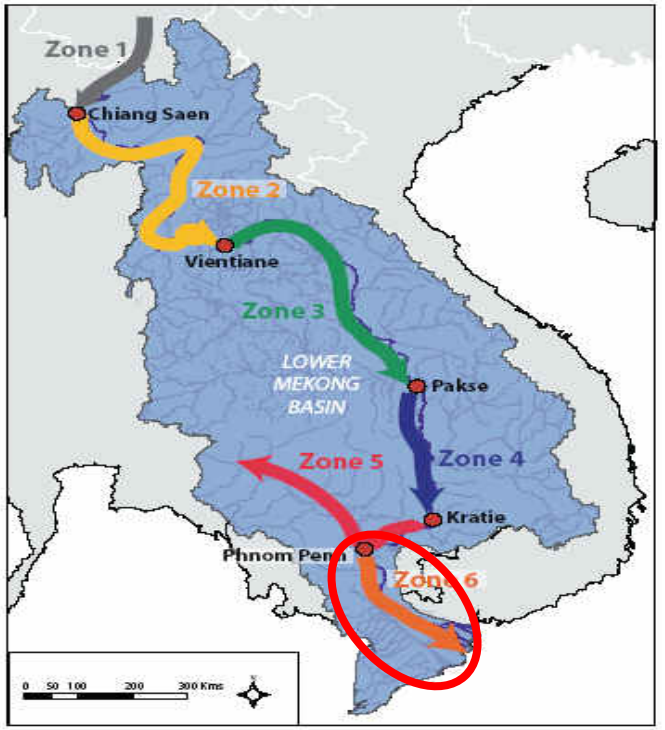
Mekong River in Plateau region between Vientiane and Pakse in Lao PDR.



Mekong River in island/wetland region between Pakse, Southern Lao PDR and Kratie, North-eastern Cambodia



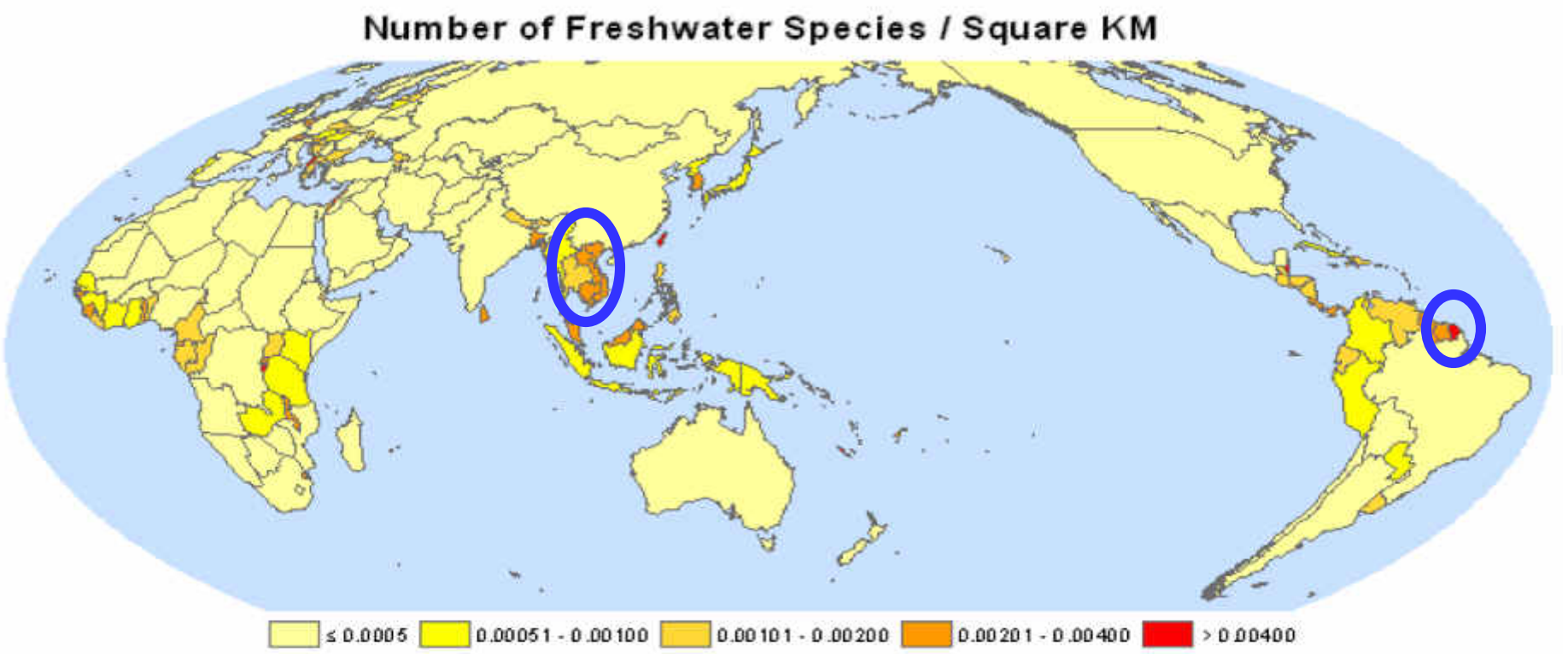
Mekong River in the Cambodia's floodplains between Kratie and Phnom Penh in Cambodia



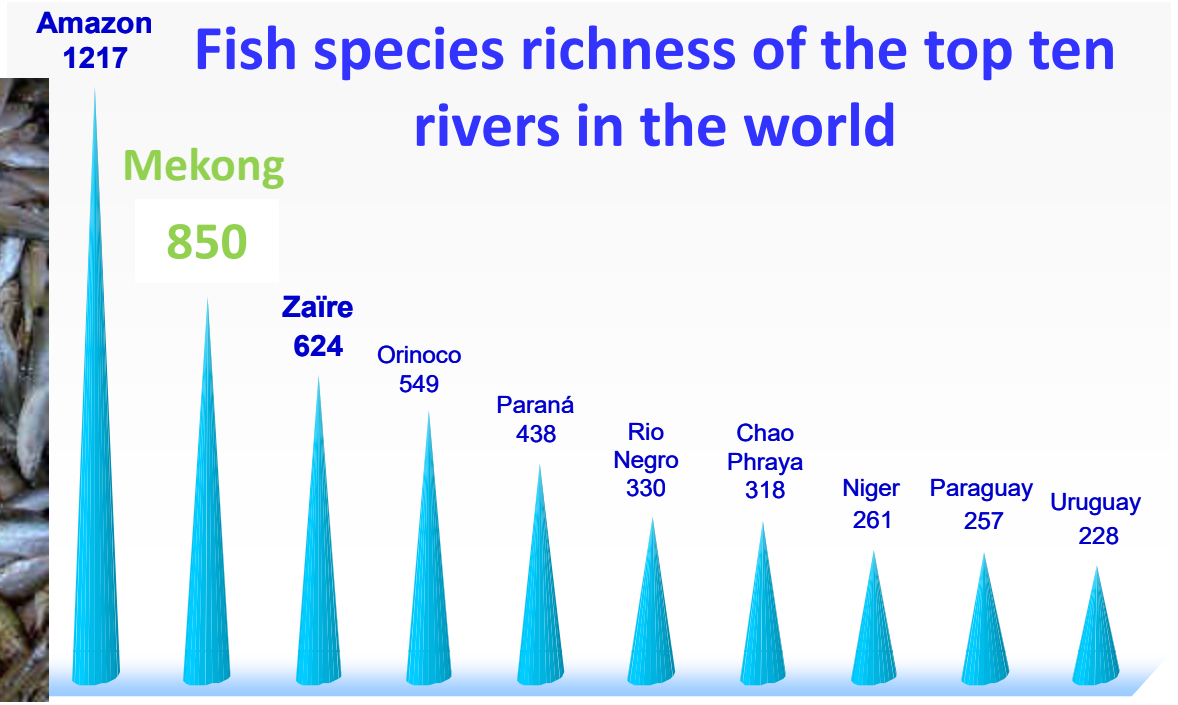
Mekong River in the Cambodia's and Viet Nam's Delta

Fishes of the Mekong River Basin

The group of **Mekong basin countries** stand out as the region of the world with the **highest freshwater fish species diversity per square kilometer**. On other continents, only French Guiana and Suriname in South America feature a higher or similar fish species diversity per unit area of land.

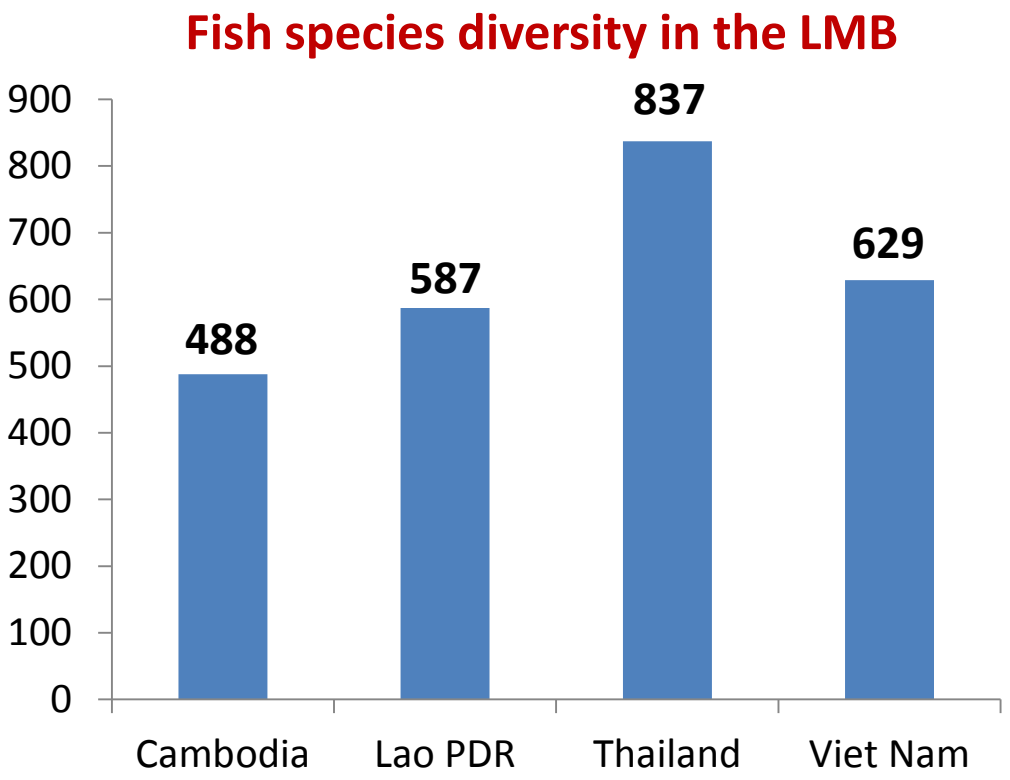


- The Mekong River has the highest fish biodiversity in the world after the Amazon River.
- **850** freshwater fish species recorded from the Mekong River Basin
- With a total estimate of about **1,100 fish species** if the possible coastal or marine visitors are included.
- A significant proportion of endemic fish species, approx. **20%**



MRC

- **Thailand and Viet Nam** are among the **top 10 countries** in the world (**302 countries**) having the largest number of freshwater fish species, followed by Lao PDR and Cambodia



MRC

Fish species diversity in the 6 main zones of the Mekong River

HIGH MOUNTAINS

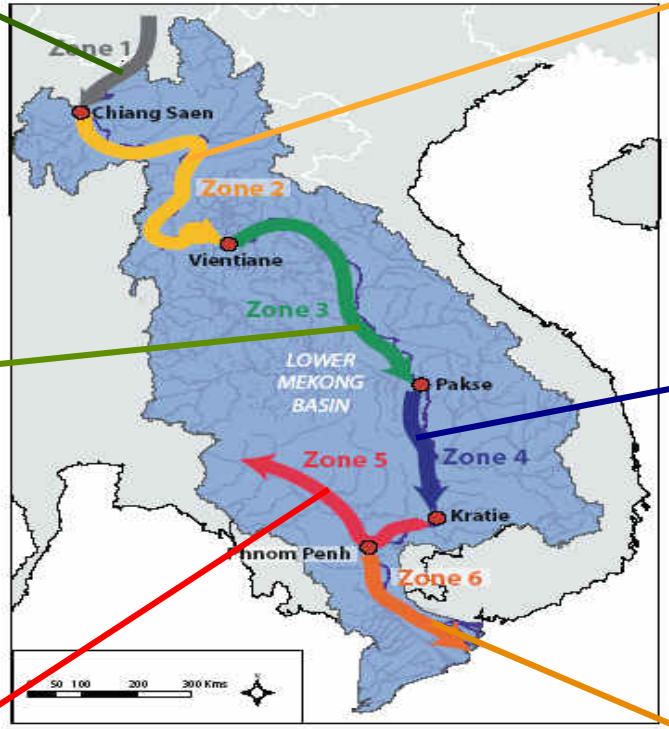
151 *species*
(12% endemics)

PLATEAU

191 *species*
(14% endemics)

FLOODPLAINS

328 *species*
(11% endemics)



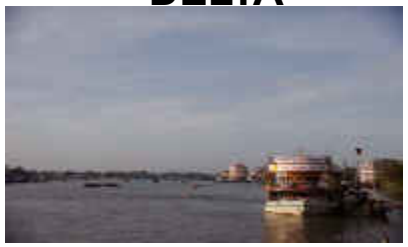
LOW MOUNTAINS

140 *species*
(18% endemics)

ISLANDS, WETLANDS

267 *species*
(16% endemics)

DELTA

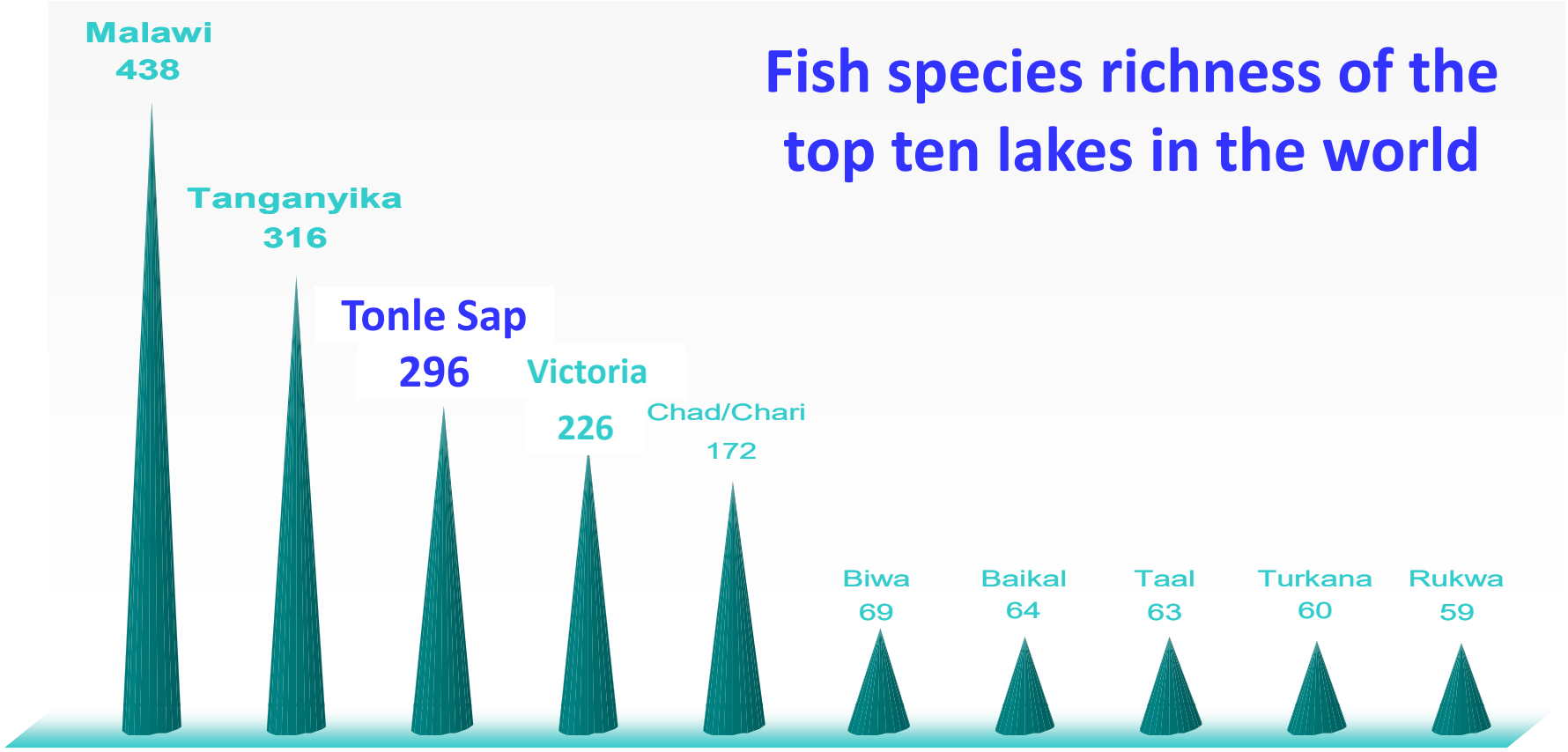


484 *species*
(6% endemics)

The Mekong River mainstream is characterized by a gradient of increasing species richness from the headwaters down to the sea

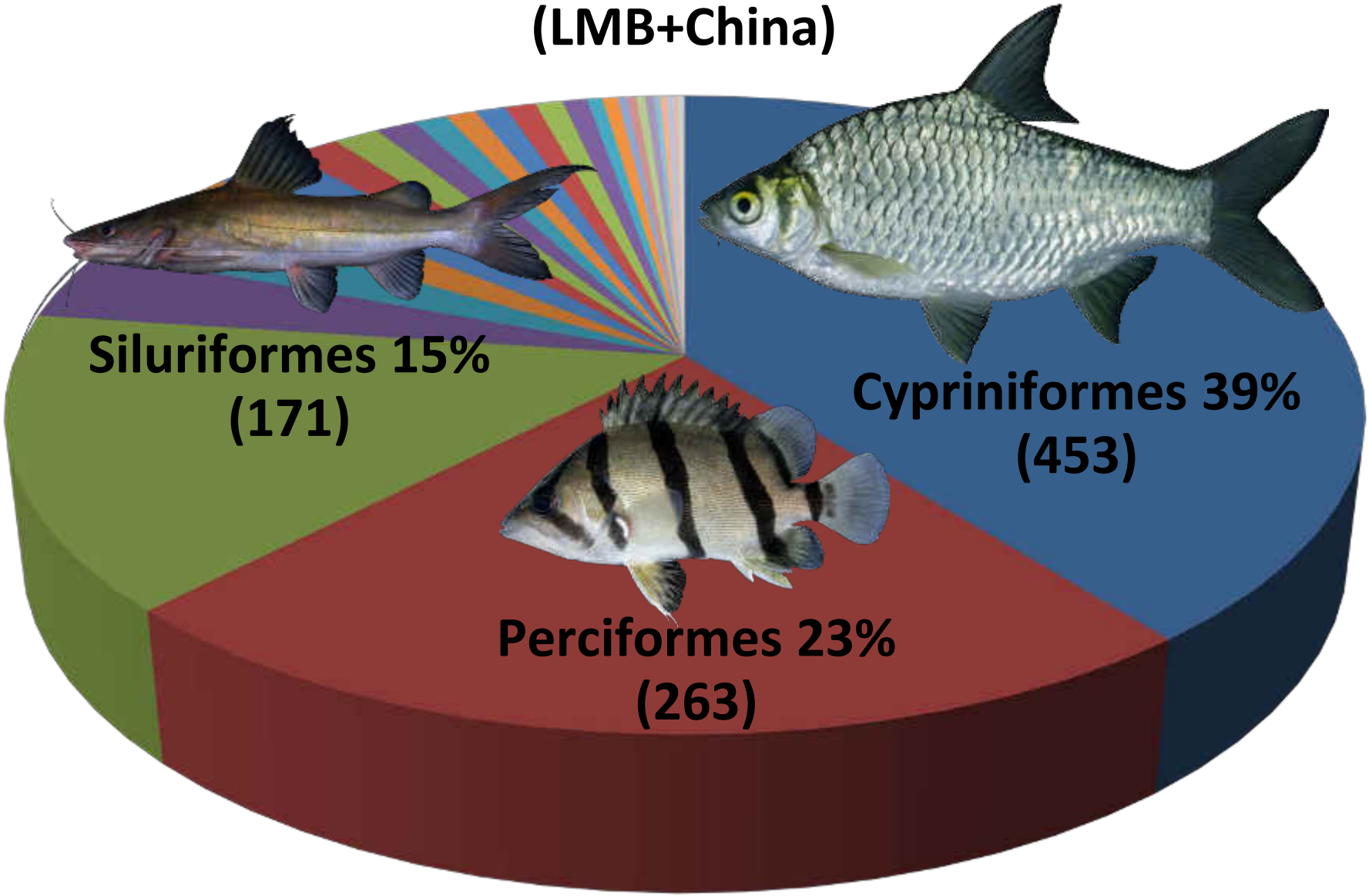
MRC

The fish species diversity of the **Tonle Sap lake in Cambodia** is ranked **third** (i.e. **296 species**) in the world after the East-African lakes Malawi and Tanganyika.



