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Modelling the structure and interannual dynamics of energy flows in Yangtze estuary and its adjacent waters

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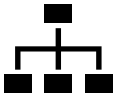
Outline of Presentation

What we did in this study?

- Constructing three ecosystem snapshots for three periods: 1985-1986, 2004 and 2014 by the Ecopath model
- Analyzing the structure of the energy flow in 2014
- Analyzing the interannual dynamics of energy flows by comparisons

Outline of Presentation

Backgrounds



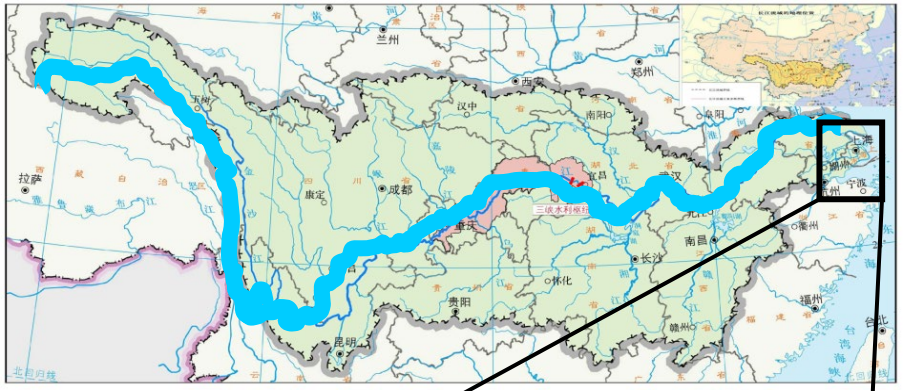
Materials and Methods

Results and Discussions

Summary

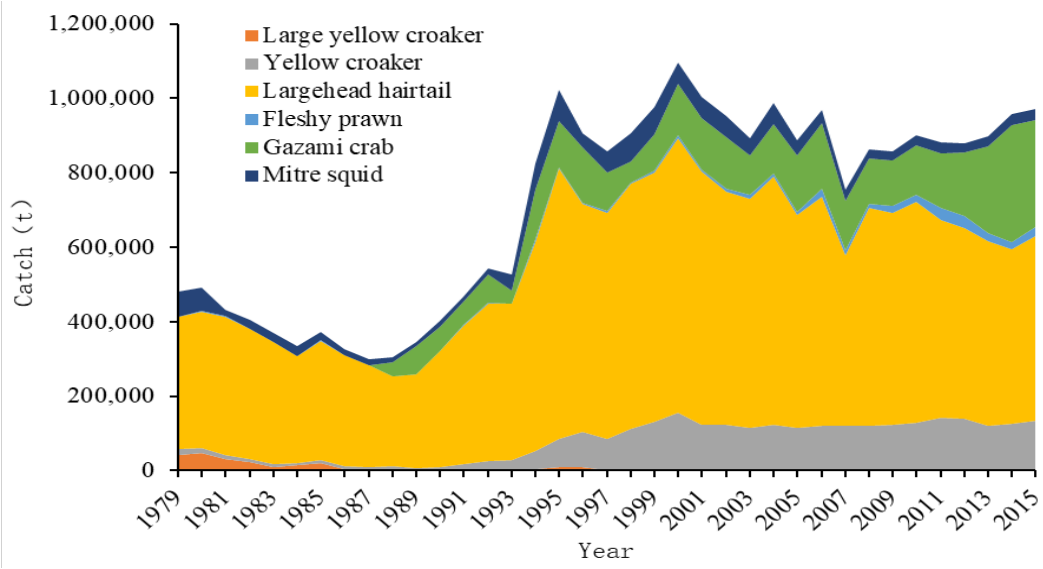
Background

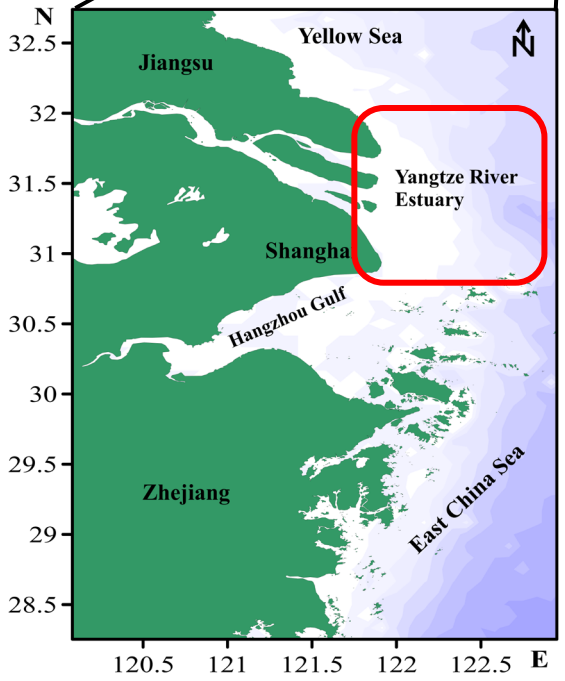
- China's largest estuary ecosystem
- A large amount of terrestrial material into this area every year via the Yangtze River runoff



