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Modeling the effect of seasonal fishing closure on the Pearl River Estuary using ecosystem simulation

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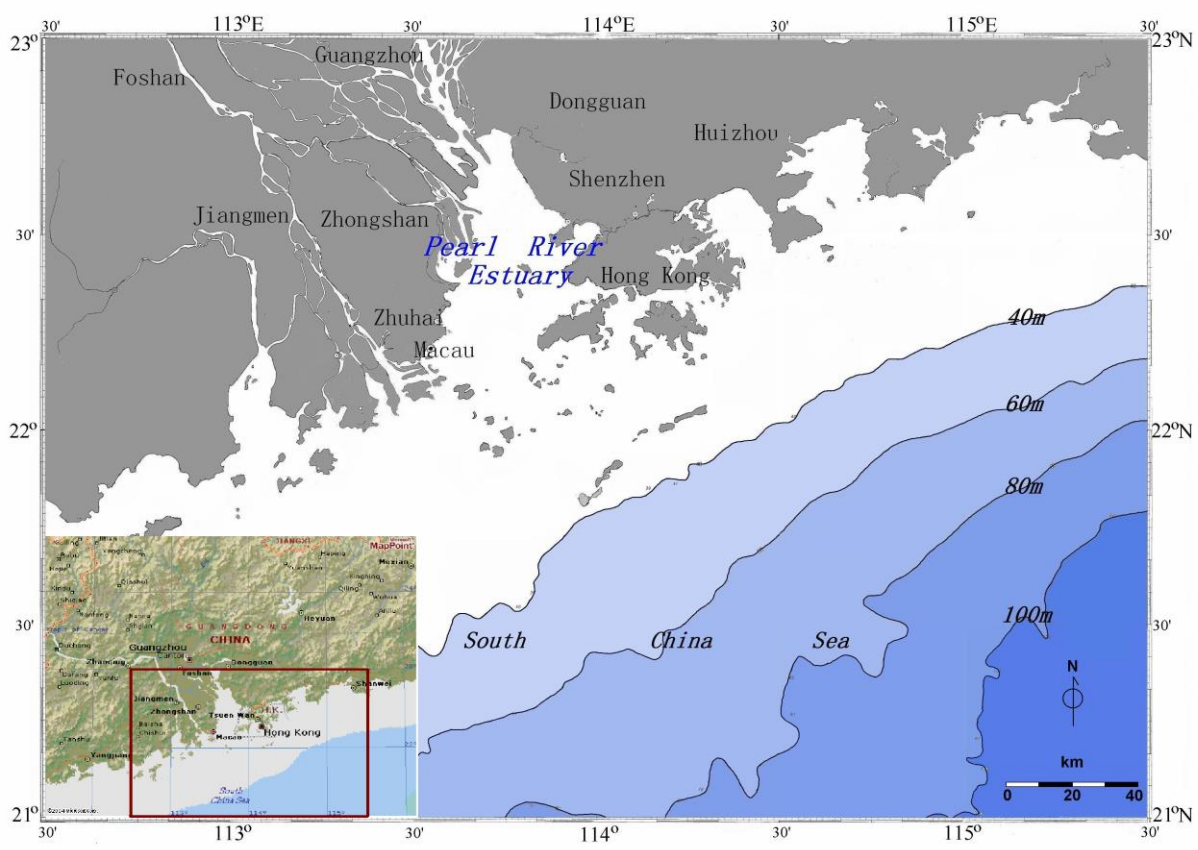
1. Background



❖The Pearl River is the second largest river in China, in terms of the flow rate. And, it is the largest river discharging into the north of South China Sea (SCS).

❖ The Pearl River Estuary (PRE) is also an important fishing ground.