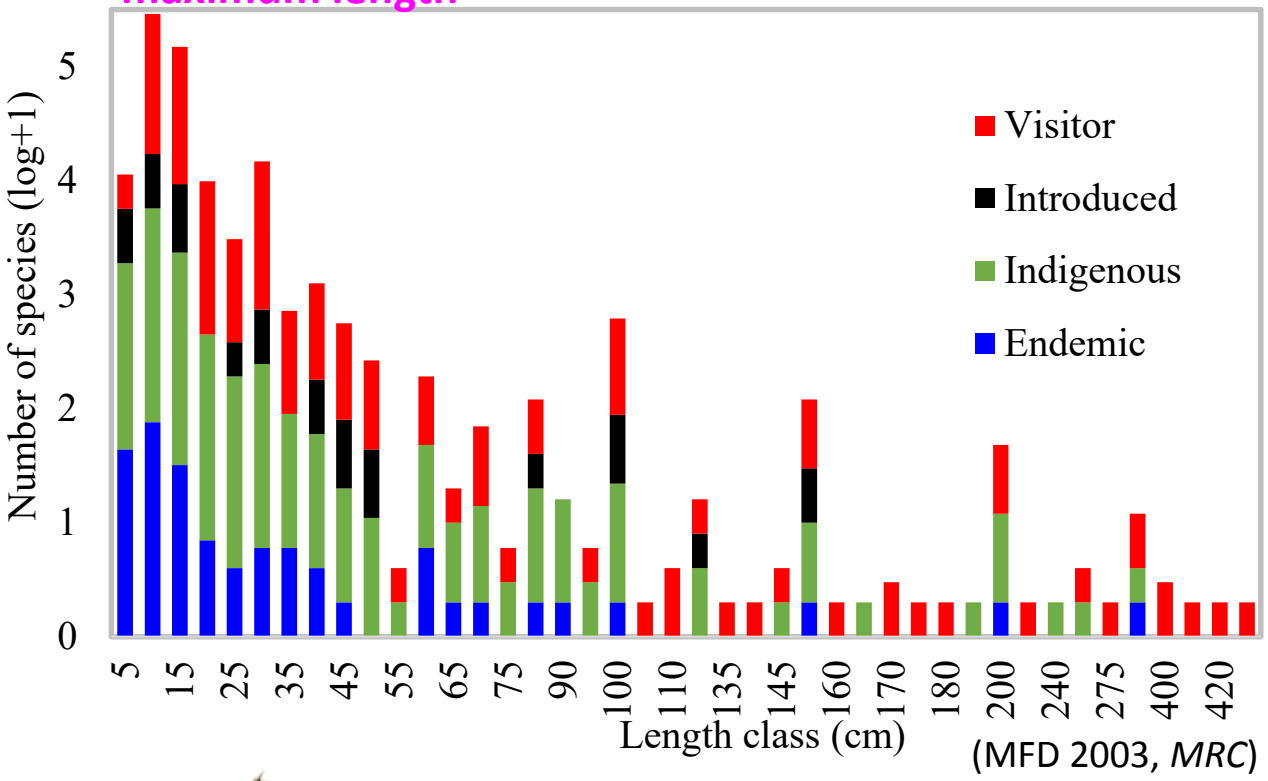
MRC

Fishes Order composition in Mekong basin (LMB+China)



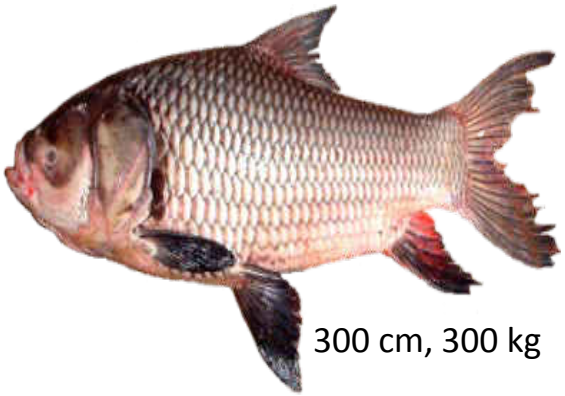
Lower Mekong fishes

Number of fish species vs maximum length



(MFD 2003, *MRC*)

300 cm, 350 kg

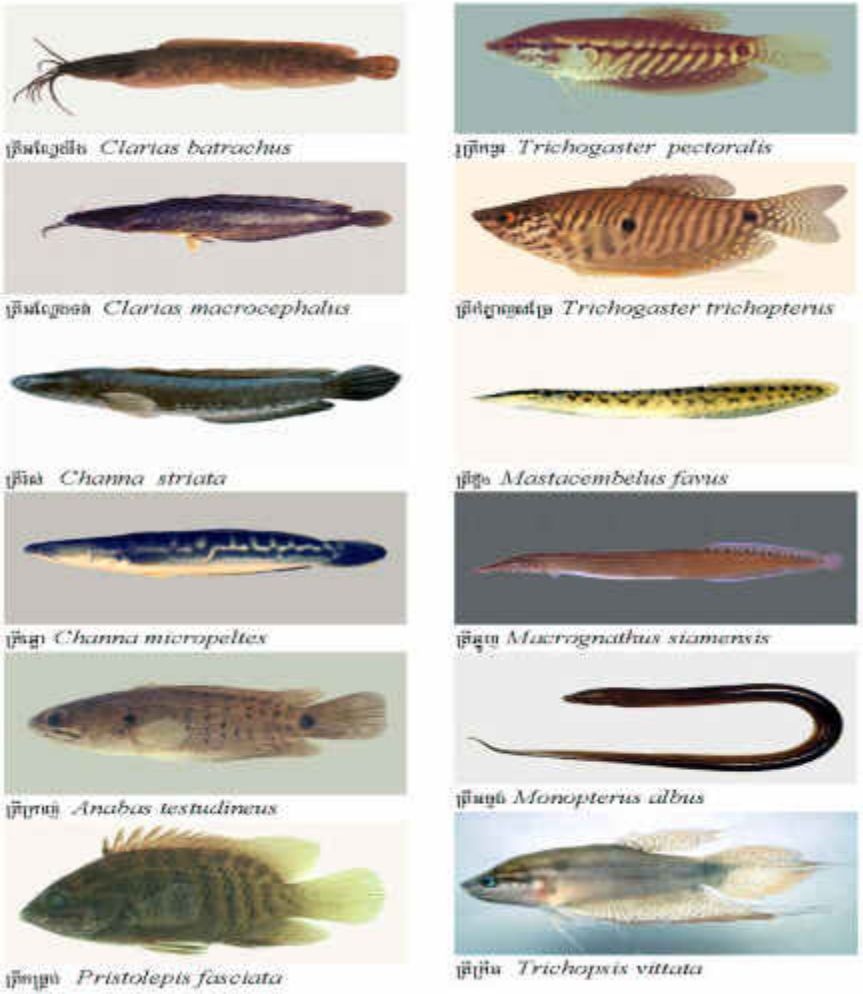


300 cm, 300 kg

Characteristics of the main fish groups

1. **Black fish**- Floodplain resident fish, with limited lateral migrations from the river onto floodplains and no longitudinal migrations upstream and downstream.

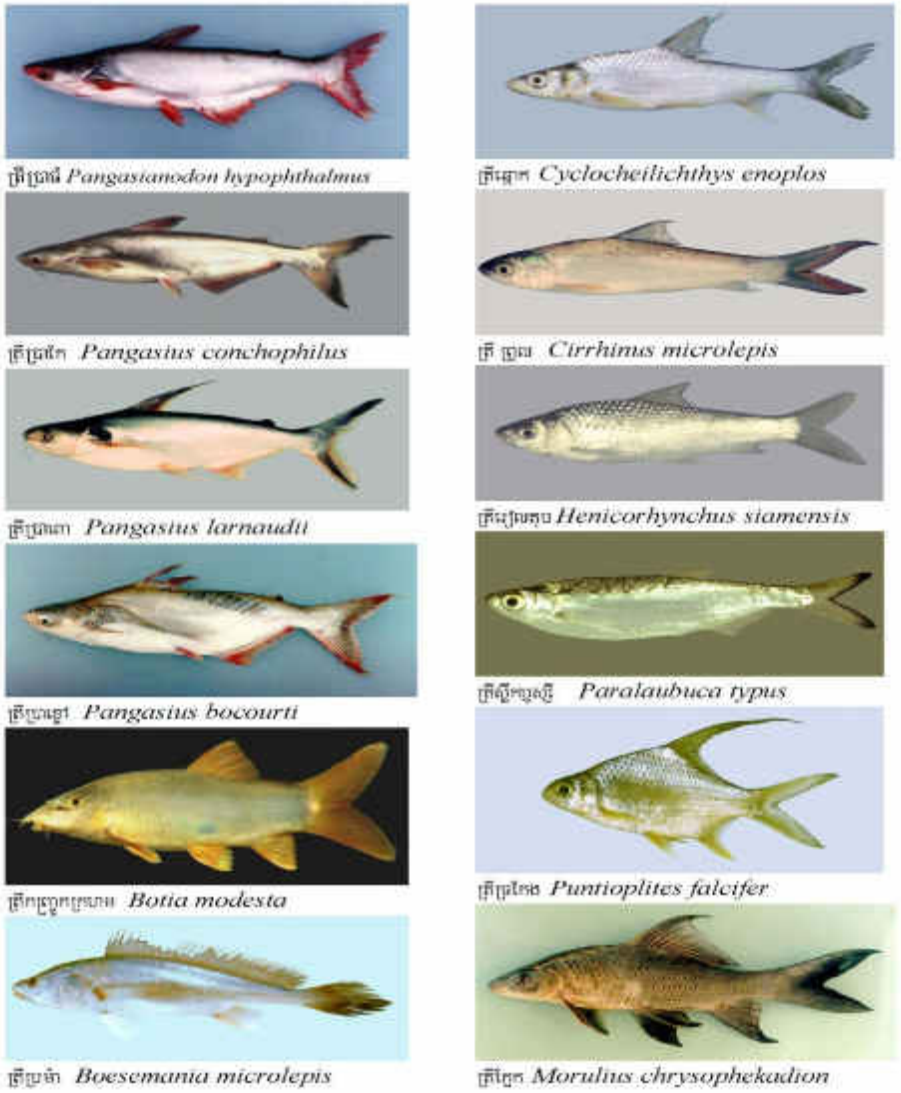
13%



MRC

2. **White fish**, undertaking long distance migrations, in particularly between lower floodplains and the Mekong mainstream and its major tributaries.

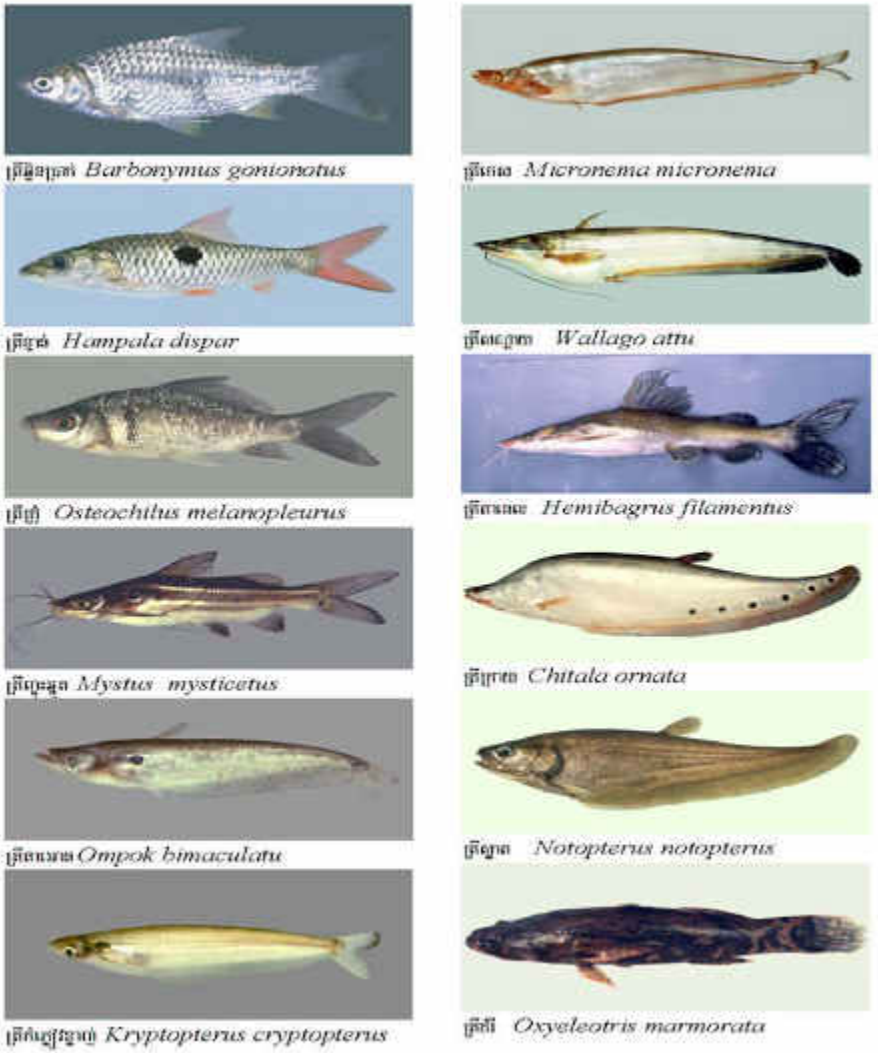
37%



MRC

3. **Grey fish**, made of fish that are not grey in colour but ecologically intermediate between the two previous groups, corresponds to fishes that do not spend the dry season in floodplain ponds, but do not undertake long distance migrations either.

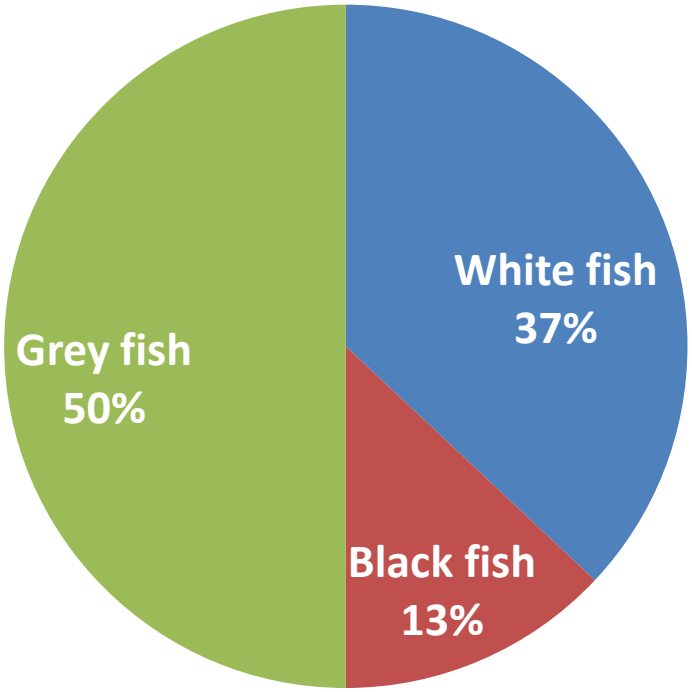
50%



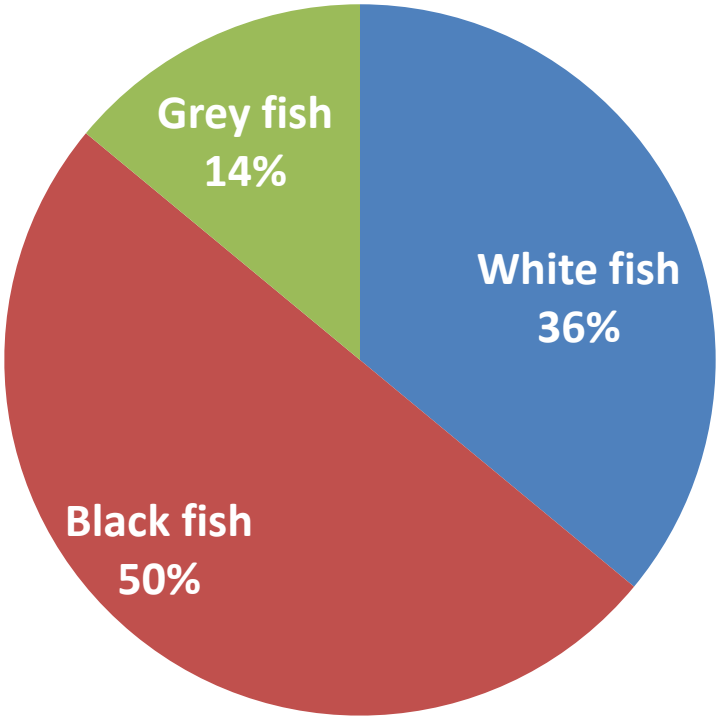
MRC

Mekong capture fish production by fish group (the case of Cambodia)

Richness by fish group



Production by fish group



MRC

Comparison with other regions

LMB fish production =

2% of **World** fisheries production
43% of **Africa** fisheries production
19% of **America** fisheries production
4% of **Asia** fisheries production
12% of **SE Asia** fisheries production
24% of **Europe** fisheries production

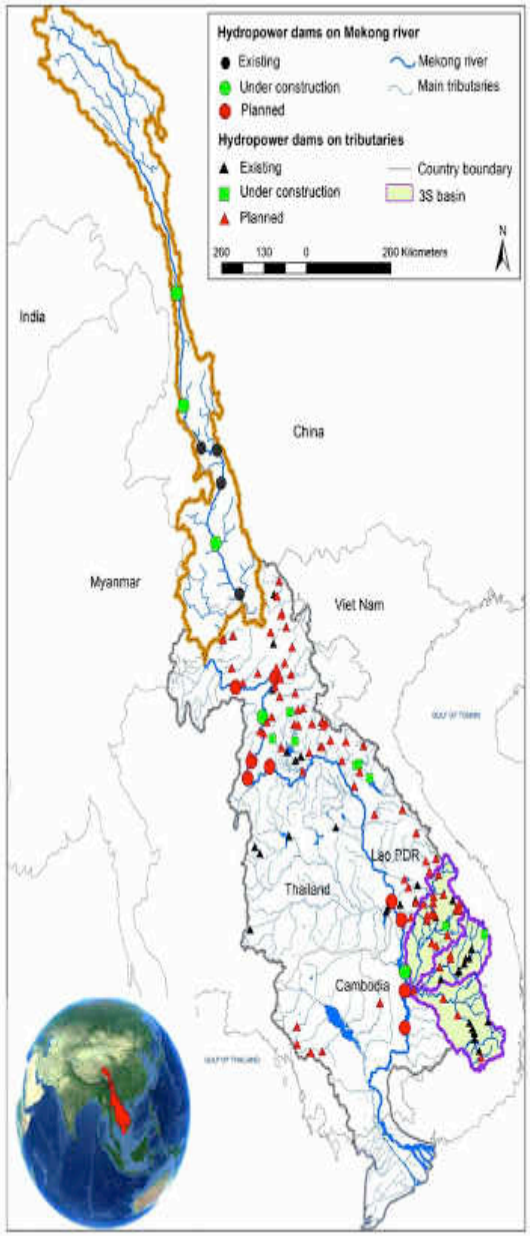
- **However, LMB fish production represents about 20% of the world inland fish production.**
- **This inland capture fish production is higher than anywhere else in the world.**

MRC

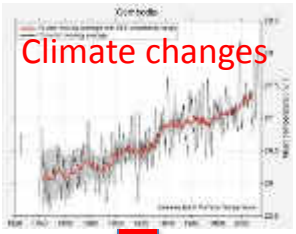
Fish vs Khmer civilisation

Lower Mekong fishes

Threats …



Climate changes



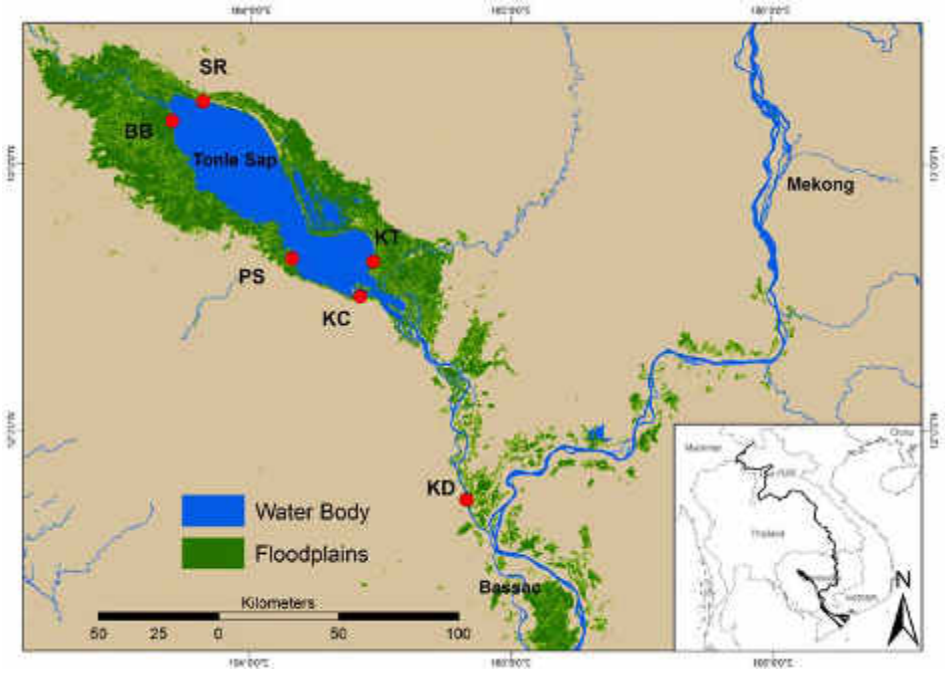
Exotic spp.