Ecopath with Ecosim

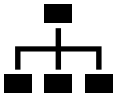
No fish is an island





Outline of Presentation

Backgrounds



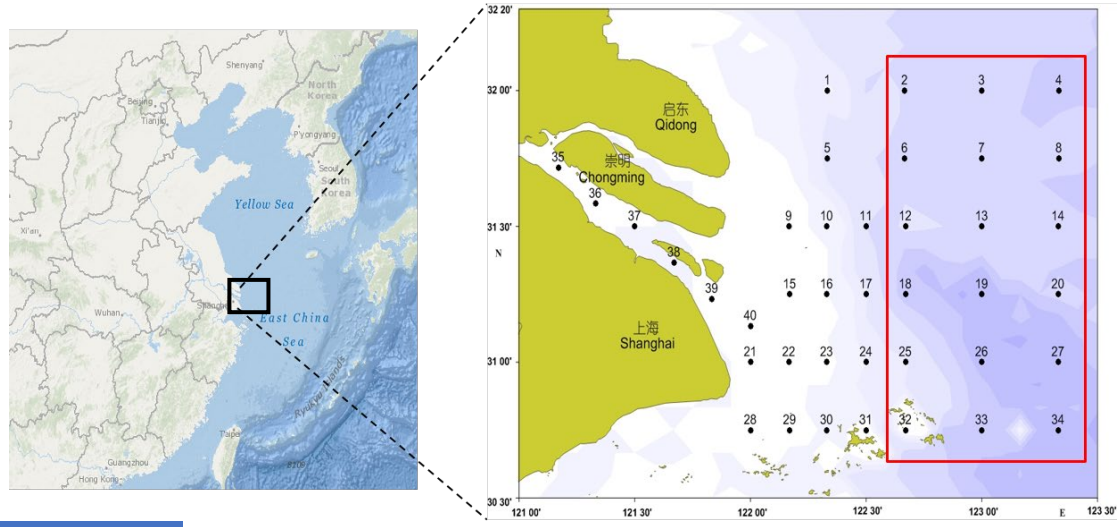
Materials and Methods

Results and Discussions

Summary

Materials and Methods

Study area



Ecopath

Ecopath with Ecosim (EwE) 6.5
(www.ecopath.org)

EcoTroph plugin

D. Gascuel and D. Pauly, 2009. EcoTroph: Modelling marine ecosystem functioning and impact of fishing. Ecol. Model. 220(21):2885–2898.

Inputs

1. Biomass
2. Production/Biomass
3. Consumption/Biomass
4. Catch
5. Diet

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6. Ecotrophic efficiency
7. Unassim. consumption
8. Off-vessel price
9. EcoTroph inputs

……

Materials and Methods

Main equations

biomass accumulation

Production **predation** **fishery** **net migration**

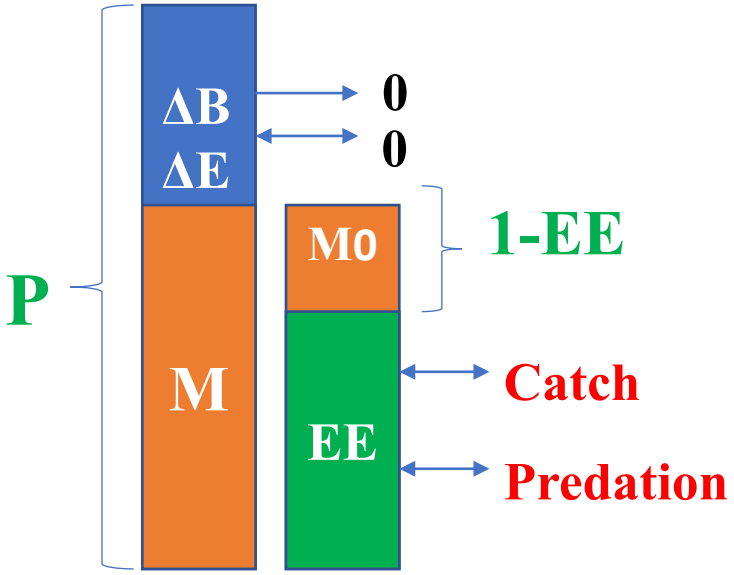
$$B_i \times \left(\frac{P}{B}\right)_i = \sum_j B_j \times \left(\frac{Q}{B}\right)_j \times DC_{ij} + Y_i + NM_i + BA_i + B_i \times \left(\frac{P}{B}\right)_i \times (1 - EE_i) \quad (1)$$

other mortality

Consumption **respiration**

$$Q_i = P_i + R_i + U_i \quad (2)$$

production **unassimilated food**



Materials and Methods

PREBAL diagnoses

(1) Biomasses across taxa and trophic levels
(2) Biomass ratios
(3) Vital rates across taxa and trophic levels
(4) Vital rate ratios
(5) Total production and removals