1. Background

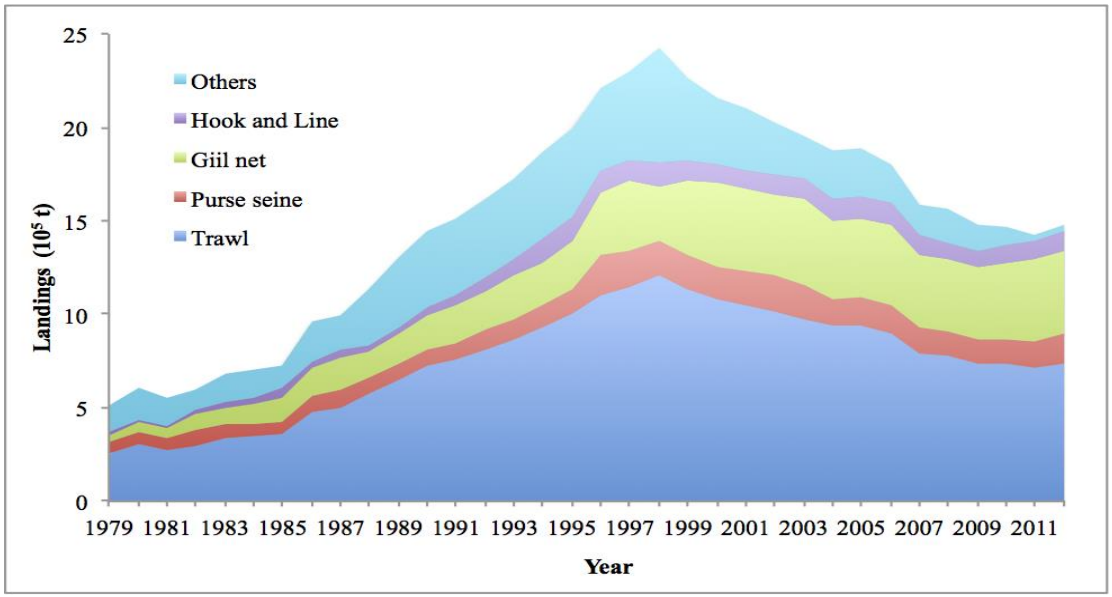
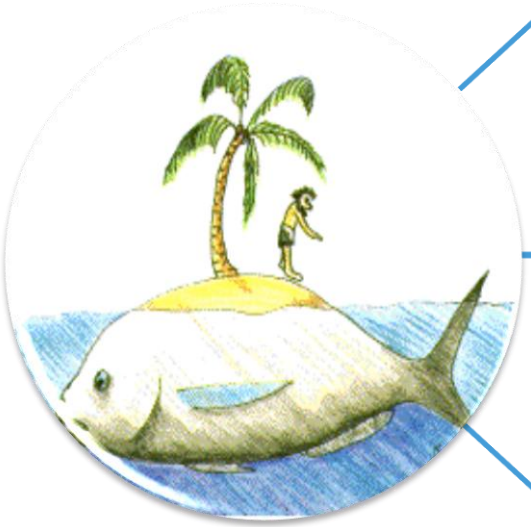


Fig. 1 Total landings off the coast of the PRE for different gears from 1979 to 2012

- ✓ As a result of rapid economic development, the PRE region has experienced overfishing and pollution during the recent three decades.
- ✓ The landings of different fishing gears in the PRE experienced substantial increase since 1979 and reached the peak values in 1998 (Figure 1). The Total landings in 1998 have been almost five times as high as in 1979.

2. Ecological model of the PRE ecosystem



Ecopath

- A static, mass-balanced snapshot of the system.

Mass balance model

Ecosim

- A time dynamic simulation model for policy exploration.

Time dynamic simulation

Ecospace

- A spatial and temporal dynamic module for exploring impact of protected areas.