Farming/habitat loss/pollution/flooded forest clearance

Illegal fishing

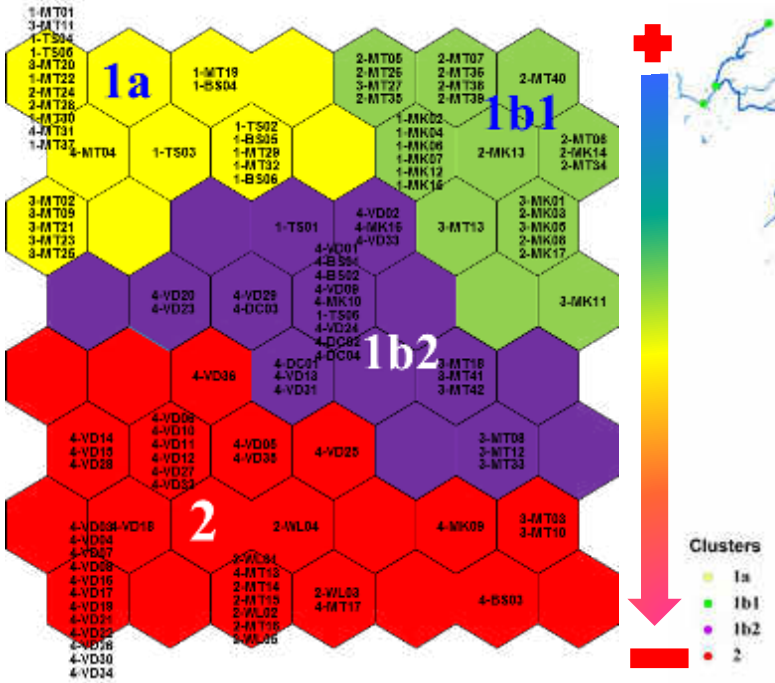
Open-access/indiscriminate fishing

Tonlé Sap Fishery in a Changing World

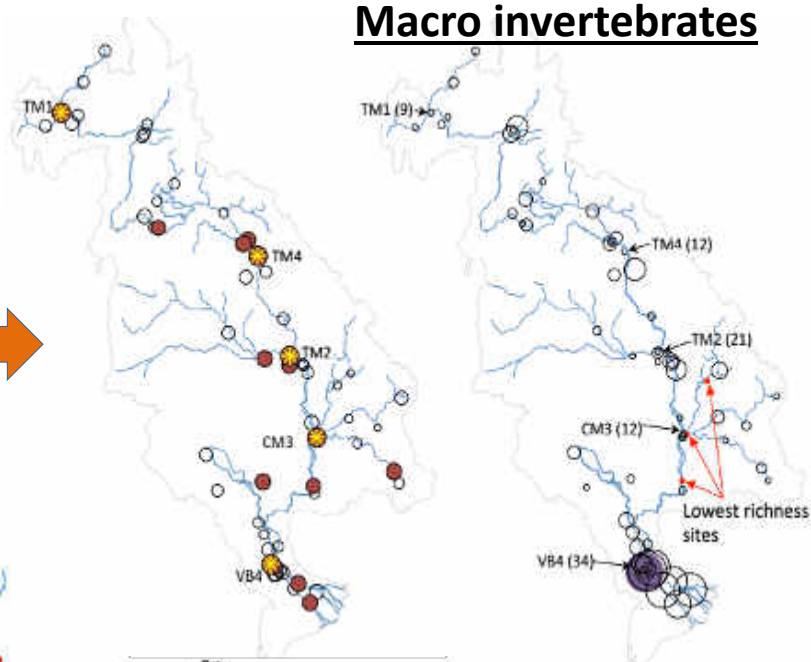


Large scale patterns of water quality and biological diversity

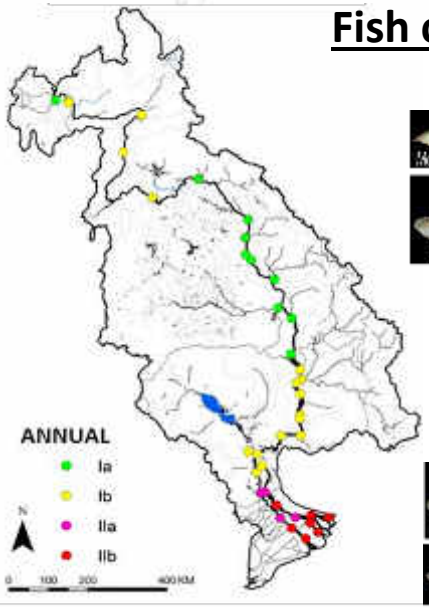
Patterns of water quality



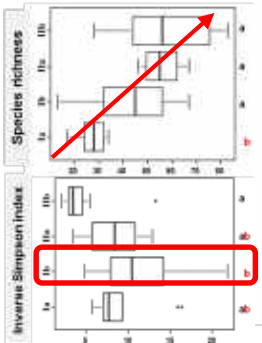
Macro invertebrates



Fish community



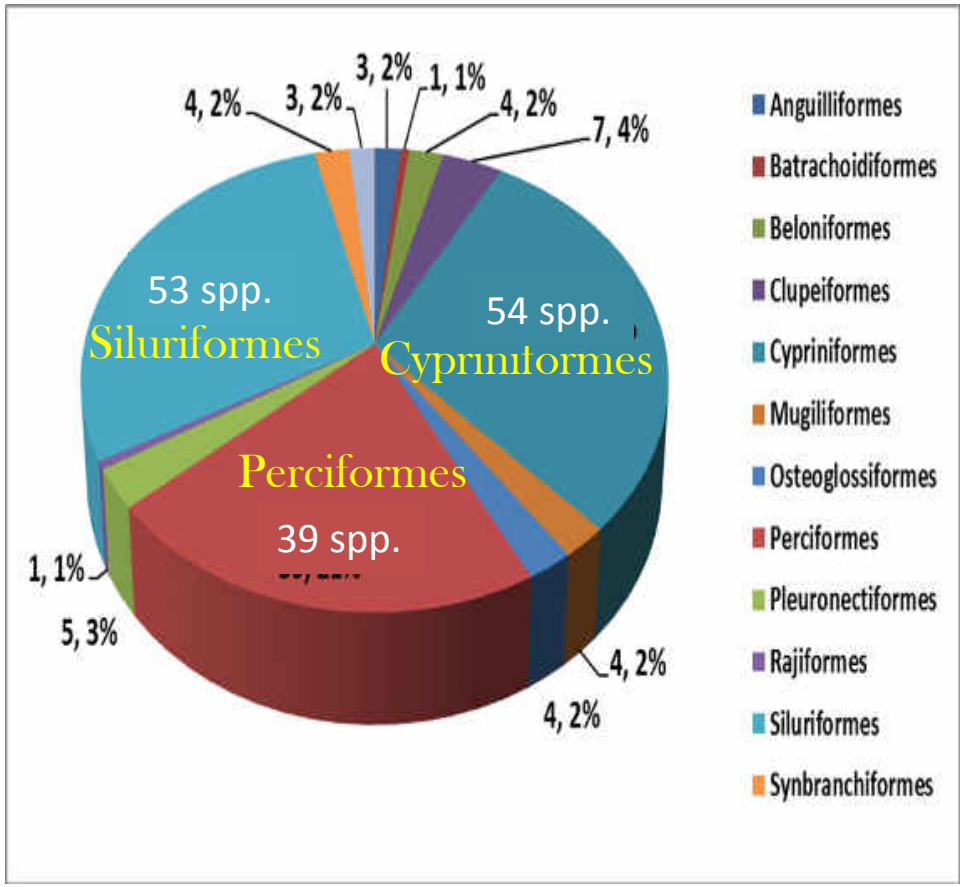
Indicator species



Plos-One: Chea R, Grenouillet G, Lek S 2016
Ecol. Freshw. Fish, Chea et al. 2016
Limnologica, Sor et al 2017

Overall assemblage structure – LMR

13 Orders 47 Families 110 Genera 182 Species

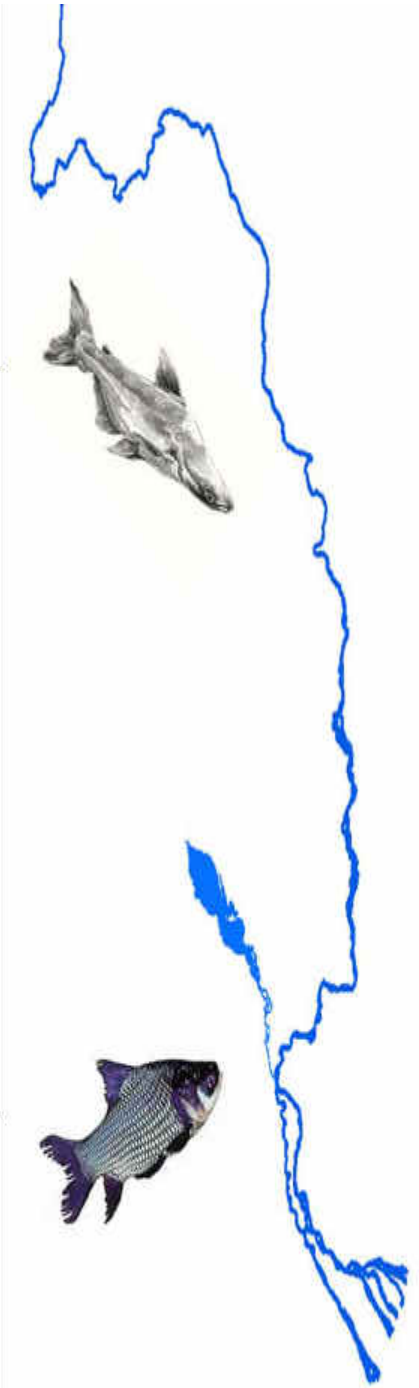


Siluriformes
Cypriniformes
Perciformes
~80%

The others

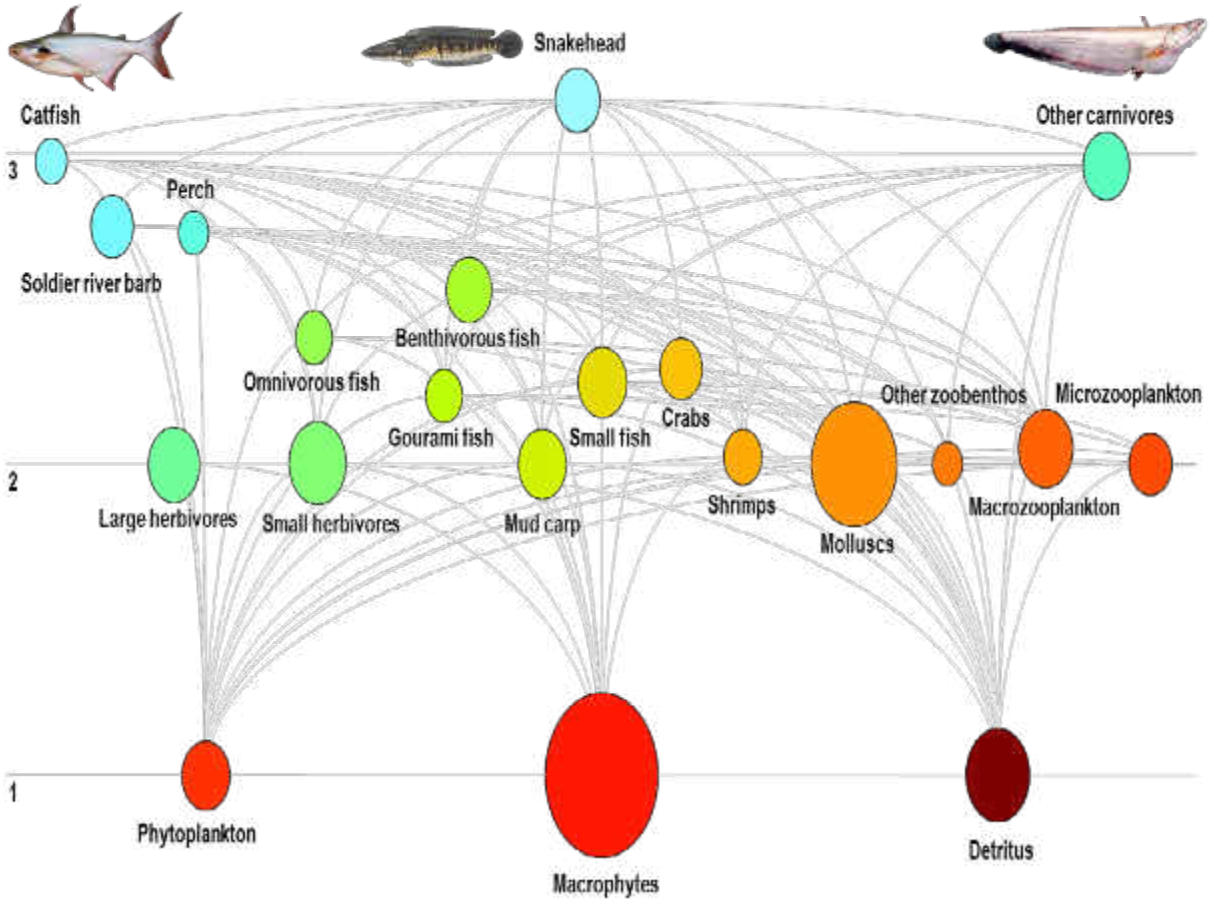
< 5%

(Chea et al. 2016, *Ecology of Freshwater Fish)*



Trophic network and energy flow in TLS

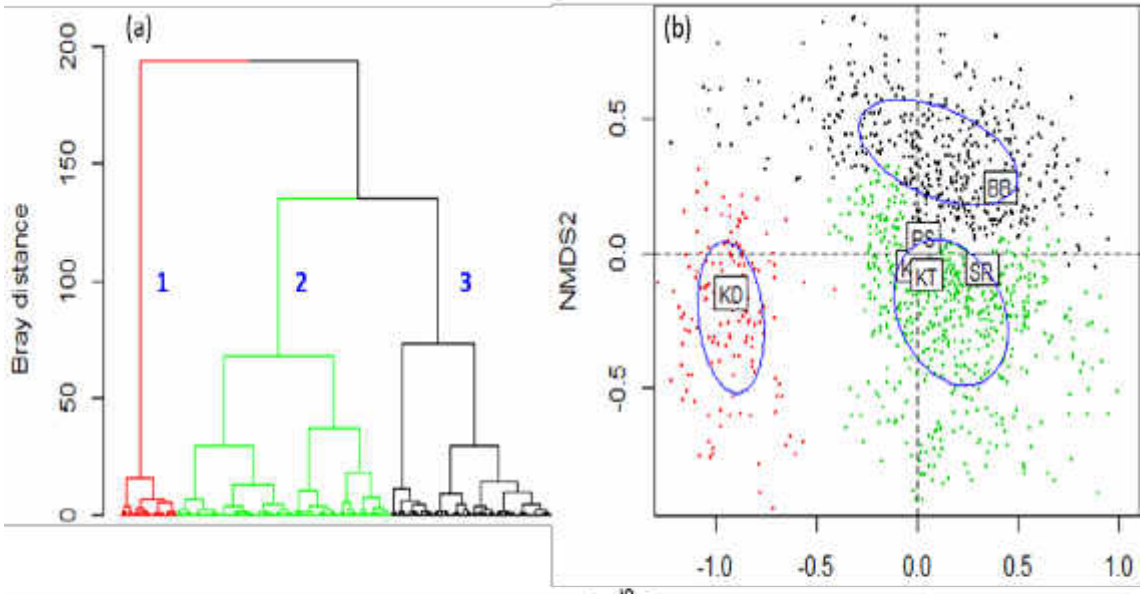
Schematic diagram of energy flow in Tonle Sap lake

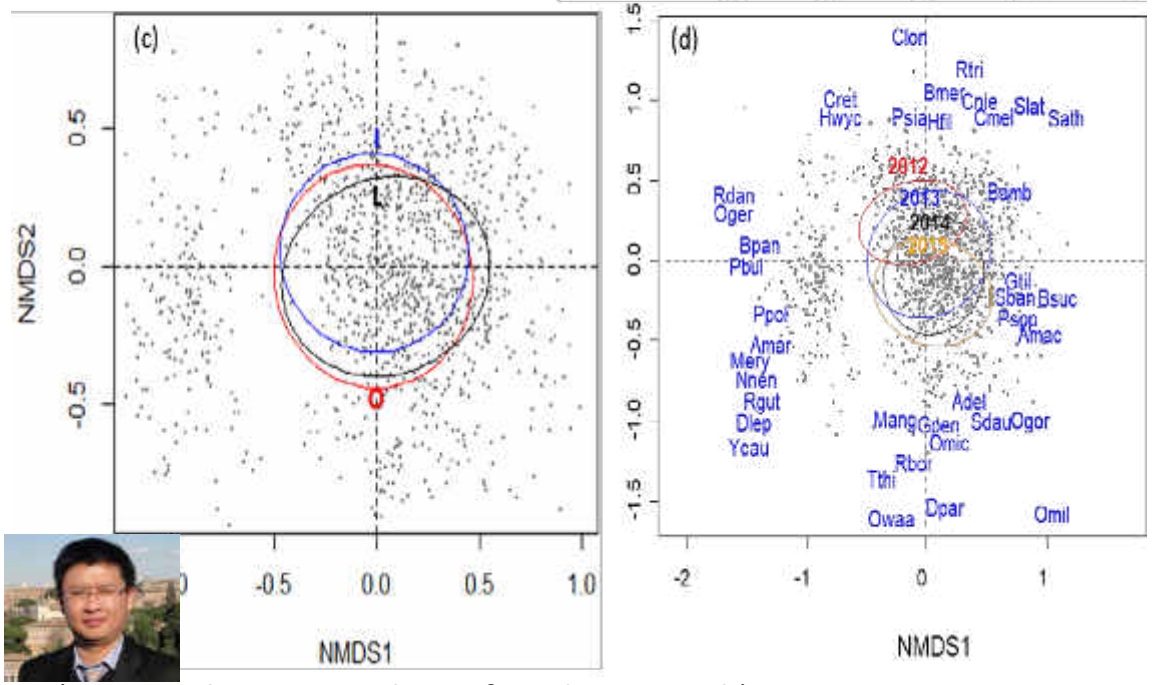


Ecol. Modelling: Chea R et al. 2016

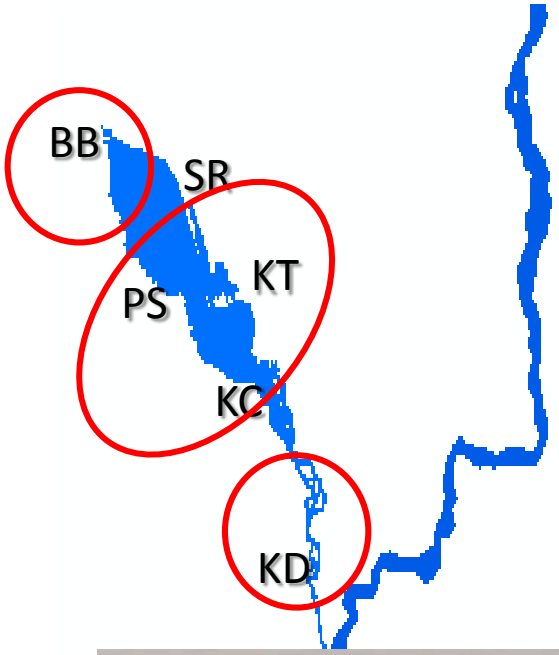
Tonle Sap was a relatively healthy ecosystem achieving a certain stage of maturity, albeit with a vulnerable food web structure.