Sensitivity

Influences of the basic inputs on the model's estimations

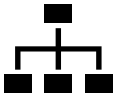
Balance of the model

Ecological and thermodynamic principles of model balance

Parameters	Range
Ecotrophic Efficiency(EE)	EE < 1.0
Gross food conversion efficiency (GE)	0.1 < GE < 0.3
Net Efficiency	Net Efficiency > GE
Respiration/Assimilation Biomass (RA/AS)	RA/AS < 1.0
Respiration/Biomass (RA/B)	Fish：1-10 $year^{-1}$；High conversion efficiency group：50-100 $year^{-1}$；
Production/Respiration (P/RA)	P/RA< 1.0

Outline of Presentation

Backgrounds



Materials and Methods

Results and Discussions

Summary

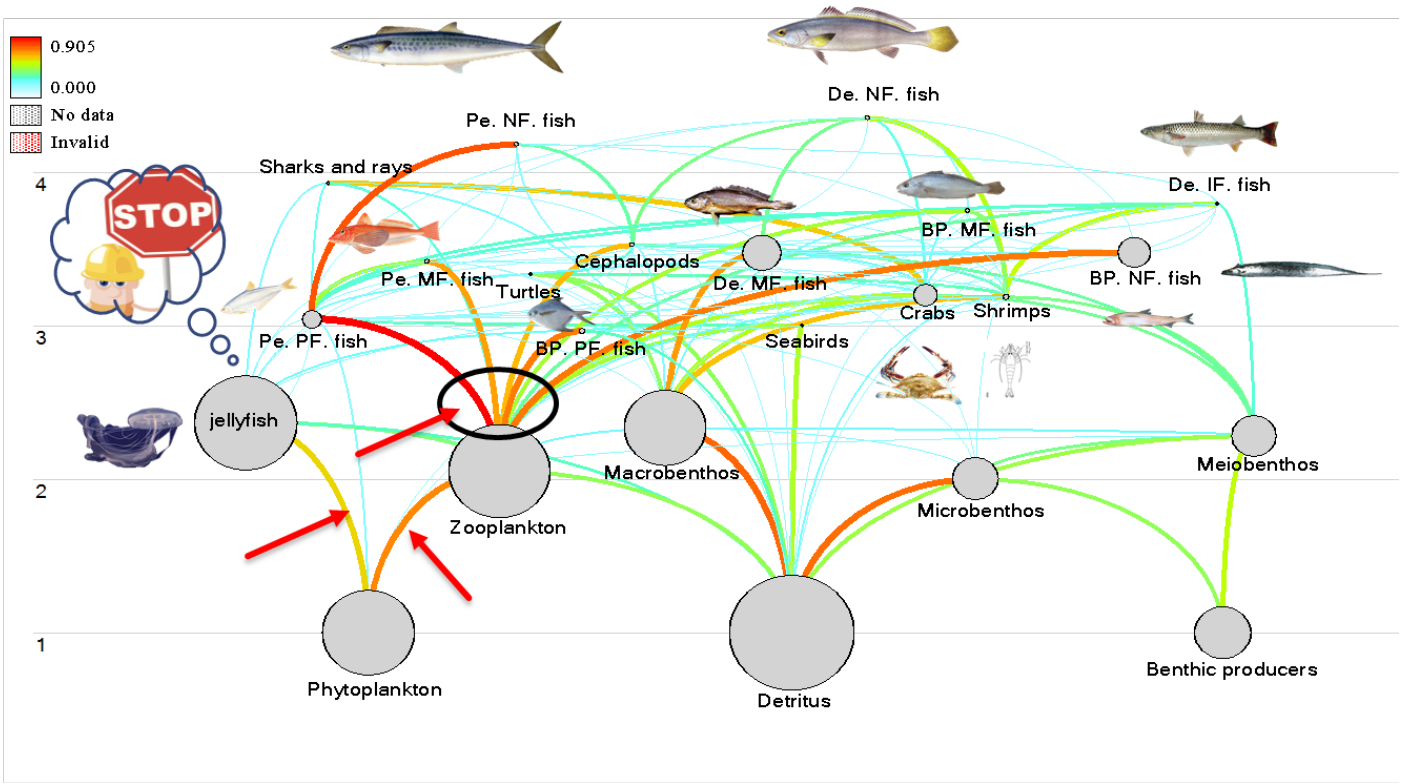
Results and discussions

- Snapshot for the estuarine energy flow in 2014
- Dynamics of energy flows from 1985 to 2014