Spatial simulation

2.2 Conceptual diagram of the PRE coastal ecosystem

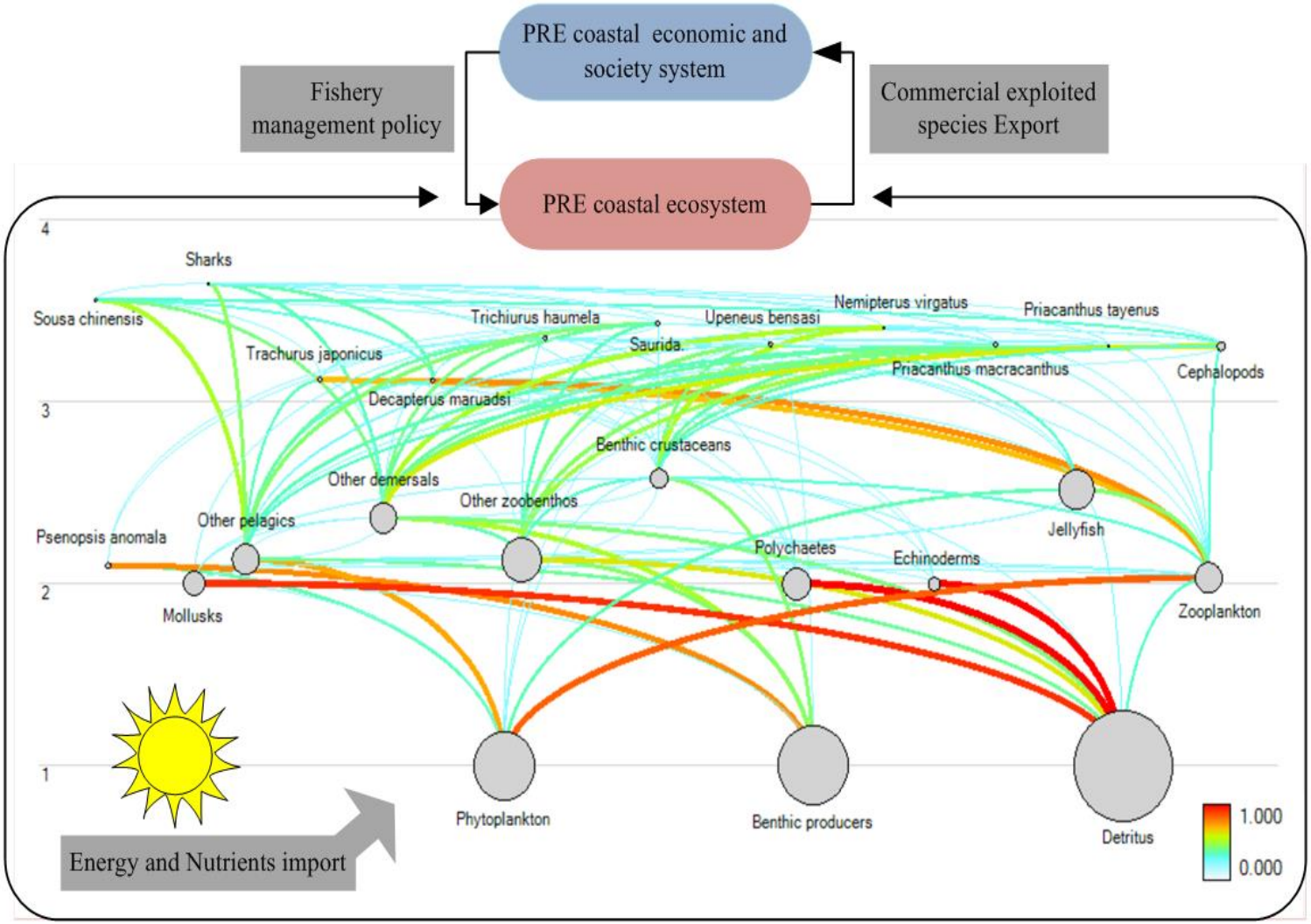


Figure 3 conceptual diagram of the PRE coastal ecosystem

2.3 Fitting the PRD Ecological model with time-series catches data

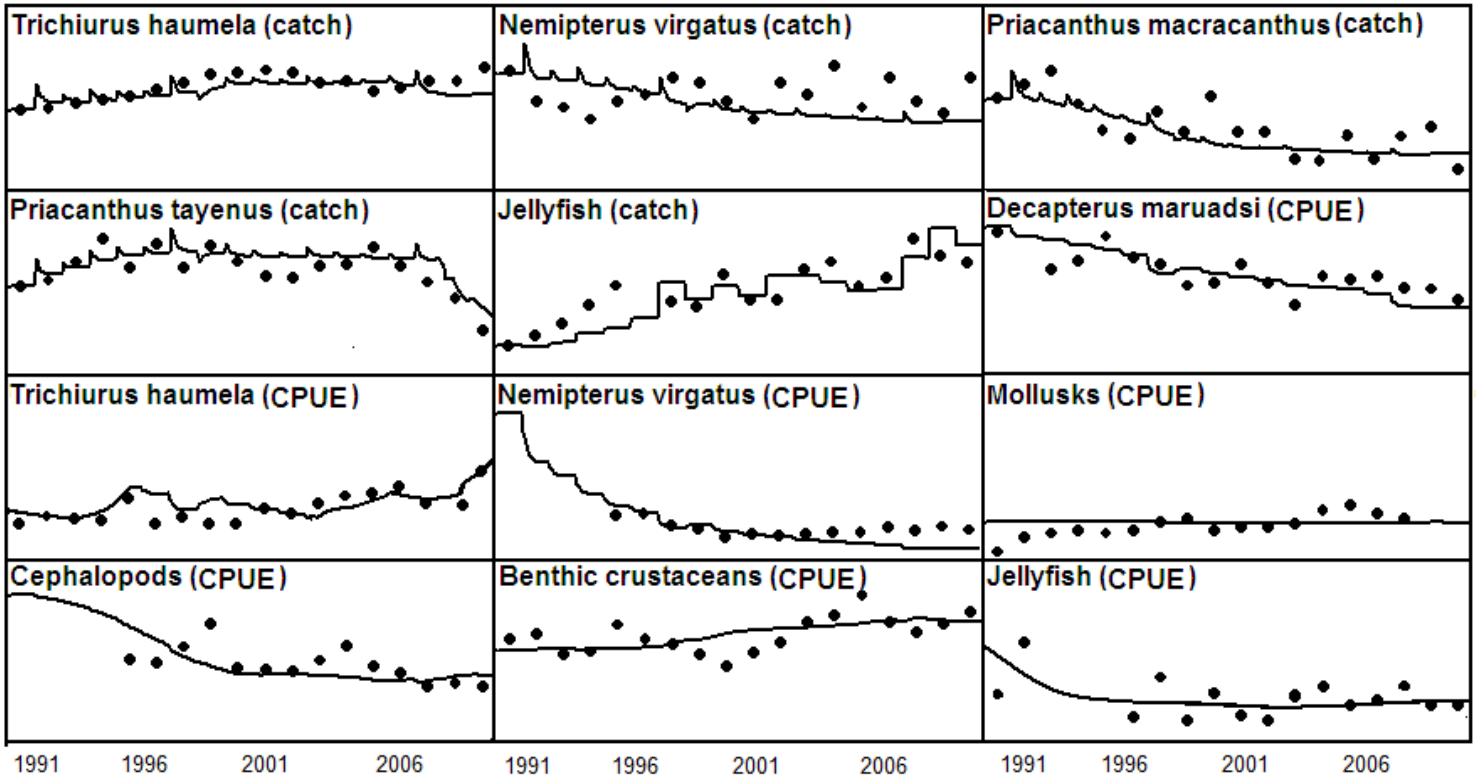


Fig.4 Best fits obtained for 12 sets of times series data on catch and relative abundance for 7 groups in dynamic simulations using Ecosim

The total sum-of –square error (SS) was minimized from 24.25 to 18.31 after varying the vulnerability (V) factor.

3. Result

- **3.1 Comparative analysis of the attributes of ecosystem maturity**
- **3.2 Cumulative impacts analysis**
- **3.3 Policy simulation**

In this study, the predicted parameters originated from the hypothetic ecosystem were input the software to construct a new Ecopath model (i.e. 2008 model) for comparative analysis of the system properties*.

3.1 Comparative analysis of the attributes of ecosystem maturity

Table 2 Summary of the Indices for the PRE Coastal Ecosystem in 1998, 2008 and 2008*

Parameter（unit）	1998	2008	2008*
Ecosystem theory indices			
Total system throughput (t km^{-2} $year^{-1}$)	1773.18	2311.86	2314.64
Sum of all production (t km^{-2} $year^{-1}$)	808.45	1082.41	1083.45