Fish distribution and assemblage patterns in TSS



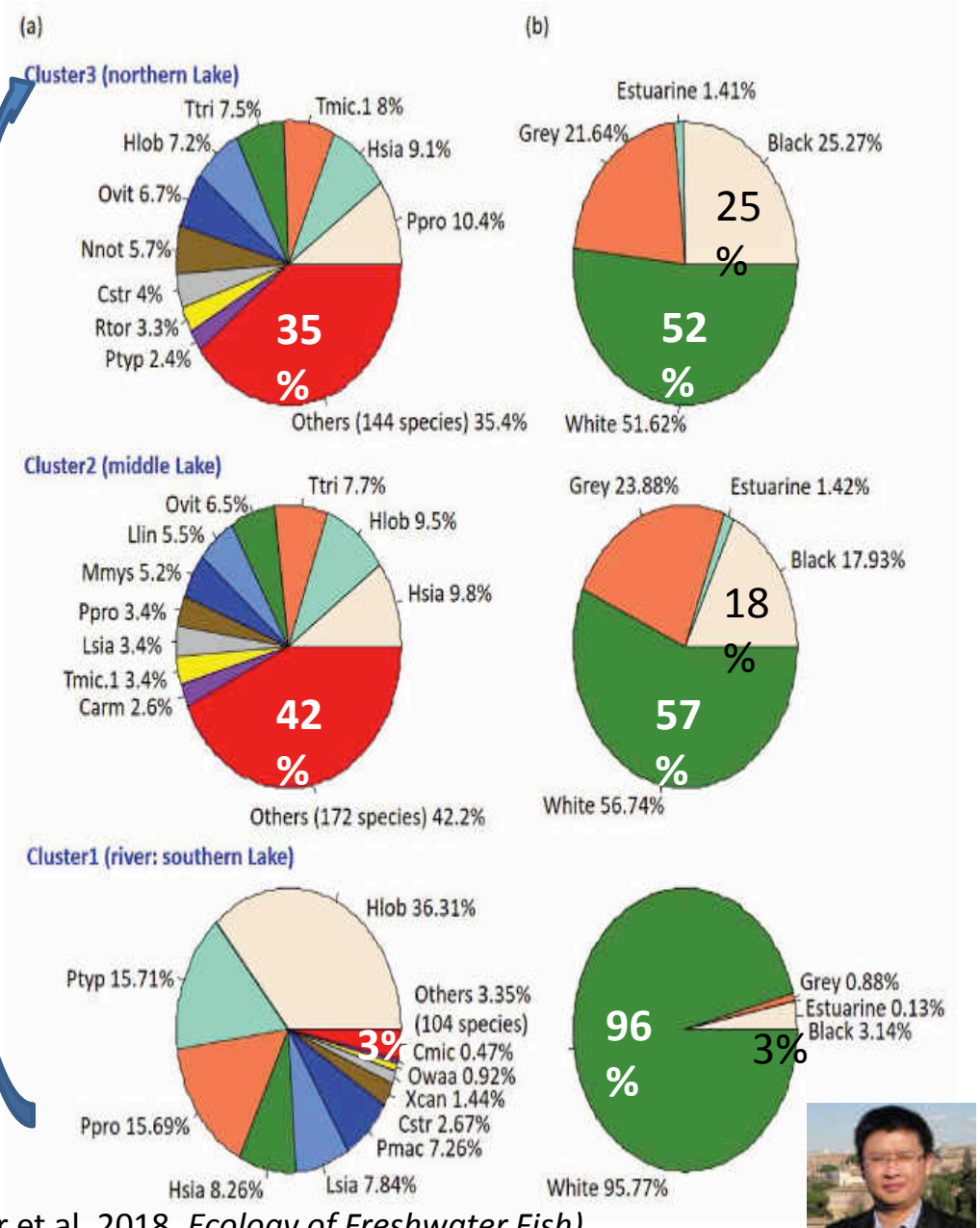


(Ngor et al. 2018,, *Ecology of Freshwater Fish)*



Castn

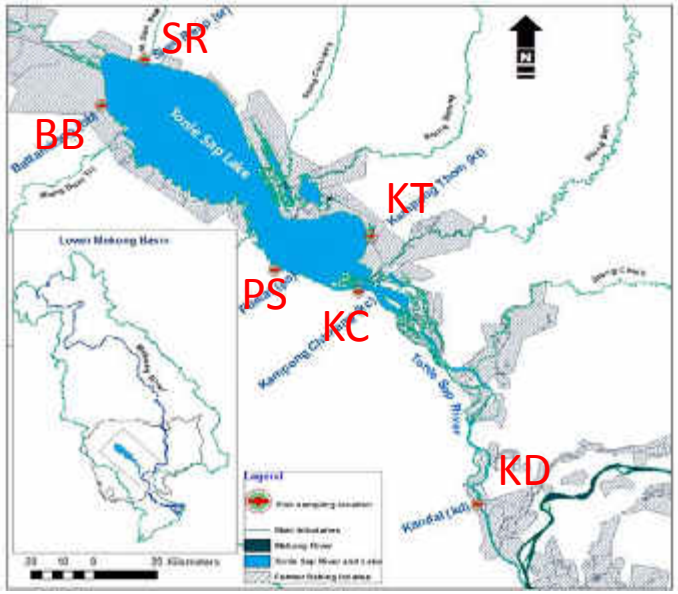
Relative abundance by cluster in TSS

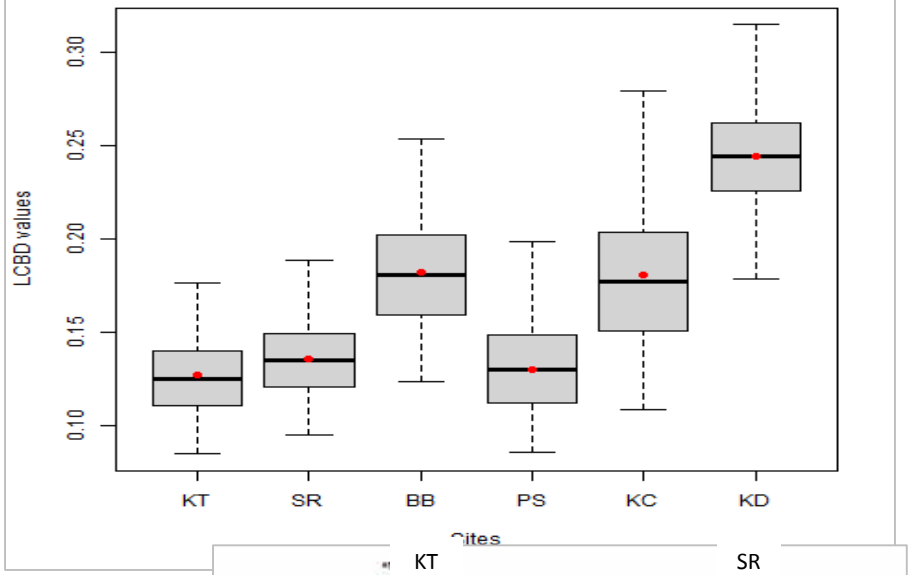


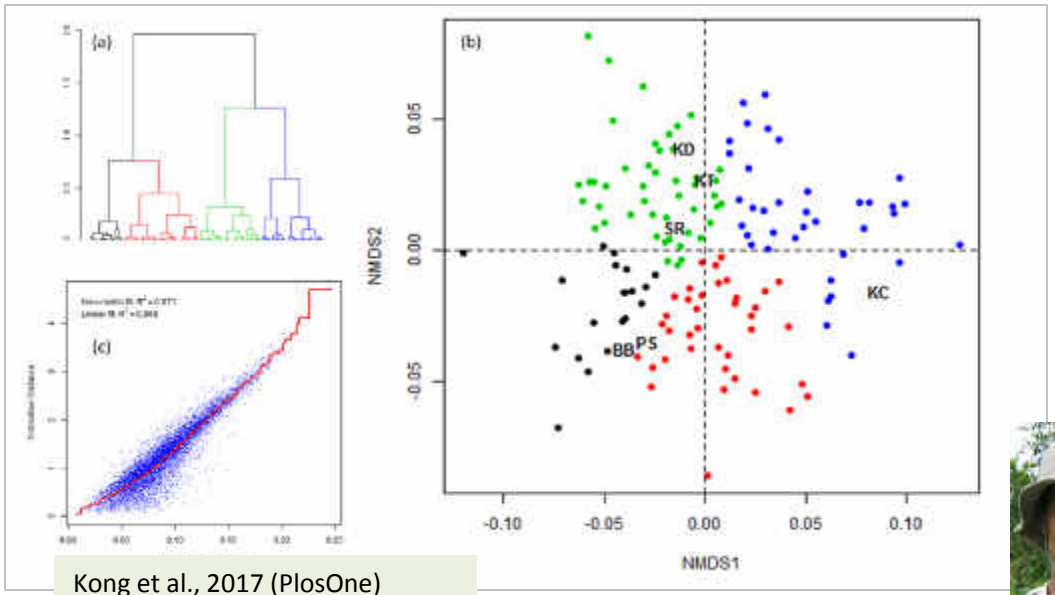
River – lake gradient

(Ngor et al. 2018, *Ecology of Freshwater Fish)*

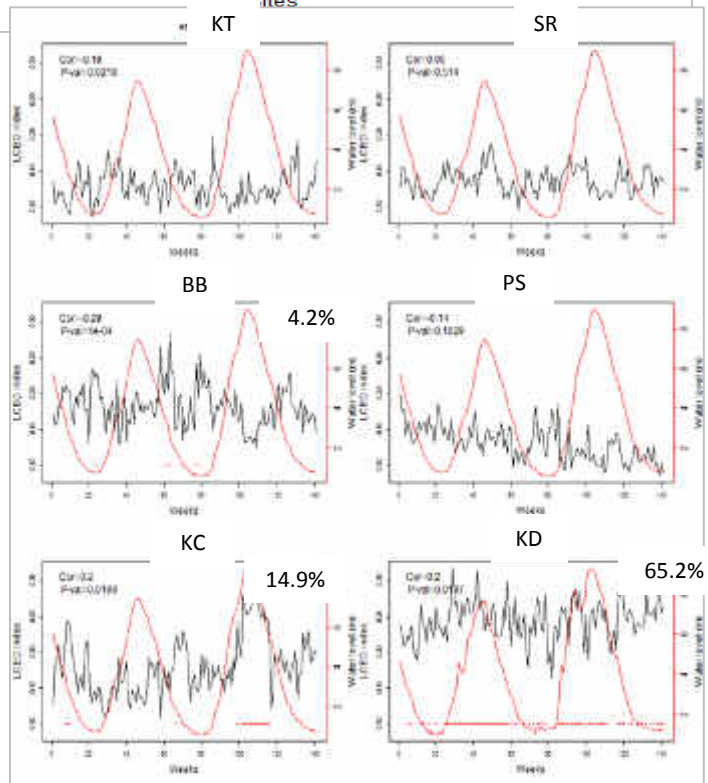
Temporal variability of beta-diversity (LCBD)



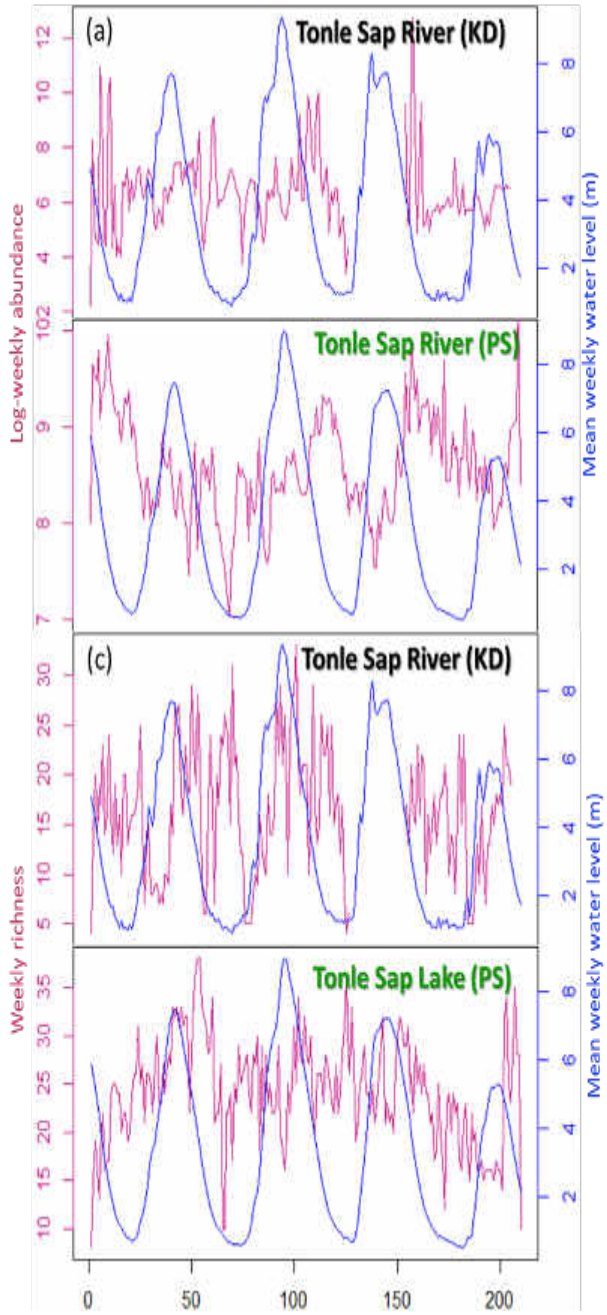


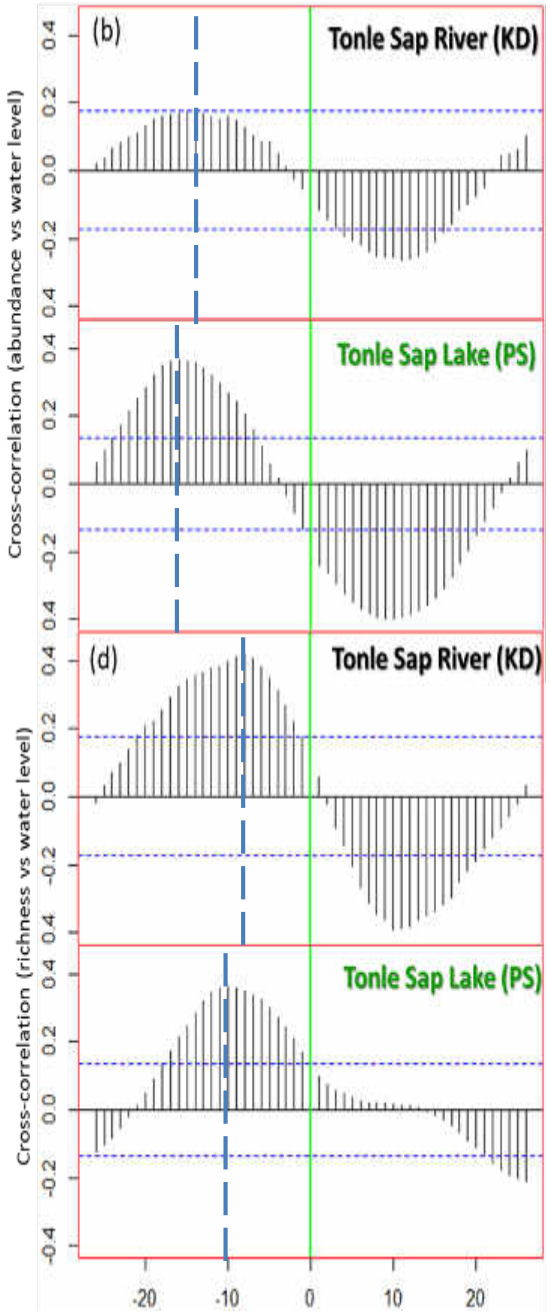


Kong et al., 2017 (PlosOne)



Cross-correlation: fish vs water in TSS





Abundance

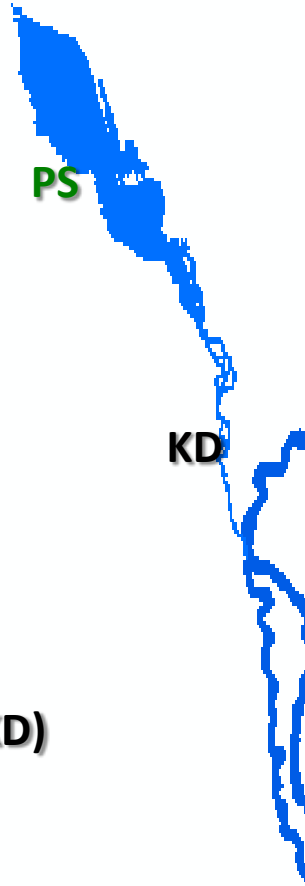
-15 weeks **(KD)**

-16 weeks **(PS)**

Richness

-8 weeks **(KD)**

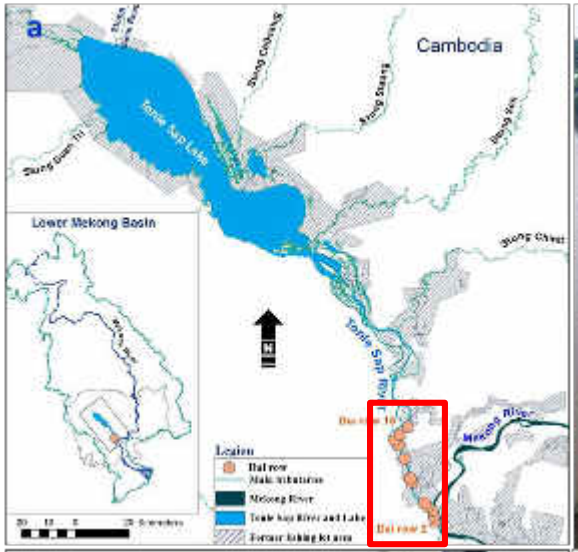
-10 weeks **(PS)**

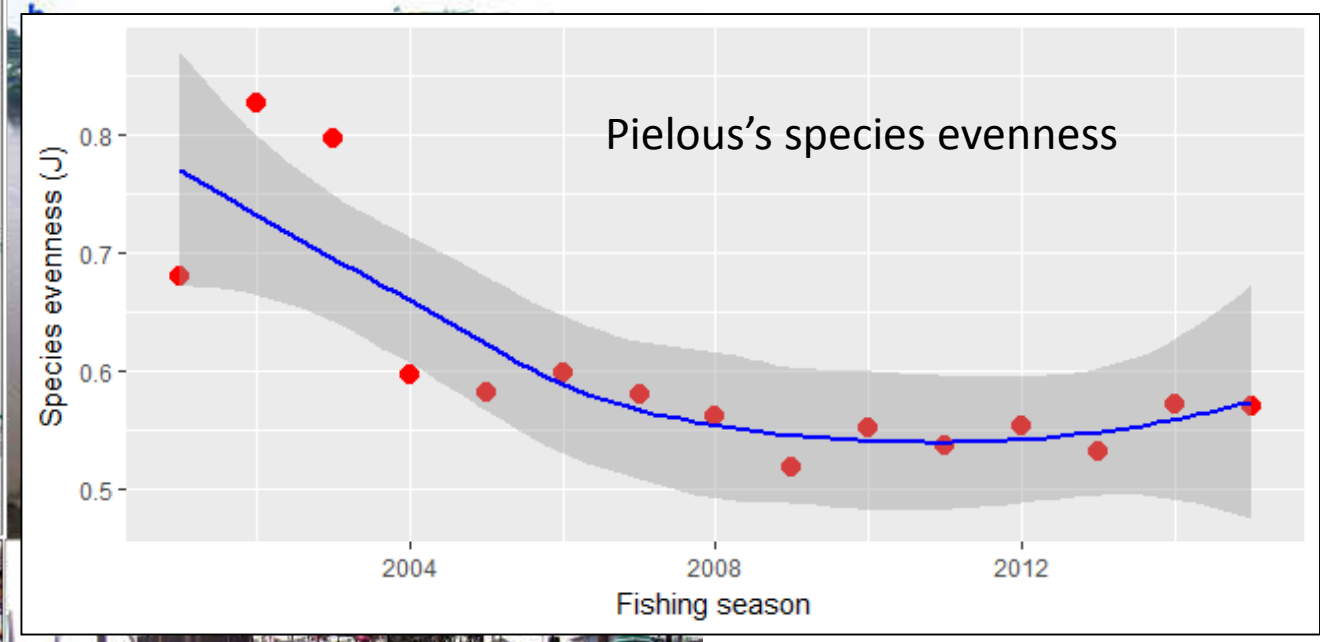


(Ngor et al. 2018, *Ecology of Freshwater Fish)*

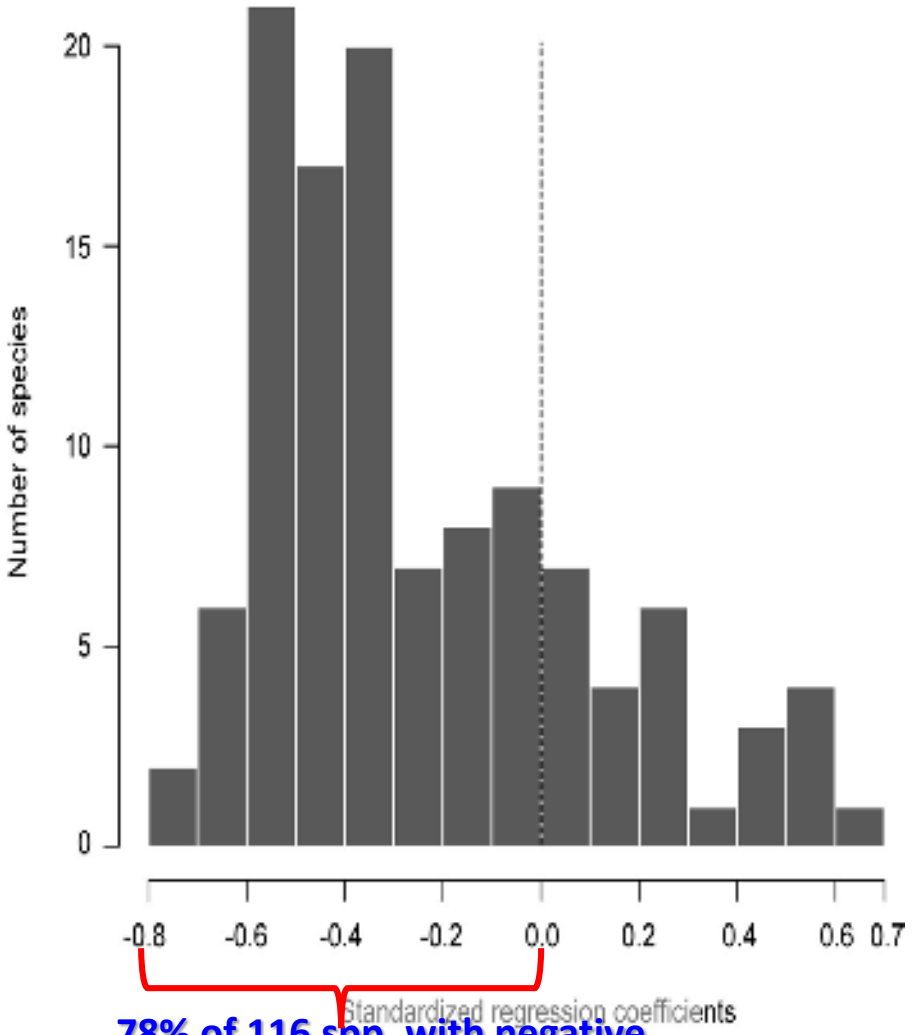
Fishing pressure in TLS

Seasonal catches of **116 fish species,** 2000-2015





Distribution of standardized regression coefficients



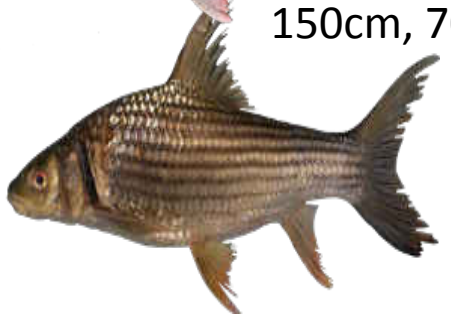
78% of 116 spp. with negative coefficients on seasonal catches

Ngor et al. 2018, *Scientific Reports*

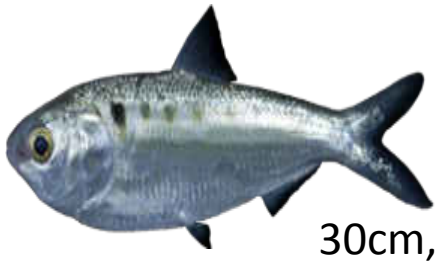
Dai fishery: catch is being hauled and emptied to the trader's boat.