Snapshot for the estuarine energy flow in 2014

Basic inputs and outputs

Group name	Trophic level	Biomass	P/B	Q/B	EE	Un. Q	Landings	Flow to detritus	NE	OI
Seabirds										
Sharks										
Turtles										
Macrobenthos										
Meiobenthos										
Microbenthos										
Cephalopods										
Crabs										
Shrimps										
De. MF. fish										
De. NF. Fish										
De. IF. Fish										
Bp. MF. fish										
Bp. NF. Fish										
Bp. PF. fish										
Pe. MF. fish										
Pe. NF. Fish										
Pe. PF. fish										
Jellyfish										
Zooplankton										
Phytoplankton										
Benthic producers										
Detritus										



Biomass: t·km-2. P/B: a-1. Q/B: a-1. Un. Q: ratios of unassimilated consumption. Landings: t·km-2·a-1. Flow to detritus: t·km-2·a-1. NE: Net efficiency. OI: Omnivory index. Major species of functional group (biomass weight > 0.10)

Snapshot for the estuarine energy flow in 2014

Keystone FGs

Relative importance index of taxa groups in 2014

No.	Taxa	Relative total impact
20	Zooplankton	1
4	Macrobenthos	0.992
10	De. MF. fish	0.915
14	Bp. NF. fish	0.839
18	Pe. PF. fish	0.784
21	Phytoplankton	0.761
5	Meiobenthos	0.722
1	Seabirds	0.706
9	Shrimps	0.646
8	Crabs	0.636
6	Microbenthos	0.59
7	Cephalopods	0.537
22	Benthic producers	0.38
19	Jellyfish	0.299
11	De. NF. fish	0.272
12	De. IF. fish	0.261
17	Pe. NF. fish	0.192
15	Bp. PF. fish	0.148
16	Pe. MF. fish	0.0705
13	Bp. MF. fish	0.0617
3	Turtles	0.0262
2	Sharks and rays	0.0002

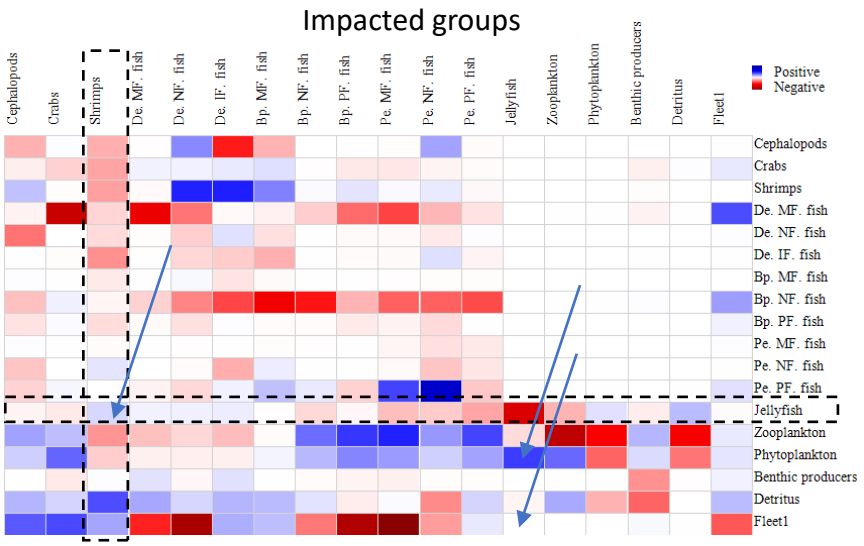
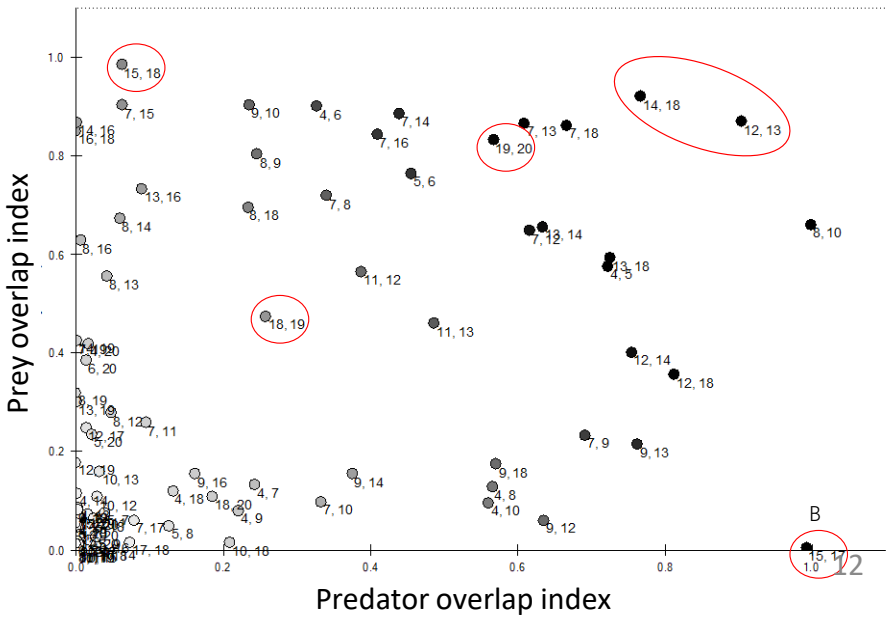