Mean trophic level of the catch	2.34	2.40	2.38
Gross efficiency (catch/net p.p.)	0.004	0.002	0.002
Calculated total net primary production (t km^{-2} $year^{-1}$)	749.48	1026.41	1027.61
Total primary production/total respiration (PP/R)	5.83	8.36	8.38
Net system production (t km^{-2} $year^{-1}$)	621.00	903.69	905.05
Total primary production/total biomass (PP/B)	22.76	25.72	25.78
Total biomass/total throughput	0.02	0.02	0.02
Total biomass (excluding detritus) (t km^{-2})	32.93	39.90	39.87
Total catches (t km^{-2} $year^{-1}$)	3.36	1.94	2.16
Connectance Index (CI)	0.28	0.28	0.28
System Omnivory Index (SOI)	0.13	0.12	0.12
Network flow indices			
Predatory cycling index (%of throughput without detritus) (PCI)	2.10	2.21	2.20
Finn's cycling index（% of total throughput）(FCI)	2.72	2.22	2.23
Finn's mean path length	2.32	2.22	2.22
Information indices			
Ascendency (% of capacity)	35.4	40.0	40.0
Overhead (% of capacity)	64.6	60.0	60.0

- Comparative analysis result implies that the ecosystem still deteriorated after ten years over-exploitation from 1998 to 2008.
- Although the fishing moratorium policy is effective on ecosystem protection, it just protects the ecosystem from exacerbation and accomplished so little in ecosystem recovery.