Example of spp. with declining

150cm, 70kg



65cm, 5kg

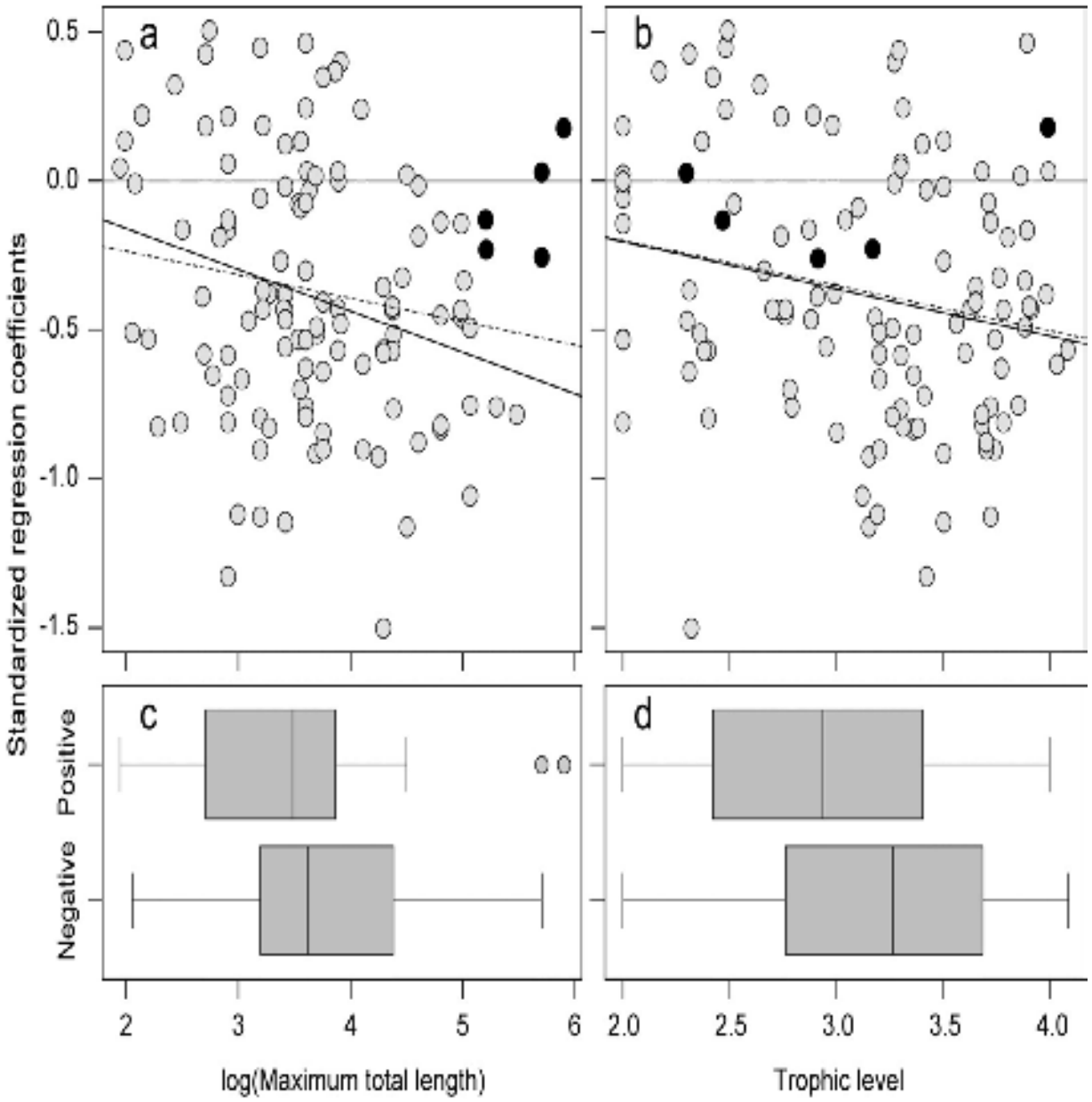


30cm, 1kg

130cm, 44kg

100 cm, 18kg

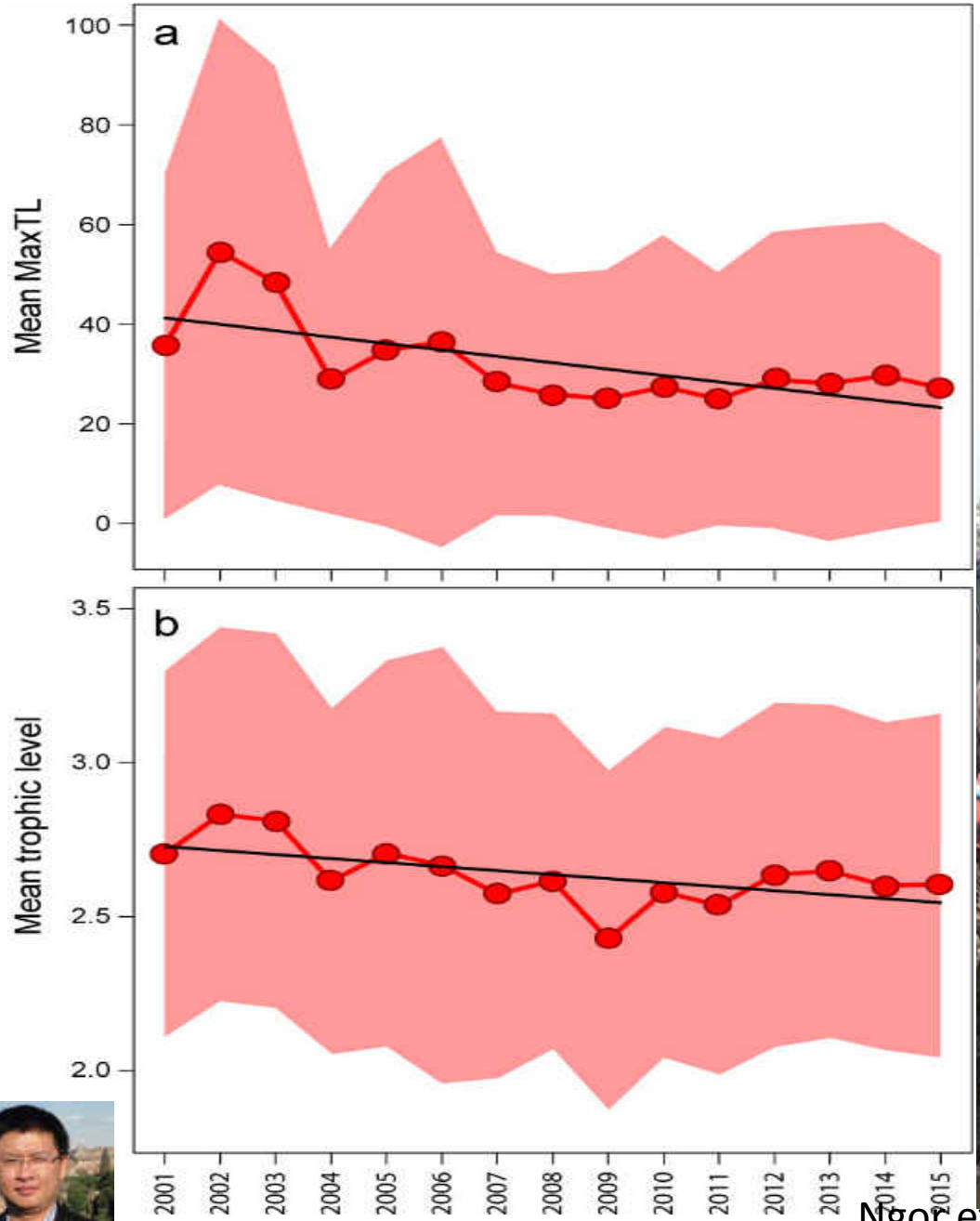
Standardized regression coef. vs max. TL and trophic level



Ngor et al. 2018, *Scientific Reports*

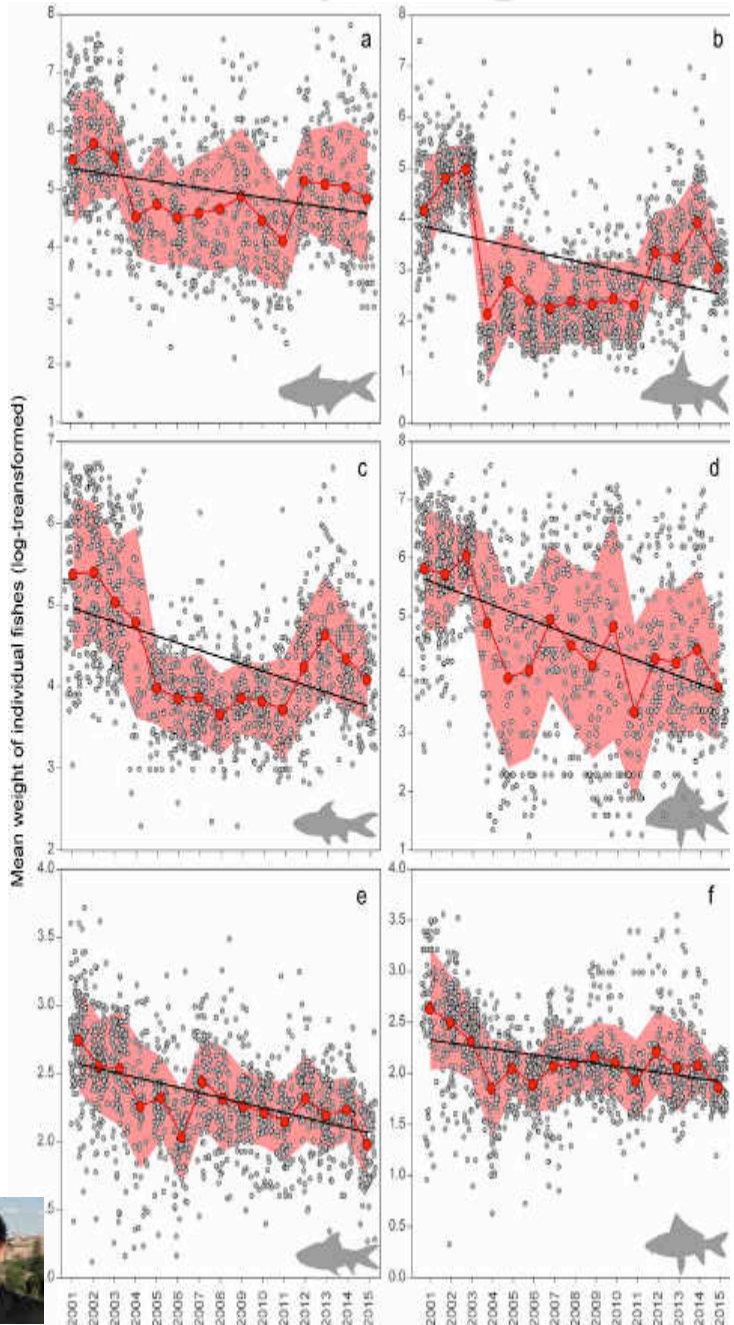
Loaches

Weighted mean for max. TL and trophic level



Ngor et al. 2018, *Scientific Reports*

Mean body weight of individual fish



a	*Osteochilus melanopleurus*
b	*Cyclocheilichthys enoplos*
c	*Pangasianodon hypophthalmus*
d	*Cirrhinus microlepis*
e	*Henicorhynchus lobatus*
f	*Labiobarbus lineatus*

Ngor et al. 2018, *revisions submitted,*

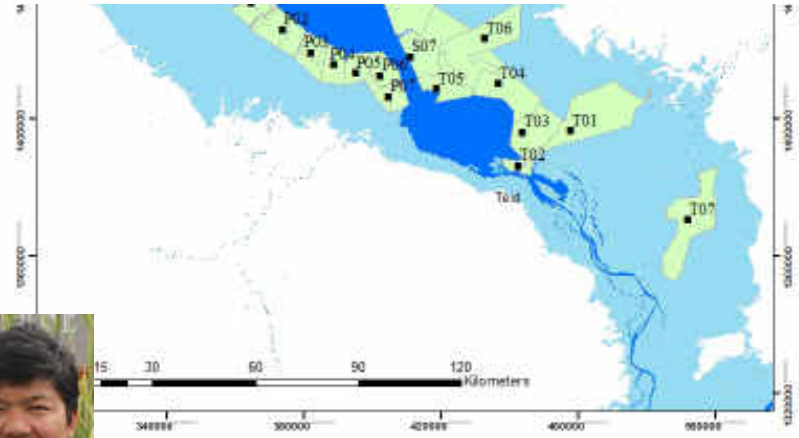
Signature of fishing lot abolishment

Industrial-scale fishery on the Tonle Sap Lake during the first half of the 20th century

Photo: Institut Océanographique de l'Indochine

the commercial fishing lots had been introduced since 1908 by **French** protectorate

fisheries policy reforms since 2001



Lot fishery in TLS

Ann. Limnol. - Int. J. Lim. 53 (2017) 485-493
© EDP Sciences, 2017
https://doi.org/10.1051/limn/2017027

Available online at:
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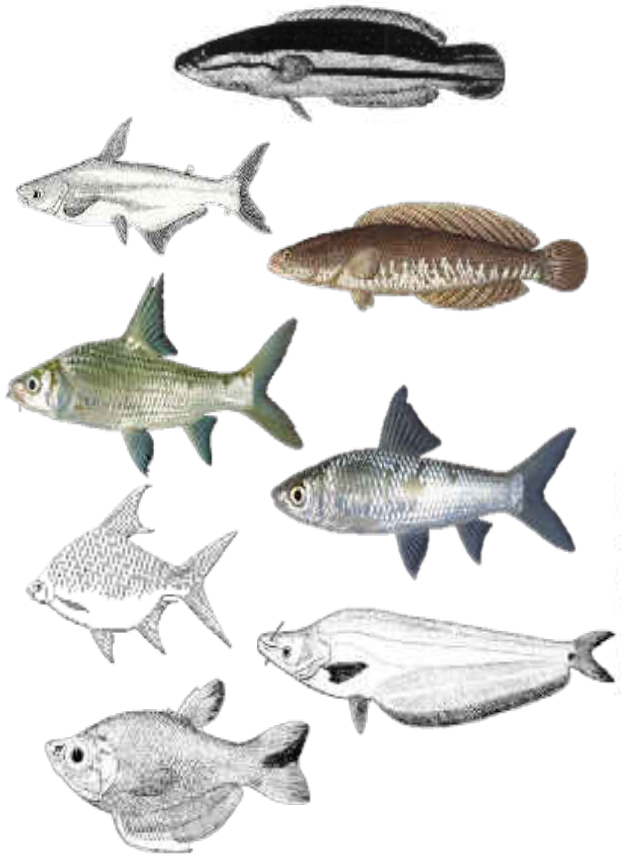
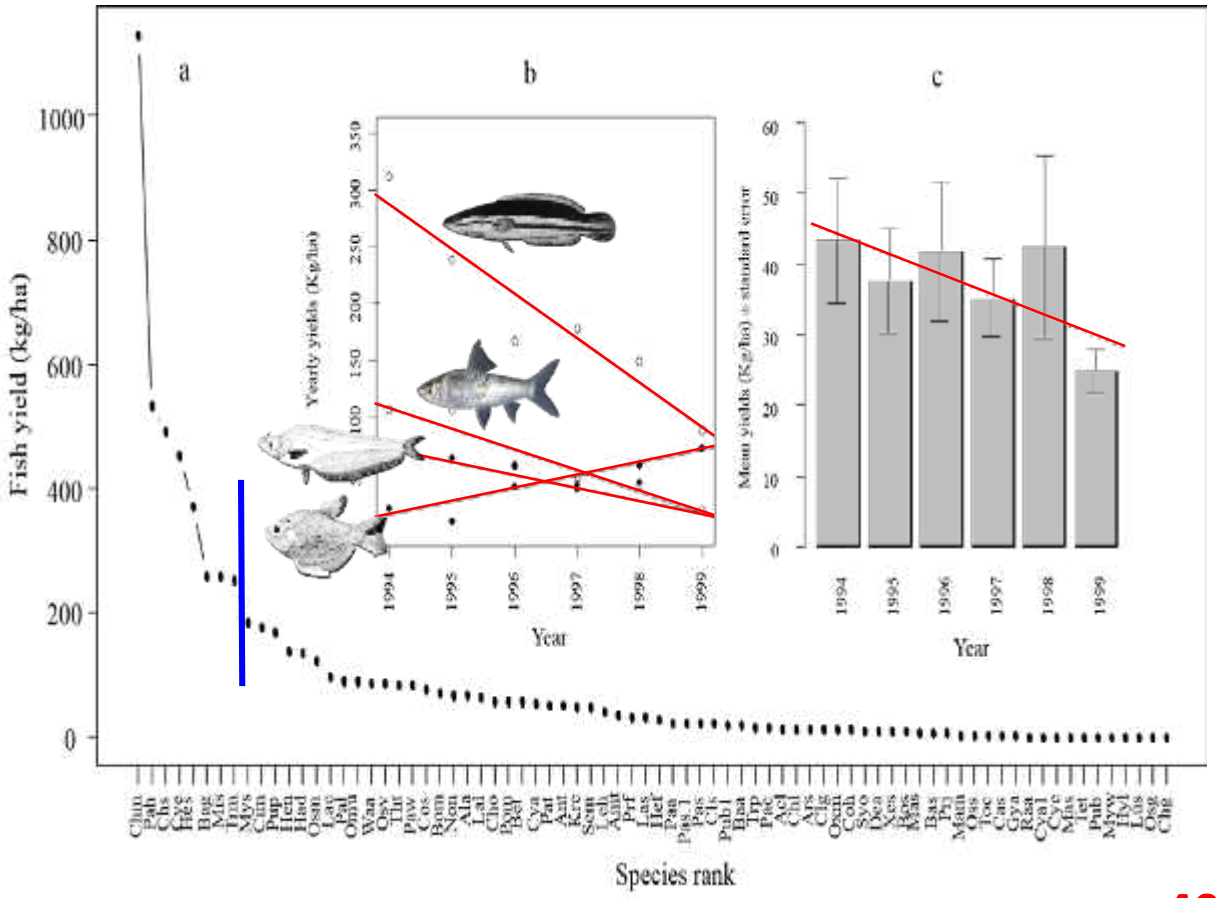
RESEARCH ARTICLE

Spatial and temporal changes in fish yields and fish communities in the largest tropical floodplain lake in Asia

Bunyeth Chan[1,2,*], Peng Bun Ngor[1,4], Nam So[4] and Sovan Lek[1,3]