Figure 4.1.2 Mixed trophic impacts in 2014



Snapshot for the estuarine energy flow in 2014

EcoTroph

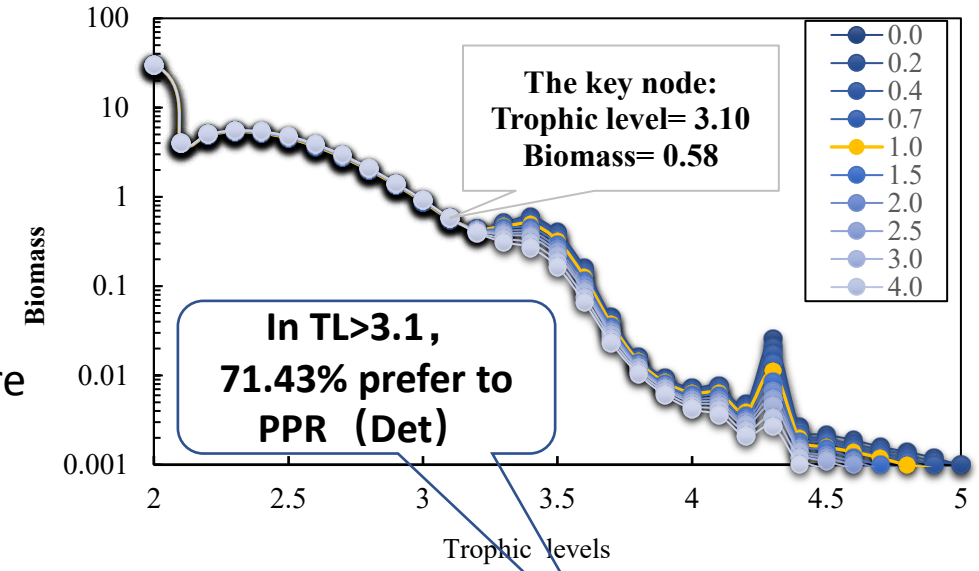
TL>3.1

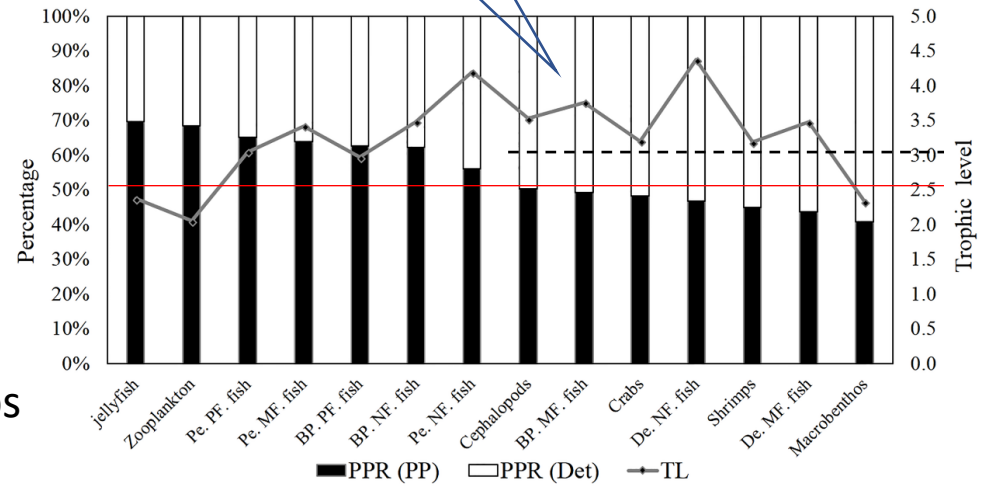
Functional groups whose TLs > 3.1 were more sensitive to fishing pressures.

PPR (PP): primary production required from phytoplankton

PPR (Det): primary production required from detritus

The ratio of PPR (PP) to PPR (Det) perhaps played a special role among functional groups.