3.2 Cumulative impacts analysis

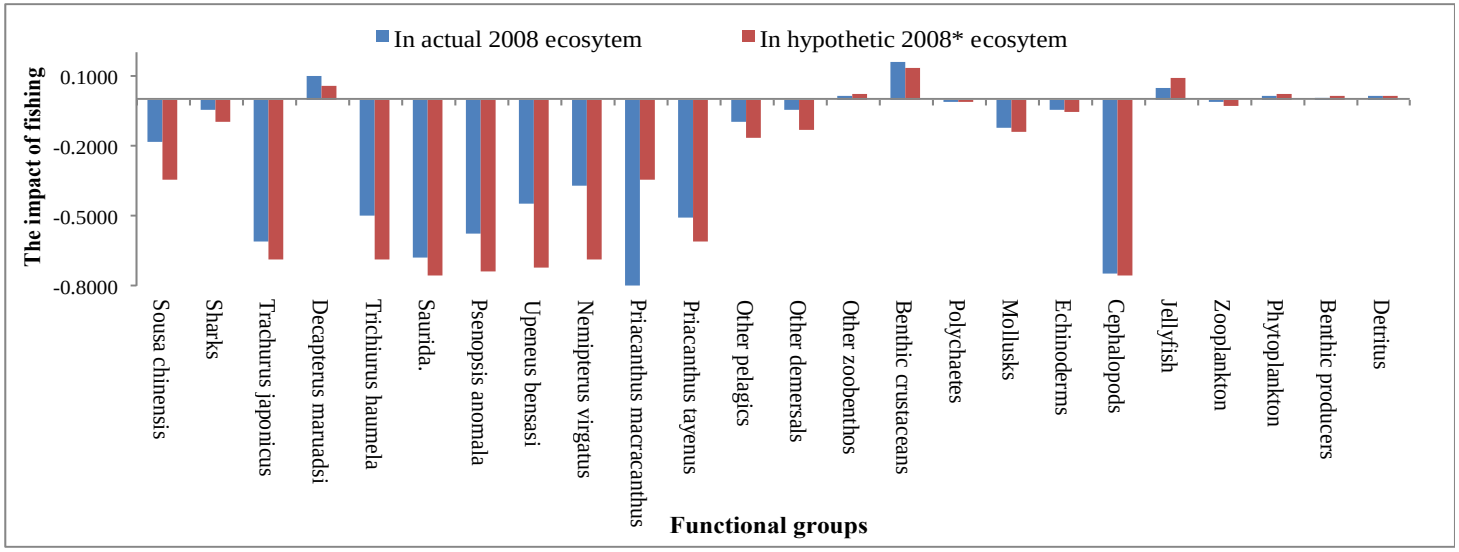


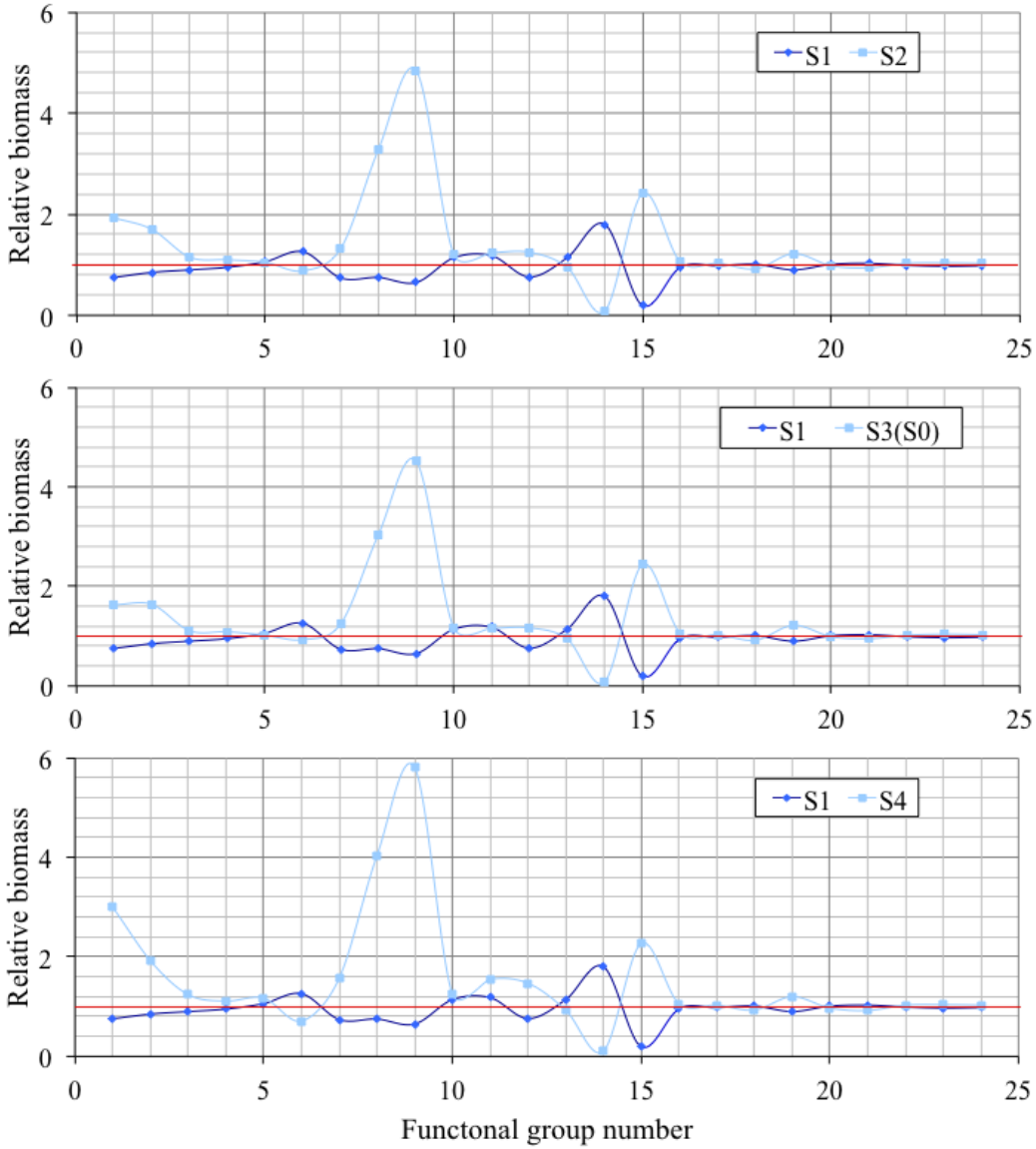
Fig.5 Cumulative impacts of fishing gears on functional groups with effort increased by 10%

- There were 17 of 24 functional groups would decreased in 2008 and 2008* ecosystem when effort increased by 10%.
- The results of cumulative impacts analysis indicated that the biomass of most functional groups in the hypothetic 2008* ecosystem were more sensitive than those in the ecosystem with seasonal moratorium was performed.

3.3 Policy simulation

- S0: the present fishing moratorium continuation;
- S1: No fishing moratorium executed;
- S2: extending the duration of the moratorium (i.e., 1 June to 1 September);
- S3: listing all fishing gears as banned based on the original fishing moratorium policy;
- S4: No fishing moratorium executed with reducing the fishing effort of all fishing gears by 50%.

3.3 Policy simulation



- As can be seen from the Figure 6, the relative biomass values of most functional groups are under the baseline in S1, which indicates that the stocks of most functional groups will shrink without fishing moratorium executed even if there is no fishing effort increased.
- In the other four scenarios, most functional groups appeared to more or less recovery from over exploitation.

4 . Conclusion

- All of these factors indicate that the summer moratorium only plays a minor positive role in the restoration process of fish community structure and function in the PRE ecosystem.
- But in reality, the problem will be how to handle the inevitable fishing effort shifting from summer to other seasons, and annual fishing effort was not effectively cut down.
- Hence, in order to protect the health of the ecosystem, a comprehensive set of restrictions on fishing effort should be implemented on the fishery in the PRE coastal ecosystem.