58% of the TSL fish yields

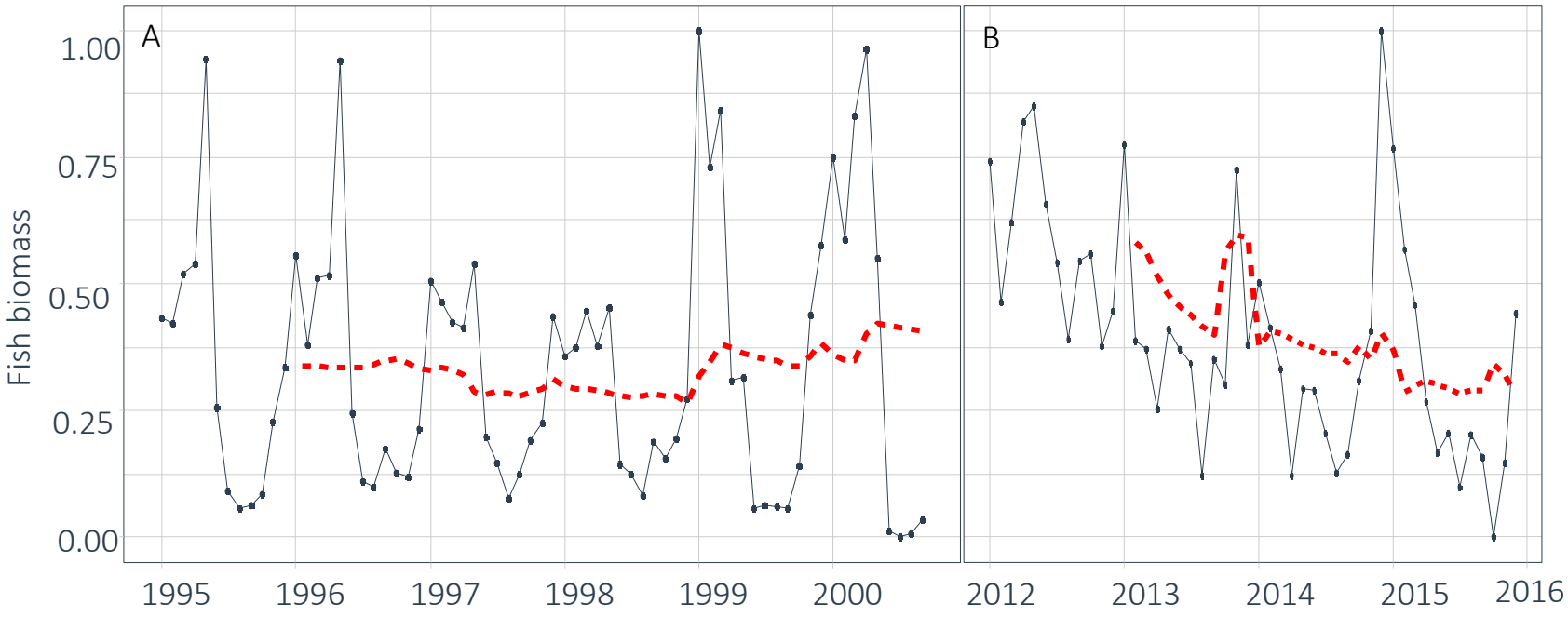


Chan et al., 2017, *Ann.lim-Int. J. Lim*

Family fishing: Temporal trends in fish biomass in the two periods

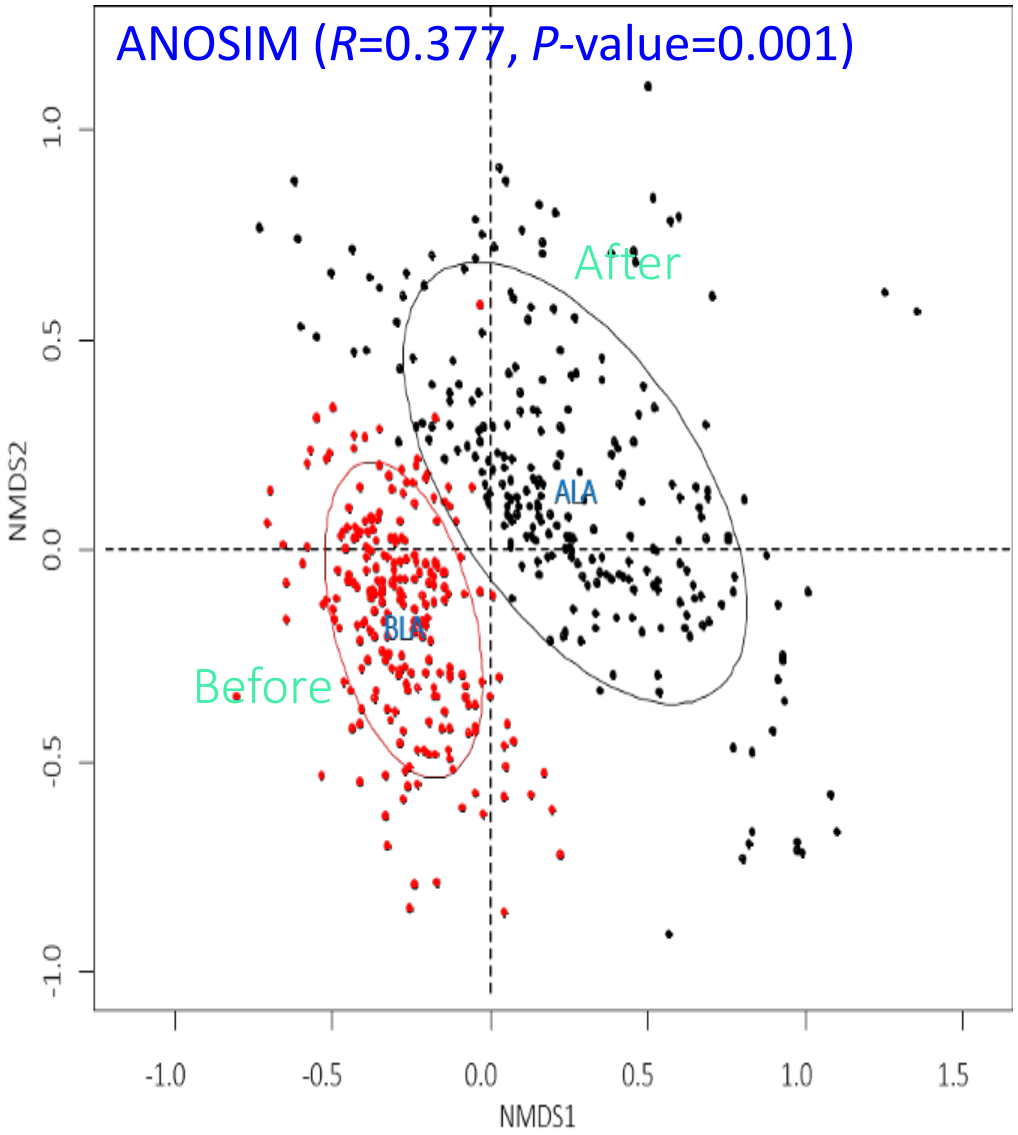
Before lot abolishment

After lot abolishment



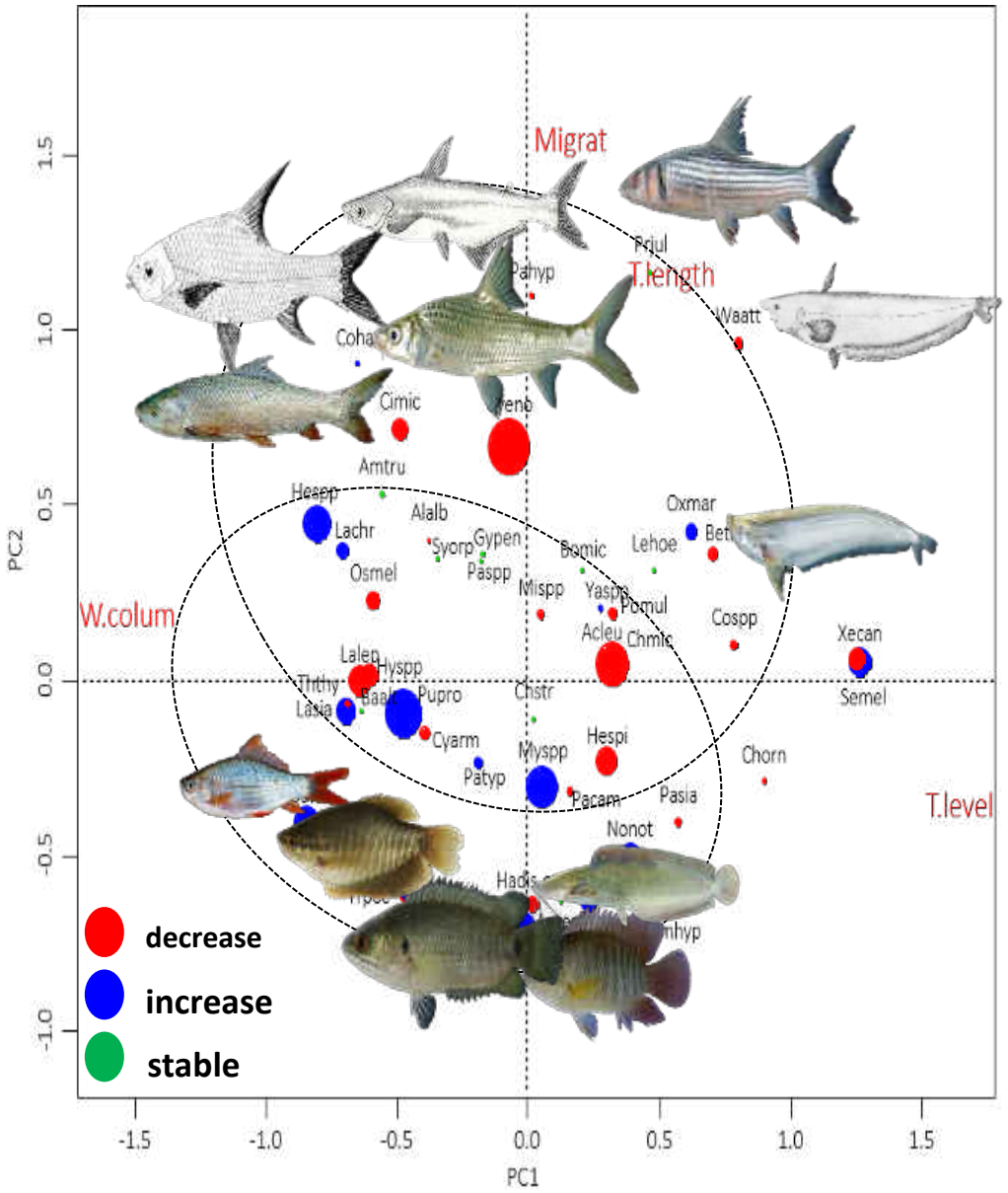
Chan et al., *In prep*

Fish community composition betwen two periods



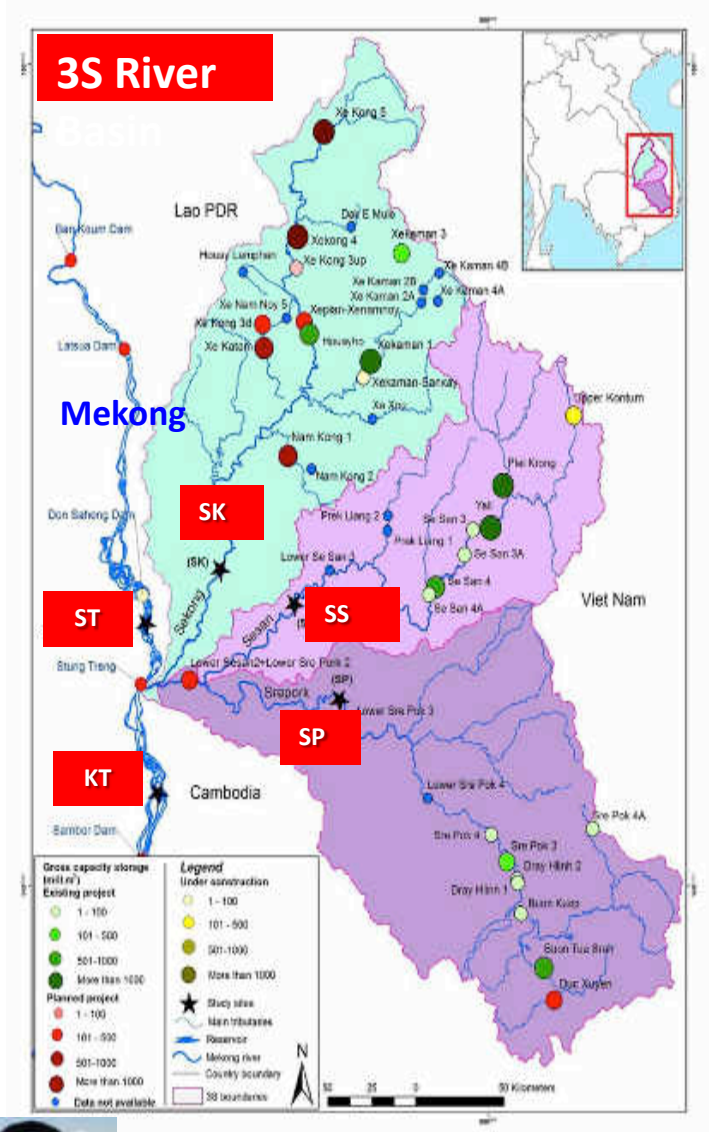
Chan et al., *Ecol Freshwater Fish., In revision*

Morphological and biological traits vs. change of spcies



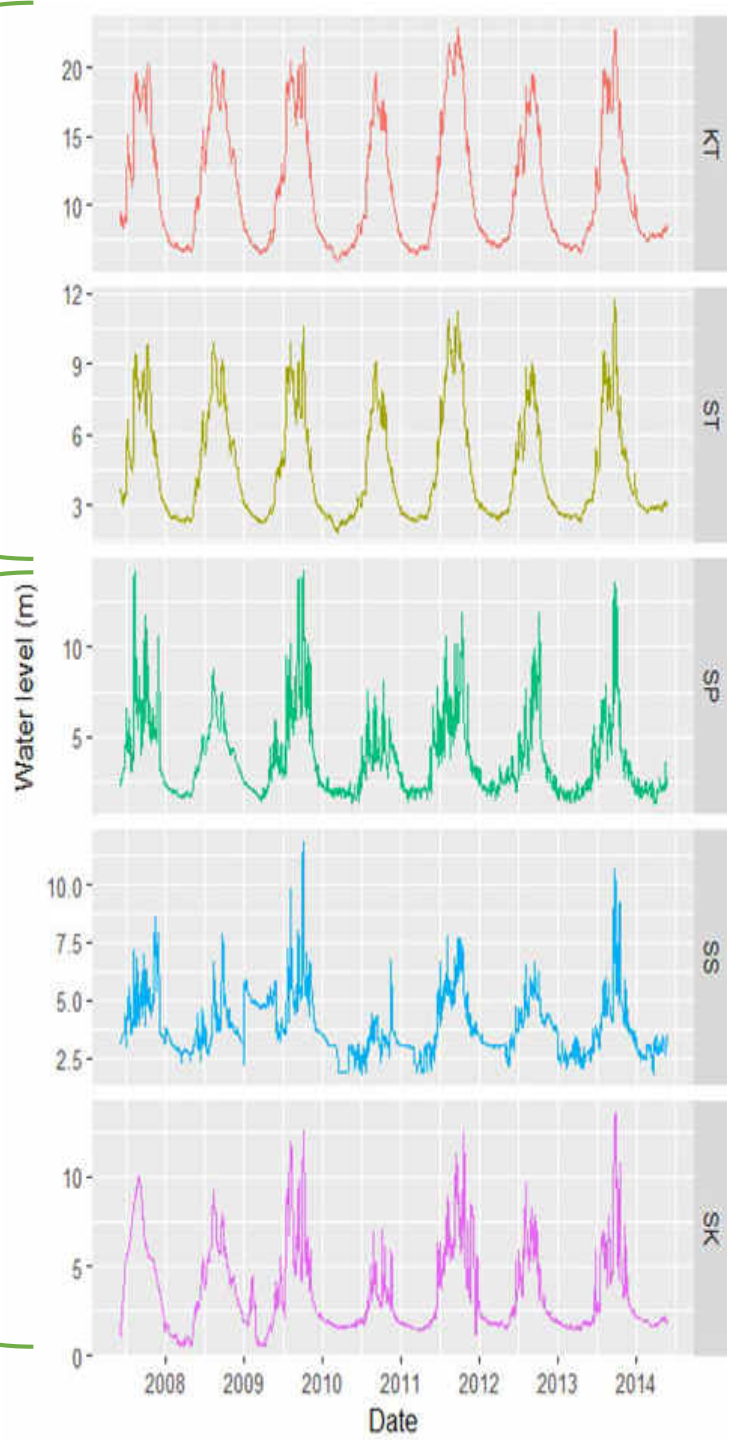
Chan et al., *In prep*

3S rivers: Site hydrology



Mekong Rivers

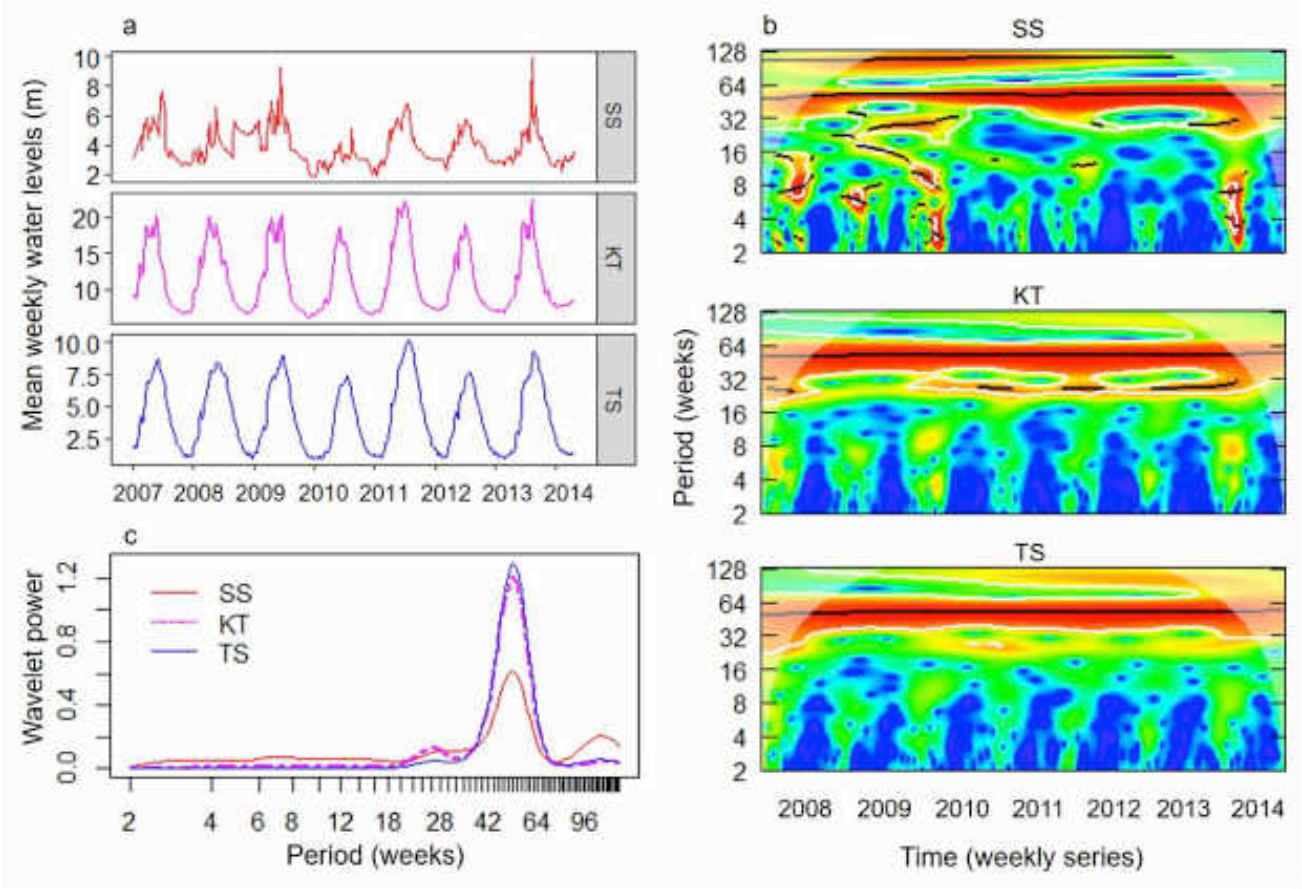
3S Rivers



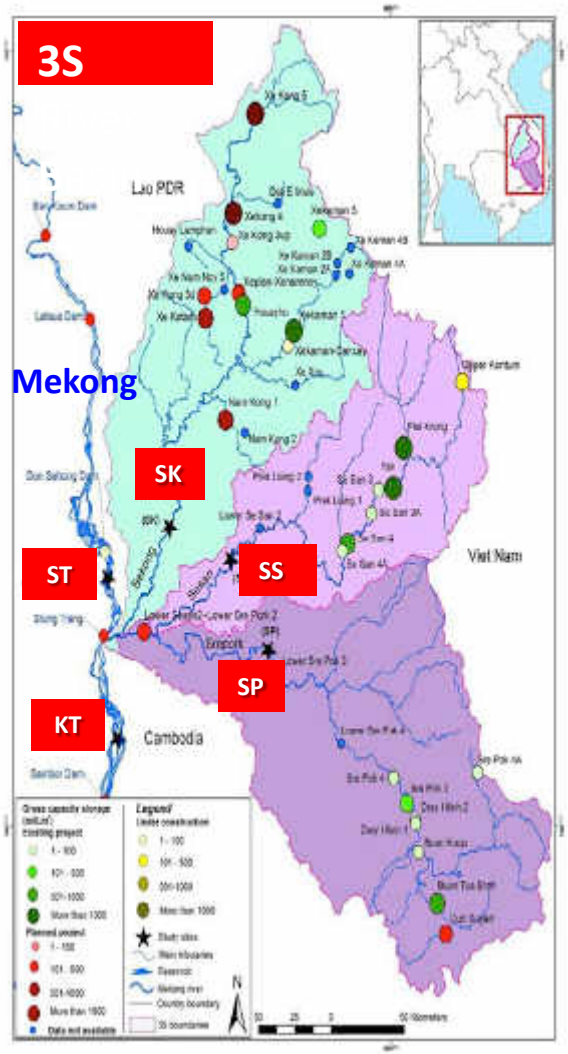
Ngor et al. 2018, *Ecological Indicators*