Primary production required decompositions of taxa groups

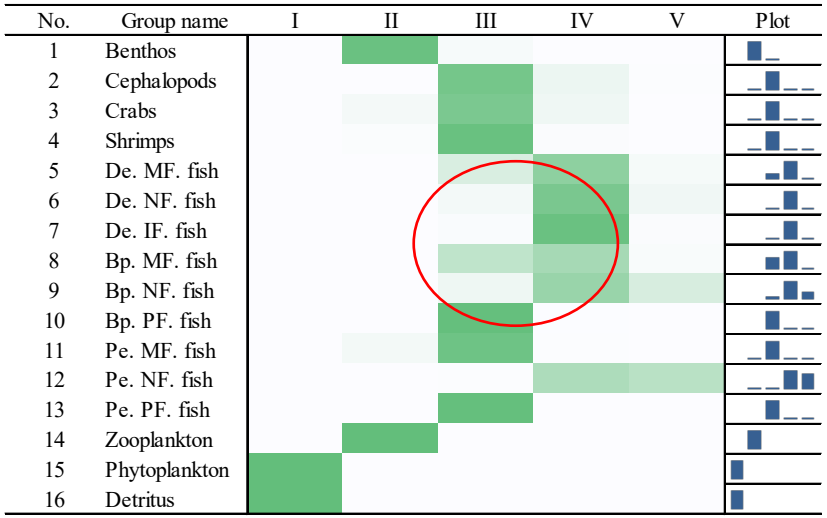
Results and discussions

- Snapshot for the estuarine energy flow in 2014
- Dynamics of energy flows from 1985 to 2014

Dynamics of functional groups from 1985 to 2014

Decompositions of TLs

Trophic level decomposition in 1985-1986

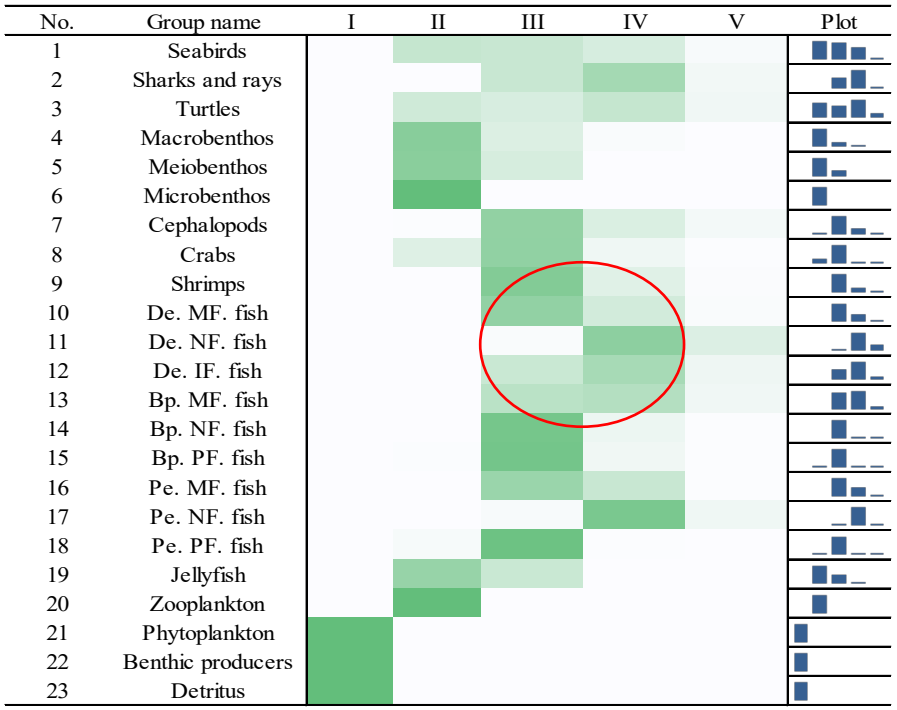


No.	Group name	I	II	III	IV	V	Plot
1	Benthos						
2	Cephalopods						
3	Crabs						
4	Shrimps						
5	De. MF. fish						
6	De. NF. fish						
7	De. IF. fish						
8	Bp. MF. fish						
9	Bp. NF. fish						
10	Bp. PF. fish						
11	Pe. MF. fish						
12	Pe. NF. fish						
13	Pe. PF. fish						
14	Zooplankton						
15	Phytoplankton						
16	Detritus						

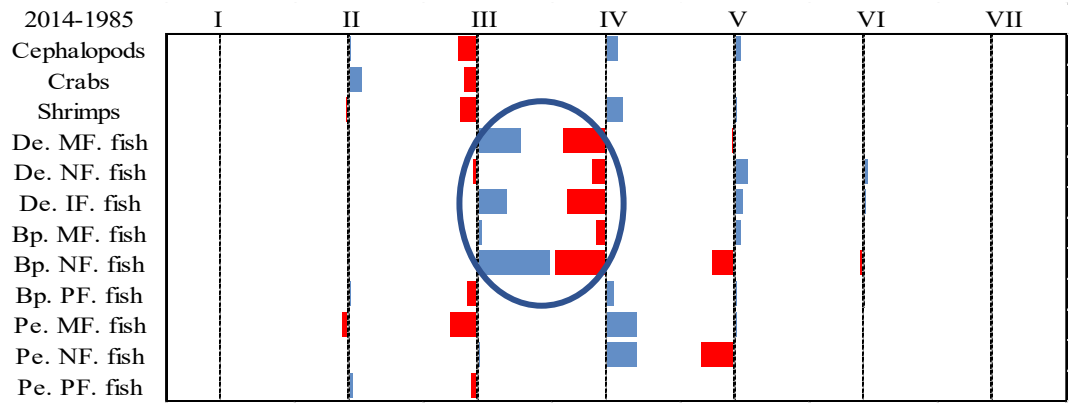
Integrated trophic level decomposition of the functional group of the Yangtze River estuary and its adjacent waters

TLs decrease: Benthopelagic and Demersal fish species

Trophic level decomposition in 2014



No.	Group name	I	II	III	IV	V	Plot
1	Seabirds						
2	Sharks and rays						
3	Turtles						
4	Macrobenthos						
5	Meiobenthos						
6	Microbenthos						
7	Cephalopods						
8	Crabs						
9	Shrimps						
10	De. MF. fish						
11	De. NF. fish						
12	De. IF. fish						
13	Bp. MF. fish						
14	Bp. NF. fish						
15	Bp. PF. fish						
16	Pe. MF. fish						
17	Pe. NF. fish						
18	Pe. PF. fish						
19	Jellyfish						
20	Zooplankton						
21	Phytoplankton						
22	Benthic producers						
23	Detritus						



Dynamics of functional groups from 1985 to 2014

Ecosystems indicators

"Good" Urgent Bad

Ecosystem indicators

Subject	Abbr.	Parameters	Maturity Criteria
Scale	SC	Sum of all consumption	↑
	SE	Sum of all exports	↑
	SR	Sum of all respiratory flows	↑
	SD	Sum of all flows into detritus	↑
	TST	Total system throughput	↑
	SP	Sum of all production	↑
	NPP	Calculated total net primary production	↑
Maturity	TPP/TR	Total primary production/total respiration	→1
	NSP	Net system production	0
	TPP/TB	Total primary production/total biomass	↓
	TB/TST	Total biomass/total throughput	↑
	TB	Total biomass (excluding detritus)	↑
	SO	System overhead	↑
	FCI	Finn's cycling index	↑
	MPL	Finn's mean path length	↑
	CI	Connectance Index	↑
	SOI	System Omnivory Index	↑
Status	GE	Gross efficiency (catch/net p.p.)	↑
	TLC	Mean trophic level of the catch	↑
	Total catch	Total catch	↑
Values	TMV	Total market value	↑
	TV	Total value	↑
	TVC	Total variable cost	↑
	TC	Total cost	↑
	Profit	Profit	↑

Dynamics of functional groups from 1985 to 2014

Ecosystems indicators

"Good" Urgent Bad

Table 6.2.1 Overall parameters of the ecosystem

Subject	Parameters	1985-1986	2004	2014	Histogram	Maturity Criteria	state
	SC	1798.098	1619.914	5444.014		↑	
	SE	661.090	1556.961	1470.900		↑	
	SP	2099.569	2852.892	4625.929		↑	
	NPP	1807.644	2576.600	3777.467		↑	
	TPP/TR	1.577	2.527	1.583		→1	
Maturity	TB/TST	0.012	0.008	0.008			
	TB	57.426	51.169	94.336		↑	
	CI	0.473	0.541	0.269		↑	
	SOI	0.103	0.069	0.220		↑	
	TMV	294448.300	675619.300	99572.060		↑	
	Profit	10161.060	135123.900	3435.240		↑	

The scale of energy flow increased significantly.

The energy flow network had more redundancies than before

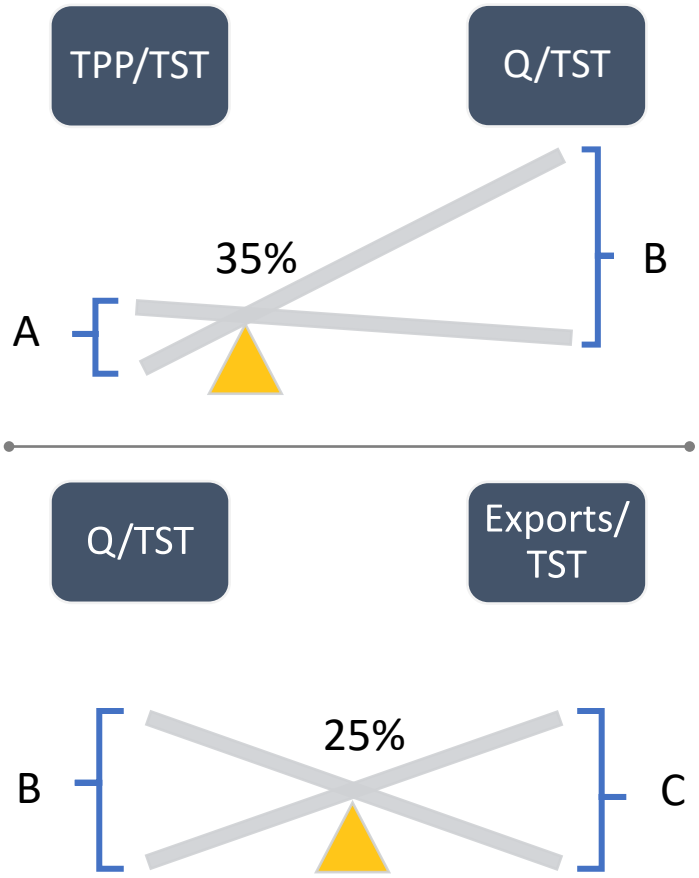
It had not recovered to the 1980s level.