Fish assemblage responses to flow changes

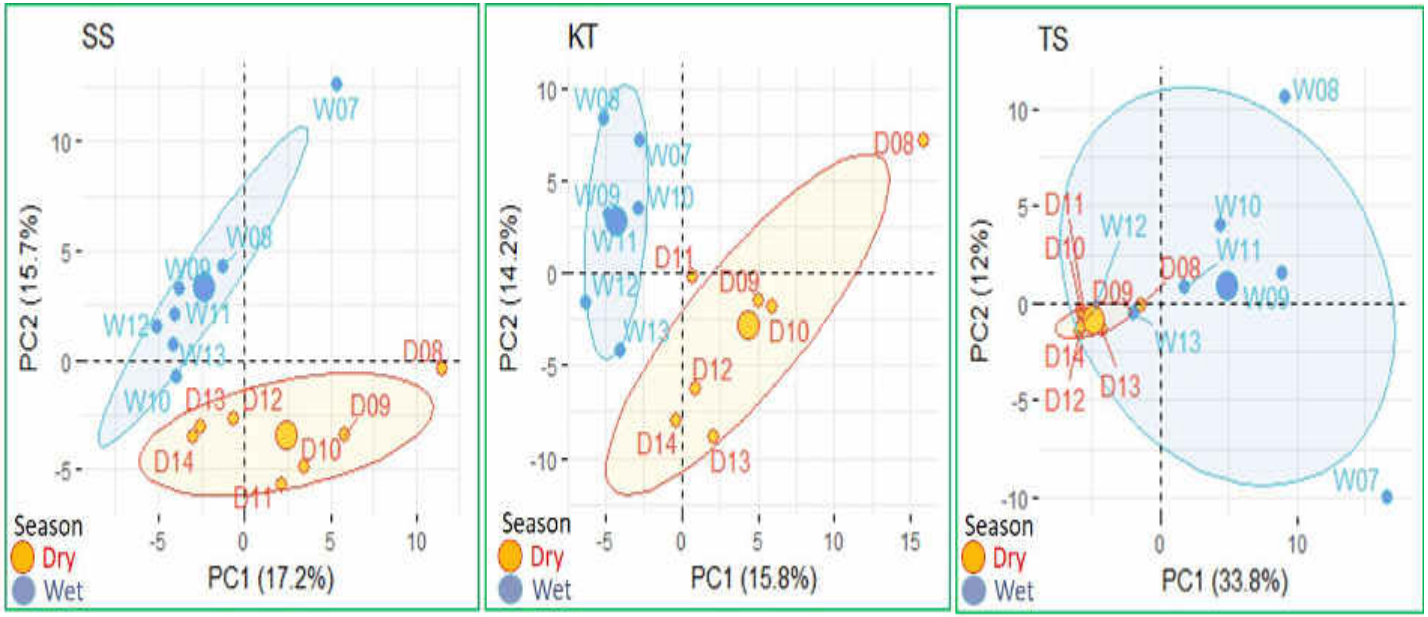
7-year daily fish and water level data

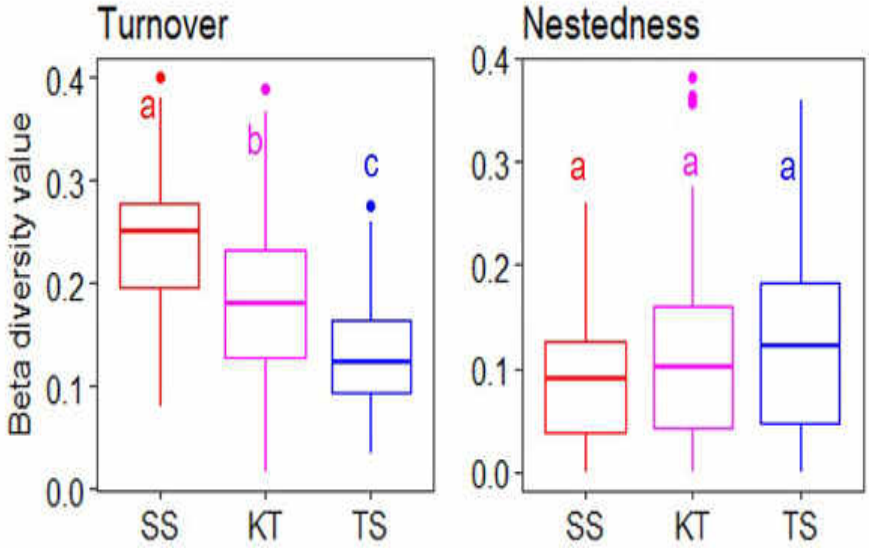


Cowell's seasonality index: SS = 0.83, KT = 0.90, TS = 0.93



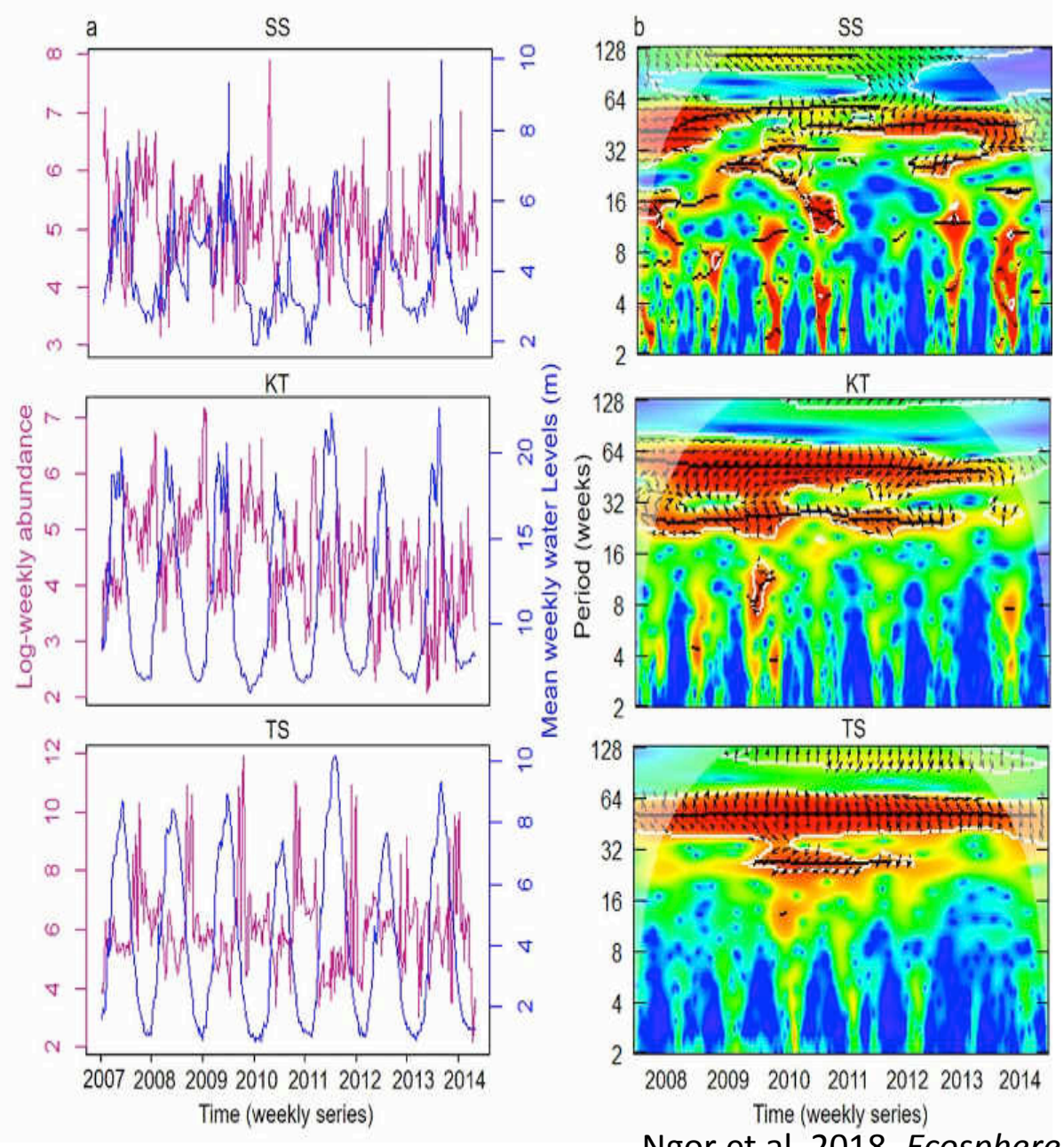
Seasonal community fluctuation/responses



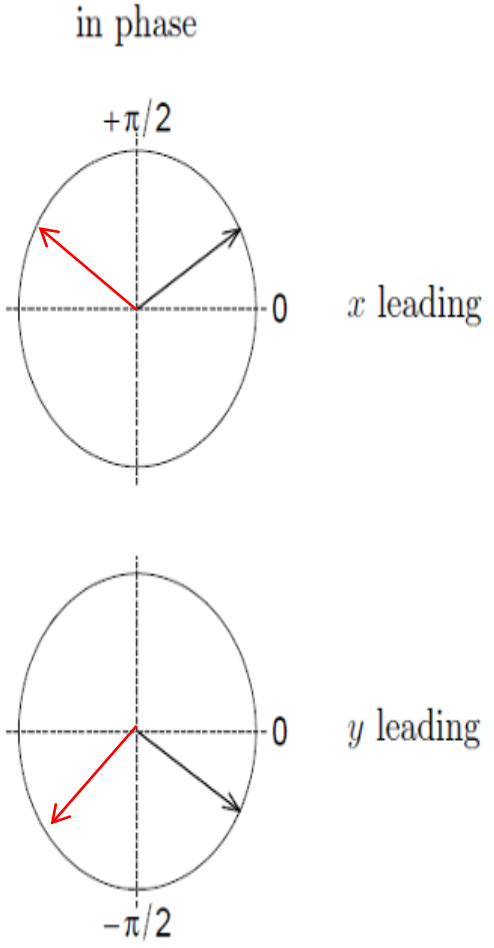


Ngor et al. 2018, *Ecosphere*

Inter-annual community responses (abundance)



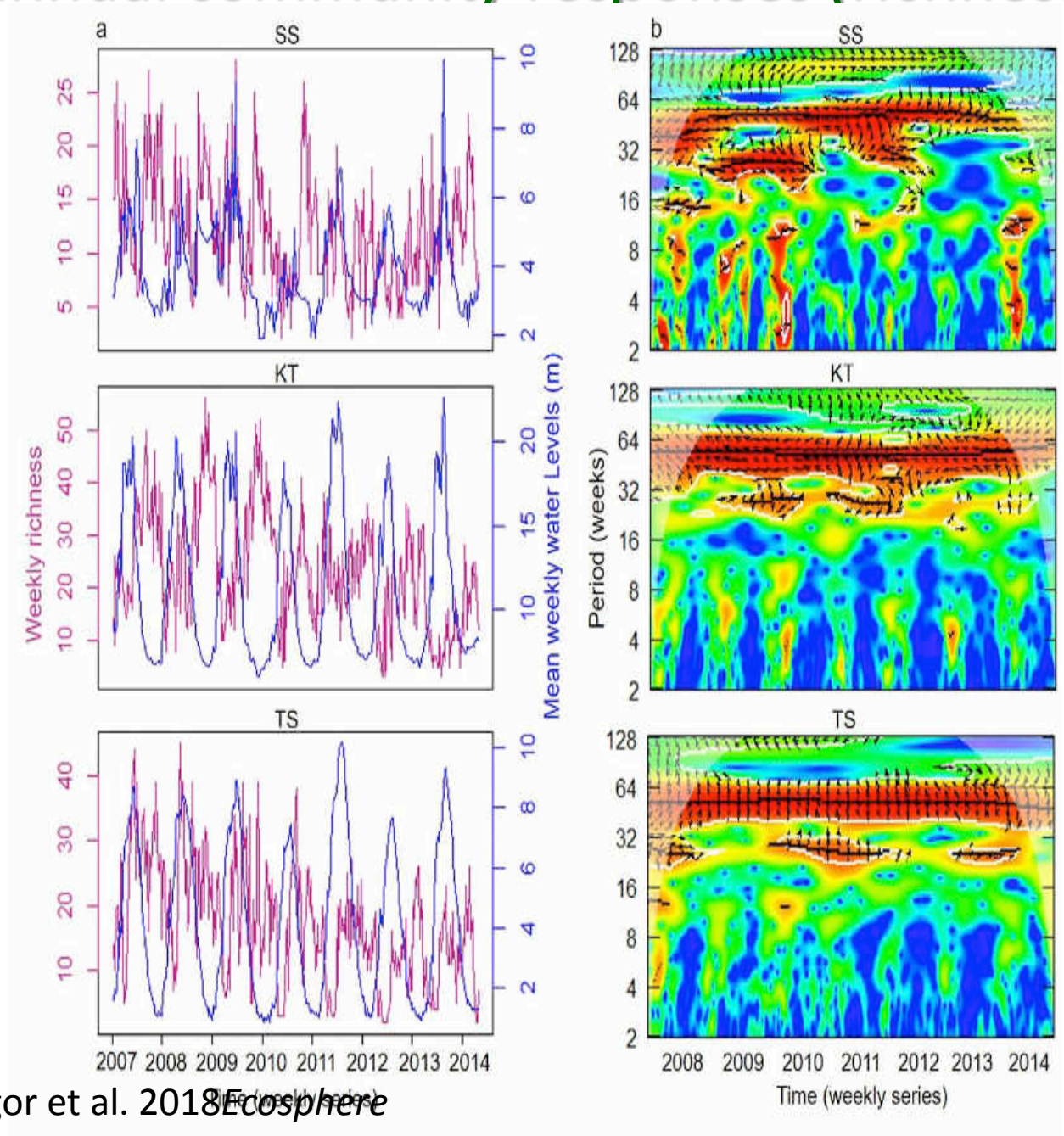
Ngor et al. 2018, *Ecosphere*



Red arrow: anti-phase

Rösch and Schmidbauer, 2014

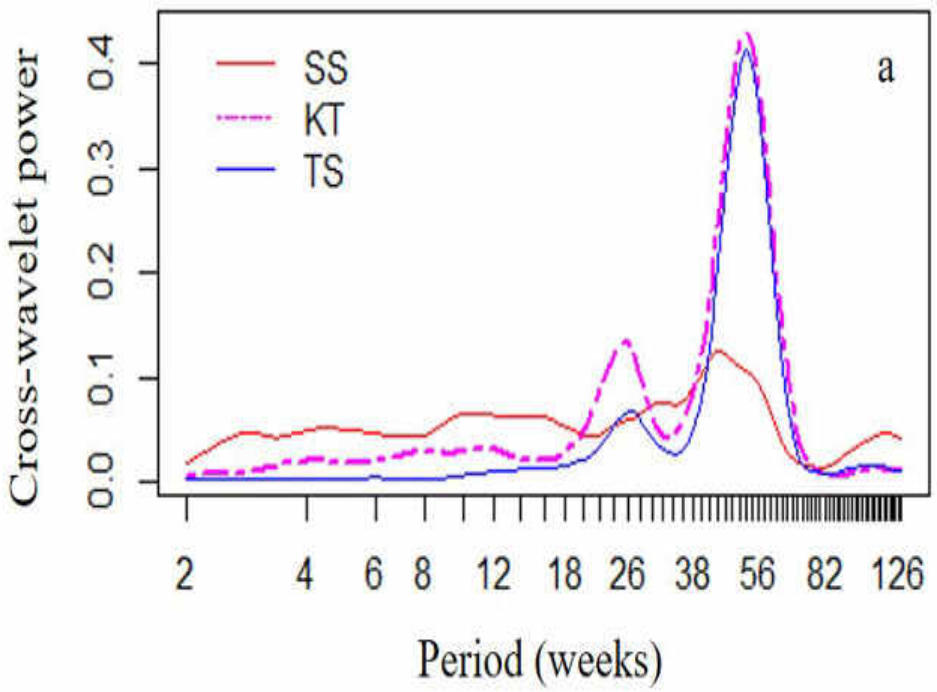
Inter-annual community responses (richness)



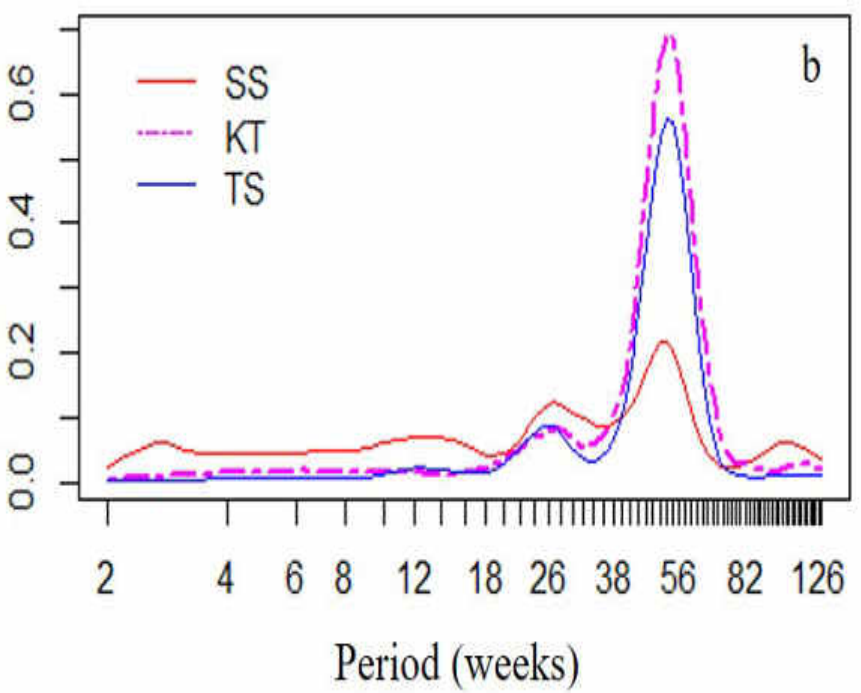
Ngor et al. 2018 *Ecosphere*

Inter-annual community responses: cross-wavelet power

Cross-wavelet power for abundance vs water level



Cross-wavelet power for richness vs water level



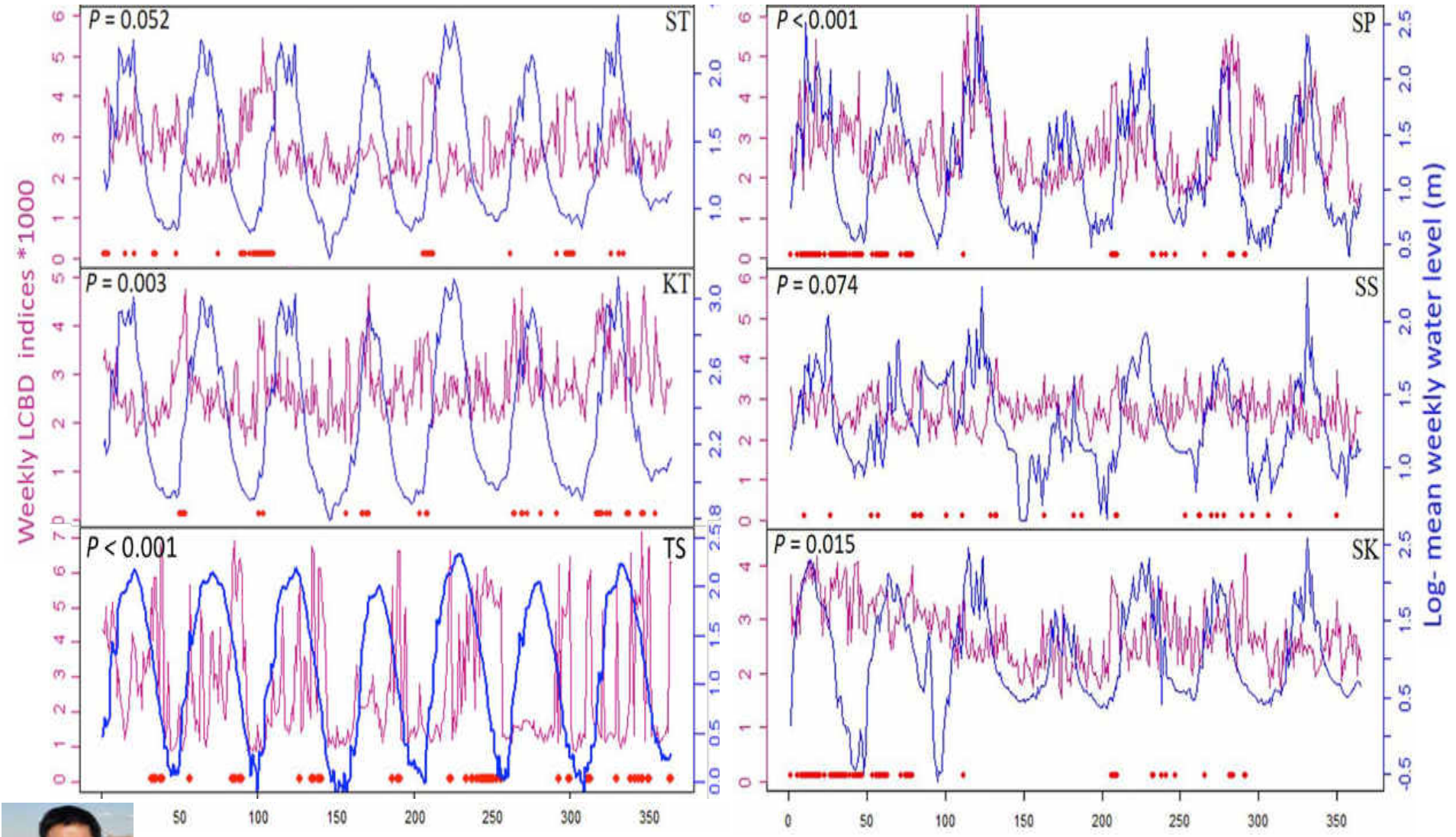
Ngor et al. 2018, *Ecosphere*

Inter-annual community responses (LCBD)

Weekly time series (June 2007-May 2014)

Strong seasonal-predictable rivers (Mekong, Tonle Sap)

Weak seasonal-predictable rivers – 3S



Ngor et al. 2018, *Ecological Indicators*

Overall synthesis

- Tonle Sap fisheries affected by indiscriminate fishing
  - ✓ Biomass deceasing
  - ✓ Size decreasing
- Fish assemblage responses to flow alternations
  - ✓ High turnover and aseasonal patterns in aseasonal-unpredictable rivers
  - ✓ Low turnover and regular peaks in seasonal and predictable rivers.
- Urgent needs for planning, fish monitoring, management and conservation.