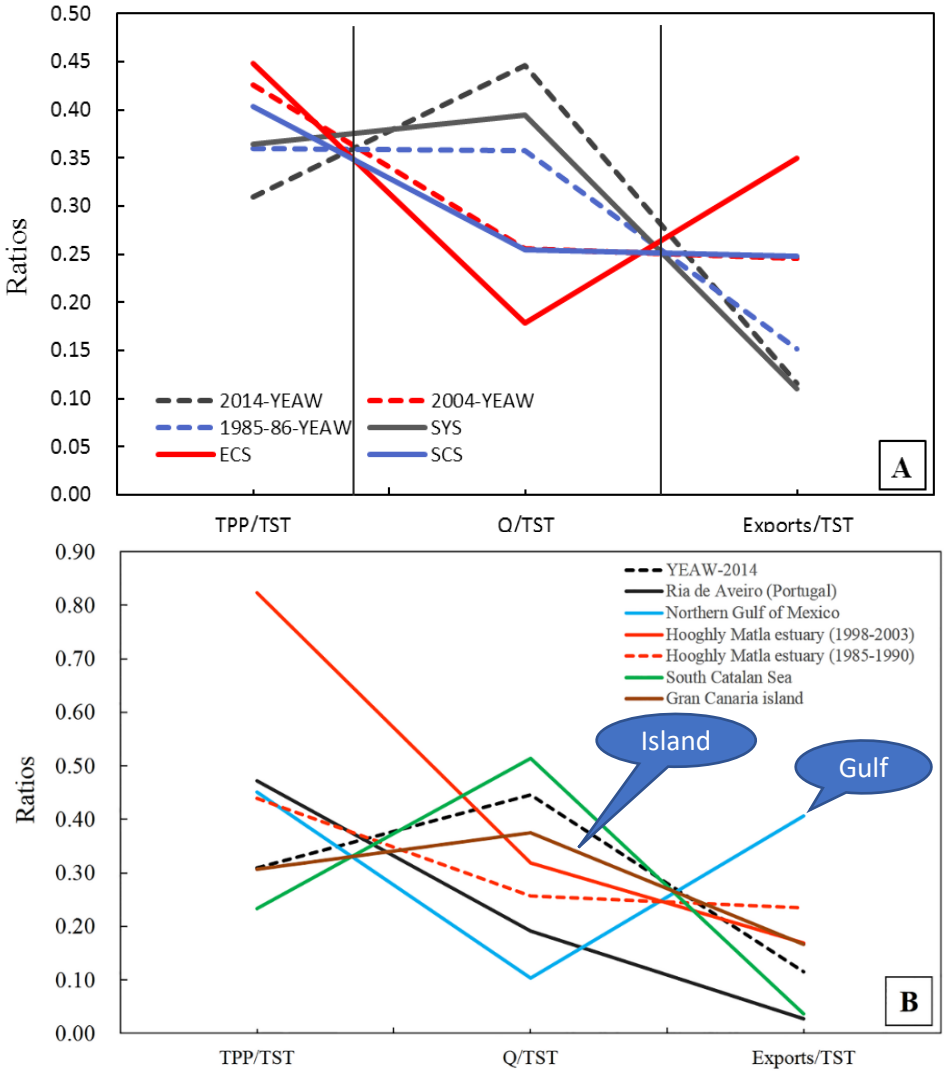
The fishing targets had developed to lower trophic levels

Fishery values were declining

Dynamics of functional groups from 1985 to 2014

Energy flows patterns

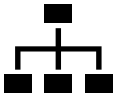




Comparisons of conservative parameters in different years and different types of ecosystems

Outline of Presentation

Backgrounds



Materials and Methods

Results and Discussions

Summary

Summary

- We have got a range of ecosystem parameters that pass a more comprehensive parametric test and balance process
- In the functional groups with TLs > 3.1, 71.43% were tended to PPR (Det). These groups were main components of catches, and more sensitive to fishing activities
- Ecological restorations of this estuary ecosystem is in process, but the status of fishery resources was still worse
- Two uncertain pivots: Exist or not, what do you think?

Thank you for your attention

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