BELMONT FORUM

MEKONG RIVER COMMISSION FOR SUSTAINABLE DEVELOPMENT
MRC

IFReDI
Inland Fisheries Research and Development Institute

Erasmus Mundus

LOTUS+

LOTUS

LOTUS

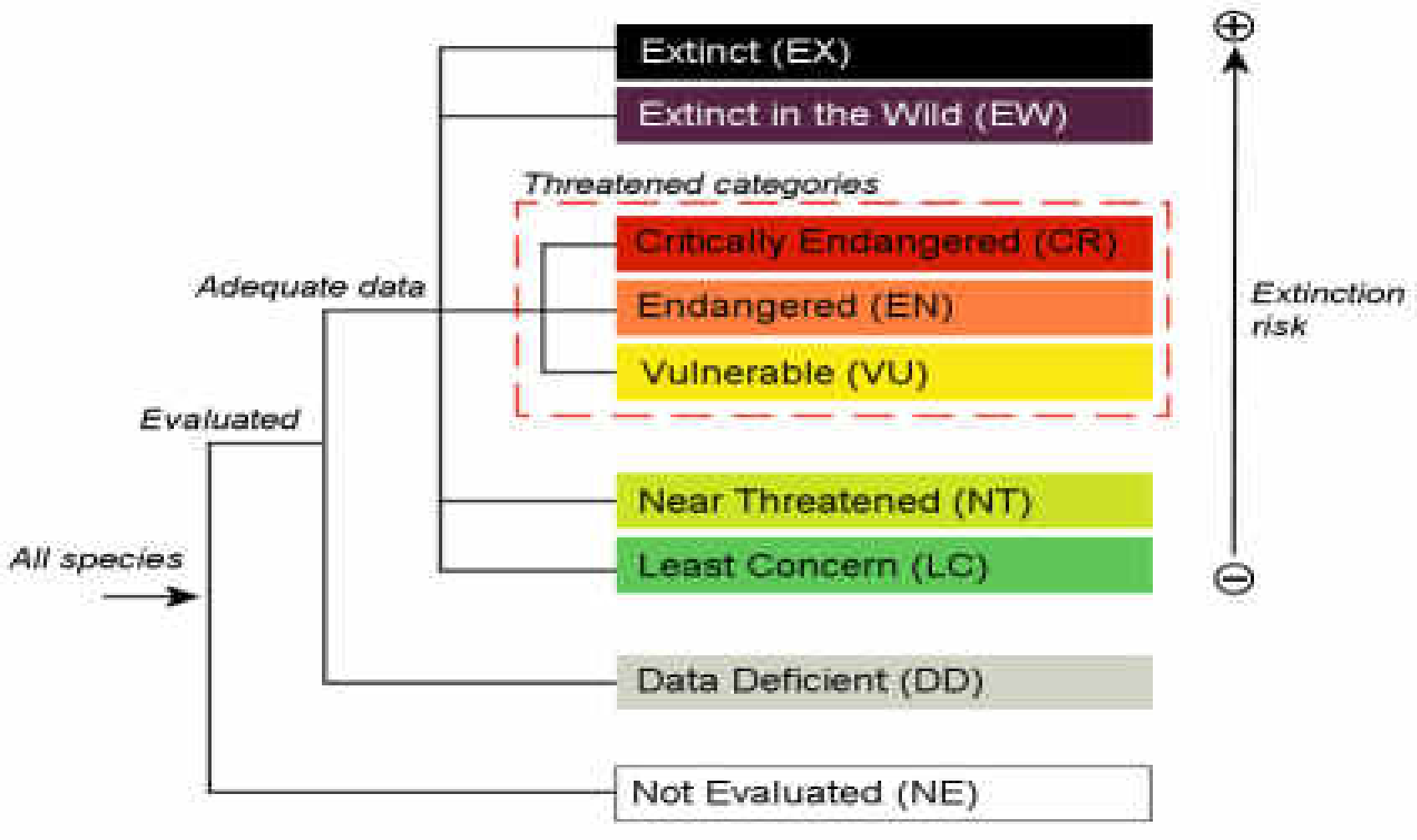
NutriSEA

UNICAM

CONSEA

Erasmus+

IUCN Red List Categories



Structure of the categories

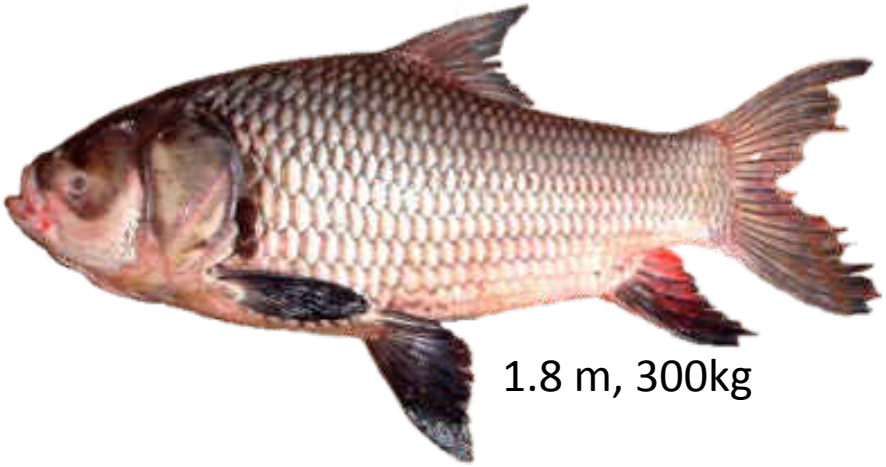
IUCN Red List Criteria for Endangered: Nature, T.(2009)

CRITICALLY ENDANGERED (CR)

Critically Endangered CR

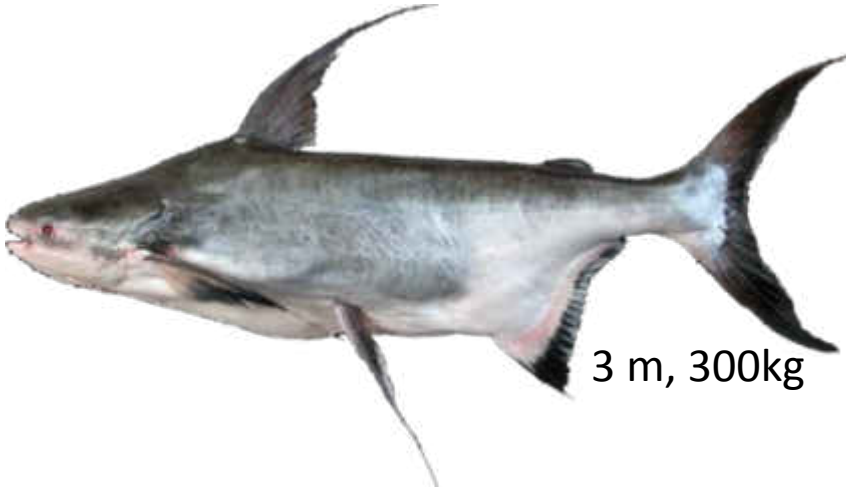
61cm

Datnioides pulcher



1.8 m, 300kg

Catlocarpio siamensis



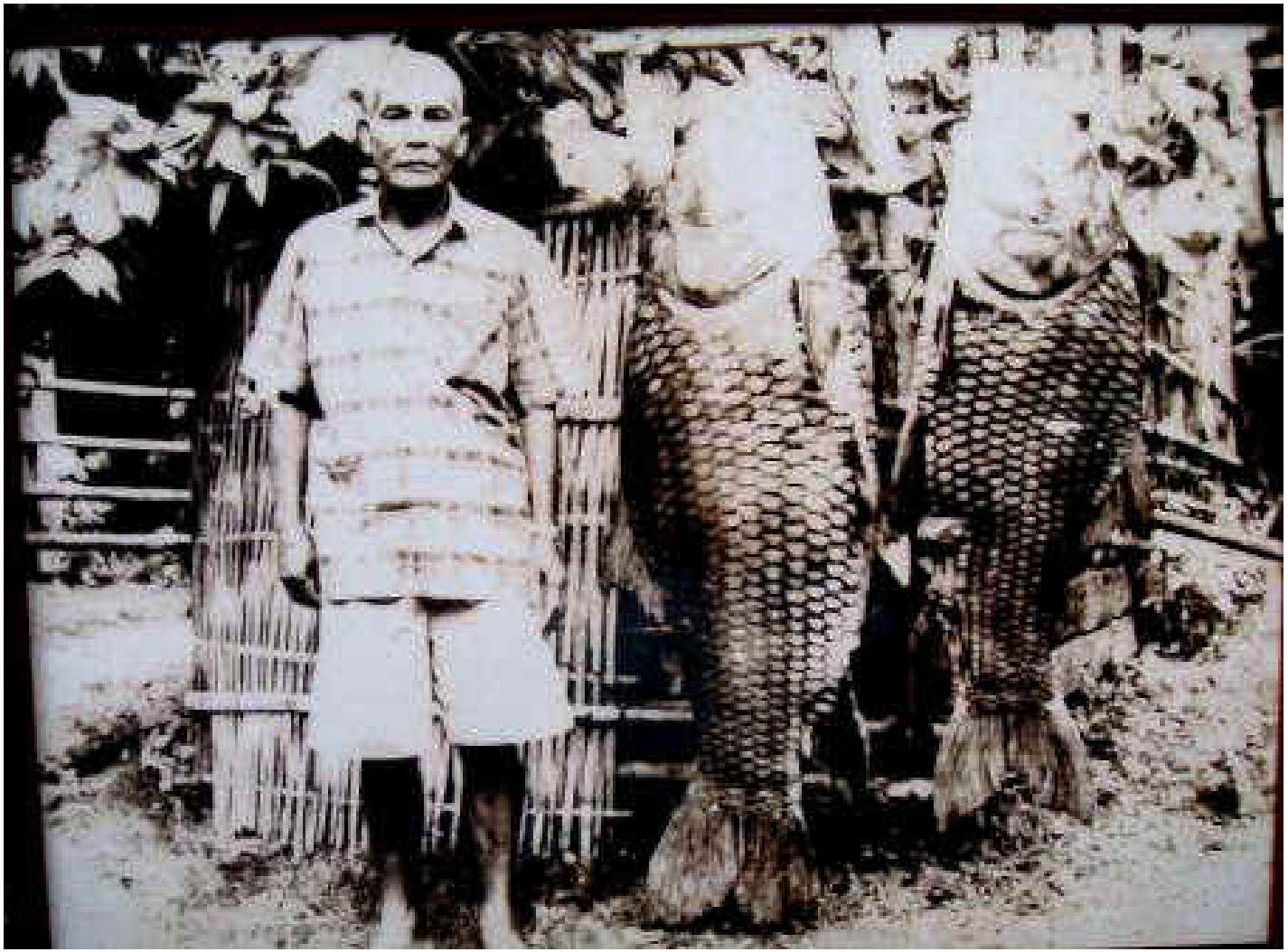
3 m, 300kg

Pangasius sanitwongsei

2.7 m, 293kg

Pangasianodon gigas

Catlocarpio siamensis



Chi River, Ban Chi Taun, Kheung Nai, Ubon, 1955

Pangasius sanitwongsei

Nan River, Staff specimens, Kasetsart Univer

90 kg. Mekong river, Kemmarat

Prince Akishino with *Pangasius sanitwongsei*
Khong Chiam 24 September 1992

96 kg. Khongchiam, 1998

Pangasianodon gigas

19 August 1968 Male 60 kg.
and 14 July 1969 Female 79 kg.
Mun River, Warinchamrap
(1971, Female 235 kg.)

2005, 138 kg. Mun River, Warinchamrap

2005, 112 kg. Mekong River, Khong Chiam, 2005

5 June 2011, 190 kg. Mekong River, Khong Chiam

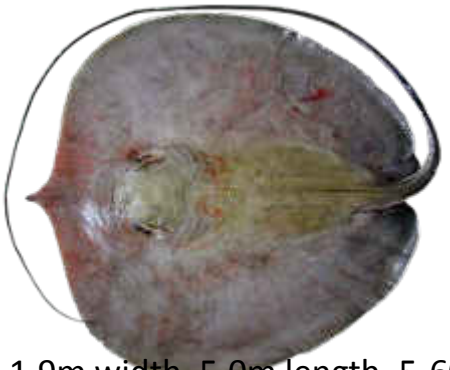
Balantiocheilos ambusticauda

Specimens from Bung Borapet, Nakhonsawan: Left-Holotype Right-Color illustration by Laung Masya Chittrakarn

This species was reported from Kemrat, Mekong river by Fowler 1934
Only this voucher specimen refer to distribution of this species in the basin

ENDANGERED (EN)

Endangered
EN



1.9m width, 5.0m length, 5-600kg

Himantura chaophraya

7cm SL

Laubuca caeruleostigmata

130cm, 30kg

Aaptosyax grypus

150cm, 70kg

Probarbus jullieni

150cm, 70kg

Probarbus labeamajor

130cm, 44kg

Pangasianodon hypophthalmus

Comparative characters for three species of Probarbus

Probarbus jullieni

150cm, 70kg

Probarbus labeamajor

150cm, 70kg

Probarbus labeaminor

150cm

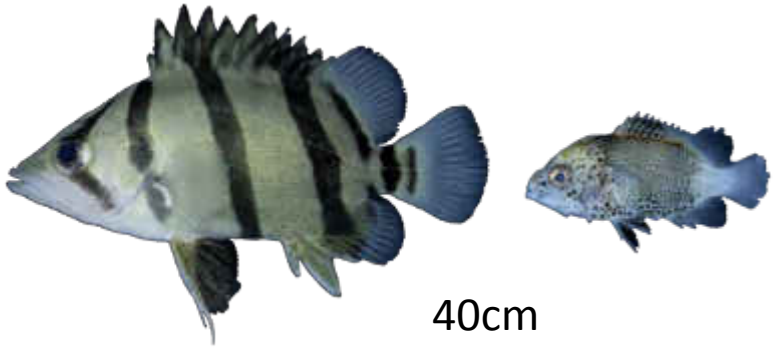
Fishes Landing Area in Ban Dan
Khong Chiam District, Ubon Ratchathani

Probarbus jullieni

Incredible thick lip of
Probarbus labeamajor

VULNERABLE (VU)

Vulnerable
VU



40cm

Datnioides undecimradiatus

60cm

Osphronemus exodon

60cm

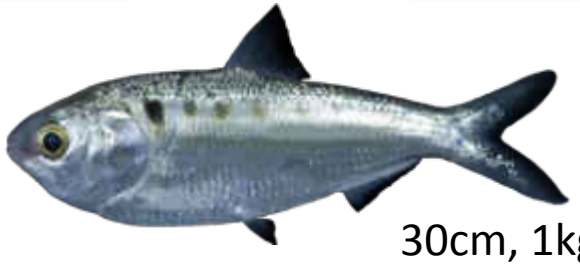
Bangana behri

65cm, 5kg

Cirrhinus microlepis

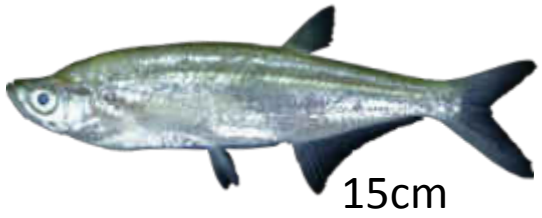
120cm, 14kg

Pangasius krempfi



30cm, 1kg

Tenualosa thibaudeaui



15cm

Oxygaster pointoni

VULNERABLE (VU)

Vulnerable
VU

40cm

Scaphognatops bandanensis

25cm

Hypsibarbus wetmorei

40cm

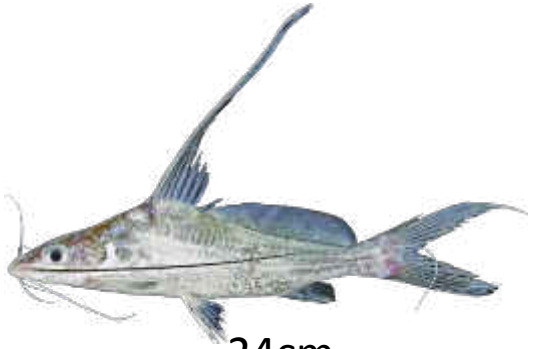
Hypsibarbus largleri

64cm

Epalzeorhynchos munense

10cm

Yasuhikotakia splendida

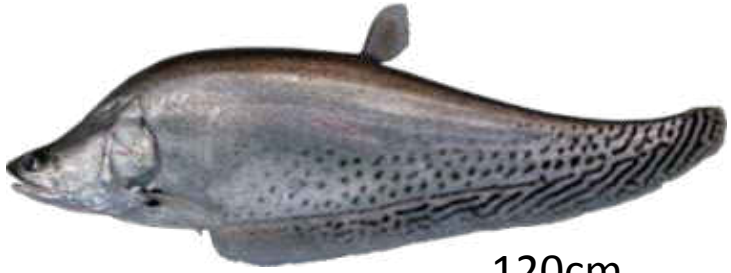


24cm

Mystus bocourti

NEAR THREATENED (NT)

Near Threatened NT

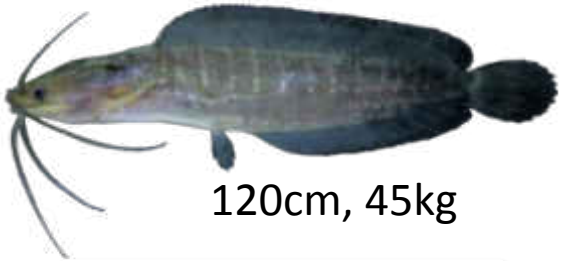


120cm

Chitala blanci

45cm

Mekongina erythrospila



120cm, 45kg

Clarias macrocephalus

Bosemania microlepis

55cm

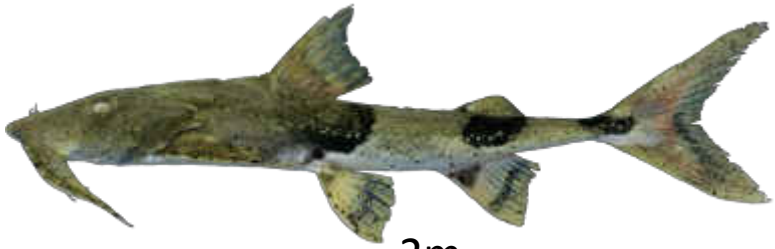
Cirrhinus molitorella

1m

Macrochirichthys macrochirus

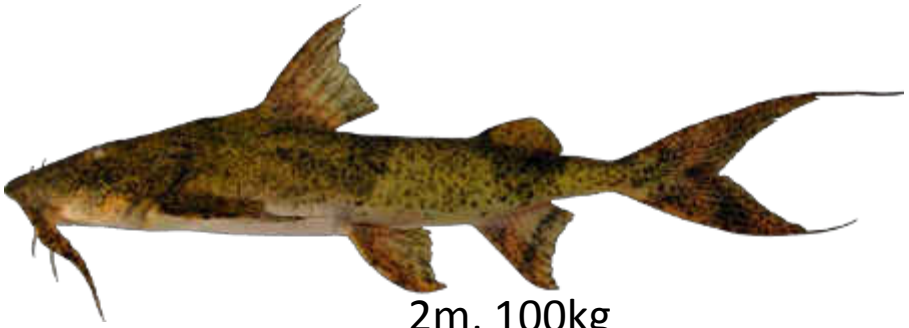
NEAR THREATENED (NT)

Near Threatened NT



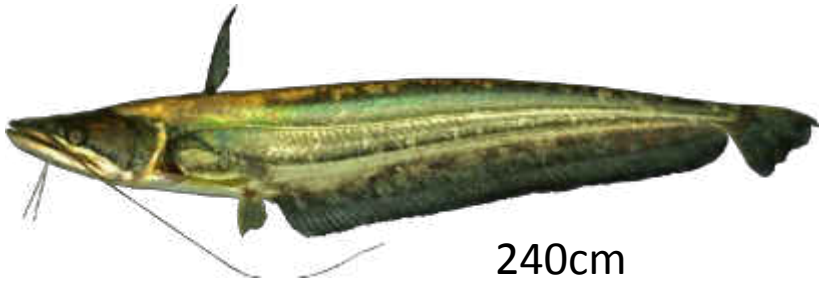
2m

Bagarius bagarius



2m, 100kg

Bagarius yarrelli



240cm

Wallago attu

60cm

Syncrossus beauforti

LEAST CONCERN (LC)

Least concerned LC

28cm

Gyrinocheilus pennocki

49cm

Labeo yunnanensis

1.5m

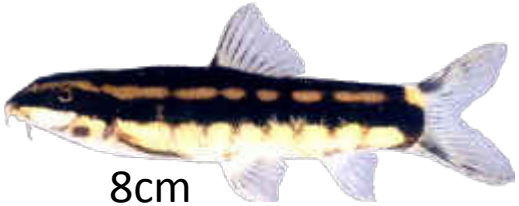
Chitala lopis

12cm

Pao baileyi

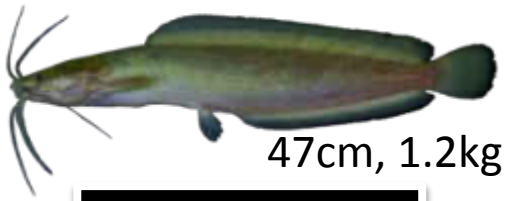
11cm

Yasuhikotakia eos



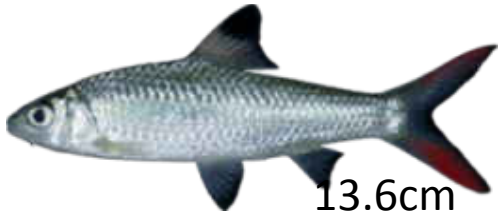
8cm

Ambastaia nigrolineata



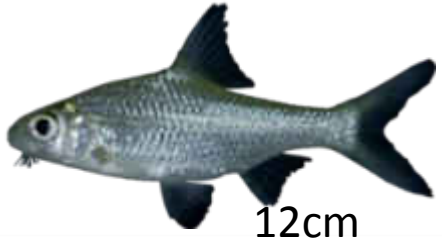
47cm, 1.2kg

Clarias batrachus



13.6cm

Dischero dontus ashmeadi



12cm

Cyclocheilichthys heteronema

2cm

Phenacostethus smithi

5.8cm

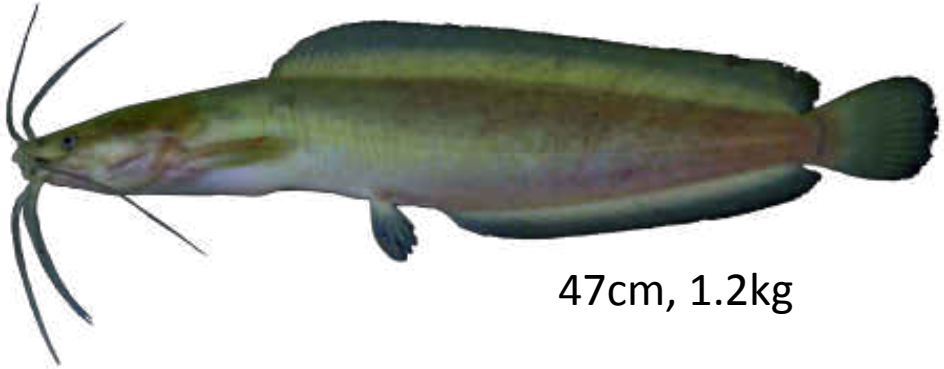
Poropuntius speleops

LEAST CONCERN (LC) – Status uncertain from Mekong basin ???

27cm

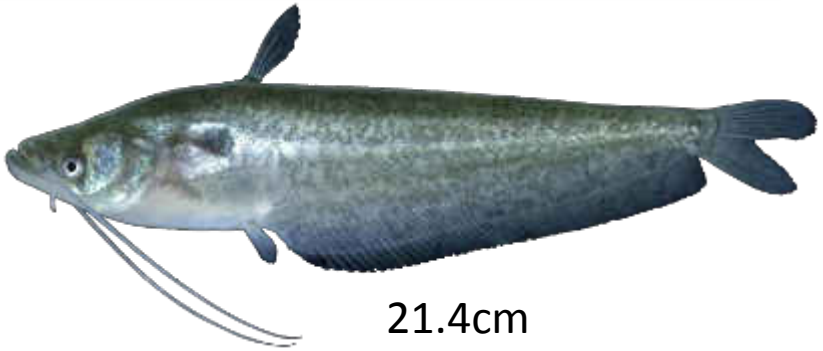
Heteropneustes kemratensis Fowler 1934

This species purposed by Fowler 1934 was the new genus “Clarisilurus” by some share external characteristic of 2 groups of Catfish (see below) but distributed of this species in Mekong still uncertain.



47cm, 1.2kg

Clarias batrachus



21.4cm

Ompok siluroides

Thailand CITES:-Appendix I

Endangered
EN

90cm TL

Scleropages formosus

3m, 300kg

Pangasianodon gigas

1.5m, 70kg

Probarbus jullieni

16 species of fishes in the world were list in this appendix list with 3 species of Mekong fishes

www.cites.org

Fish Mekong status

Total: 1148 species

Critically Endangered (CR)	Endangered (EN)	Vulnerable (VU)	Near Threatened (NT)	Least Concern (LC)
18	27	42	37	430

412 species were not get status