

## **Spatial Modelling of fishing protected area and fishing closure in the East China Sea**

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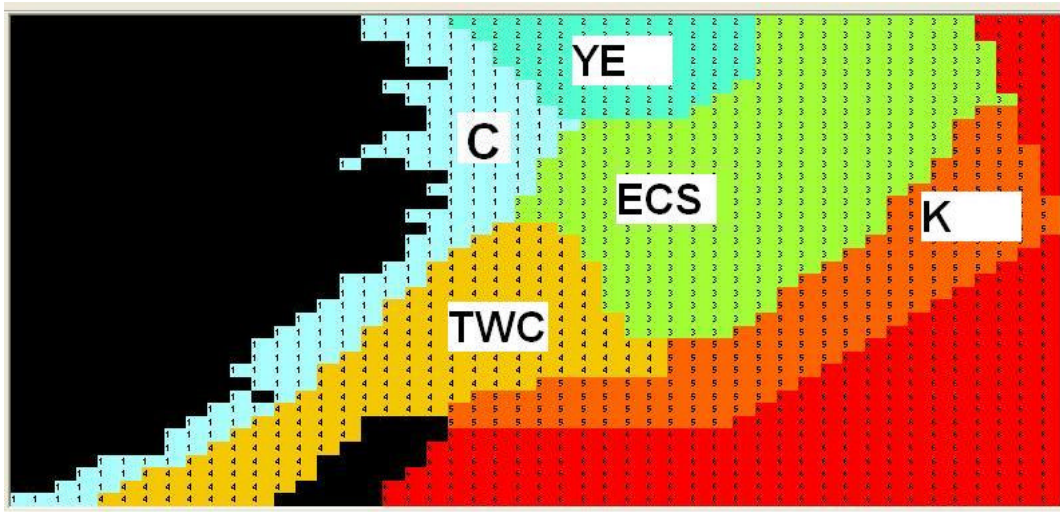
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### **1. Problems in respond with Ecospace model**

The Chinese East China Sea supports a highly productive fishery and is rich in biodiversity. In 2002 landings from the Chinese East China Sea accounted for over 7% of reported global landings. Economic development and population growth in China over the last four decades has lead to intensifying anthropogenic impacts in the East China Sea with impacts on fishing stocks and biodiversity. In response to this the government of the People's Republic of China has introduced a range of spatial management measures including large scale seasonal spatial closures, off-shore fishery boxes and coastal biodiversity protected areas. A spatial ecosystem (Ecospace) model of the Chinese East Sea has been developed to examine the effects of spatial closures in the East China Sea. The model has been used to simulate the large scale spatial closure and off-shore fishery boxes.

### **2. Habitat definition**

Five habitats (Fig. 1) have been defined based on the distribution of water mass, water depth, bed sediment, water temperature and salinity and nutrient level.



### H1: Alongshore current water (C)

The habitat C is mainly covered by alongshore currents and also characterized by the lower salinity 28.4 (in summer) ~ 30.4 (in winter), remarkable inter-annual variation of water temperature from 11.59°C (in winter) to 24.5 °C (in summer), lower transparency (generally less than 5 m) with high turbidity and nutrient over the bed sediments composed of muds, silts and fine sands.

The alongshore current area on the continental shelf of ECS provides natural spawning grounds for many species with high economical value such as hairtail and large yellow croaker. There are 17 national natural reserves and 5 special marine protection areas. China had set the prohibited fishing line around the -50 m water depth contour in order to protect the coastal fishery resources and spawning ground environment since 1955. So, we take the west waters of the prohibited fishing line as habitat C alongshore current area.

### H2: Mixed water with Yellow Sea and East China Sea (YE)

Mixed water mass are formed wherein the area in northwestern continental shelf of ECS distributed the cold water driven from Yellow Sea and high salinity water driven from offshore ECS. This water mass was featured with lower temperature ranging from 9.8°C (in winter) to 28.3 °C (in summer), higher salinity ranging from 30.1 (in summer) ~ 32.0 (in winter), and bed sediment composed of mud and silts in the ECS water.

This habitat was assigned the special fish species of *Coilia* and *Setipinna taty*. Hairtail juvenile reserve has been since planned in 1981 to close fishing with trawl during August, September and October.

H3: Warm water on the main continental shelf of the East China Sea

Warm water distributed on the main continental shelf of the East China Sea was from the Kuroshio water rush into the continental shelf of ECS with the temperature ranging from 13°C (in winter) to 29 °C (in summer), salinity ranging from 33(in summer) ~ 32.0 (in winter), and bed sediment composed of fine sands and silts. This habitat was assigned the most of fish functional groups and spawning hairtail reserve has been planned since 1988 to close fishing with trawl during May and June.

H4: Taiwan warm water

Taiwan warm current was characterized by higher salinity, warm, blue water color and higher water transparent. And the interannual variation of temperature and salinity of Taiwan current are smaller than the alongshore current.

H5: Kruoshio water

200m depth contour was considered as the shelf break line of ECS. The Kruoshio is mainly influence the east of shelf break line. The Kruoshio is characterized by high but steady salinity and temperature and steady water mass distribution.

**3 Assign habitats**

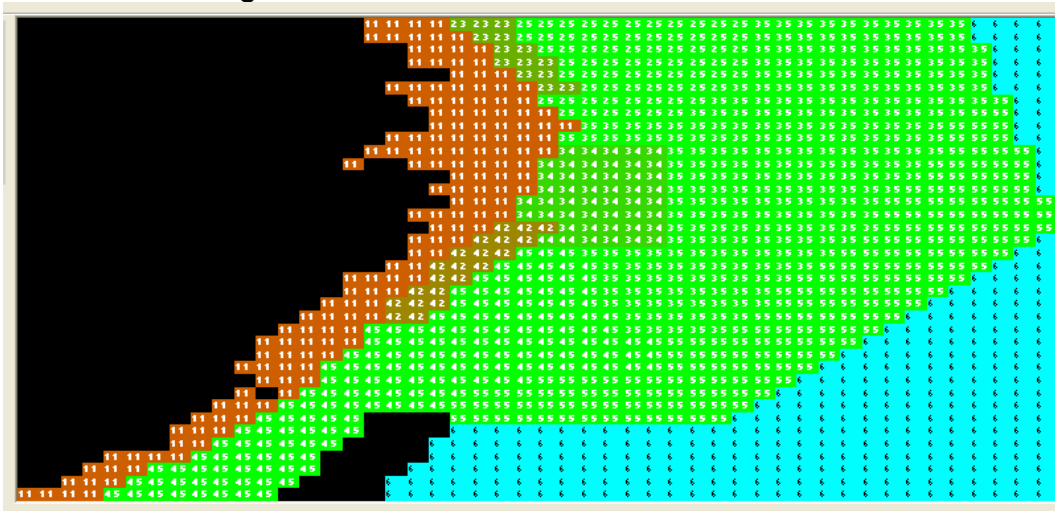
The habitat of 40 functional groups are based on the biomass distribution map according to the fishery survey data from 1997-2000, and other 5 groups as sea birds, sea turtles, marine mammals, *Seriola lalandi* and *Acipenser sinensis* are according to the record of fishery and survey.

Table 1 Habitat assignment of East China Sea ecosystem

GroupHabitat	All	C	YE	E	TWC	K
Marine mammals						
Sharks and rays						
Lophius litulon						
Sphyraena						
Seriola lalandi						
Larimichthys crocea (2+)						
Saurida						
Seaturtles						

Branchiostegus						
Trichiurus lepturus (2+)						
Scomberomorus niphonius						
Nibea albiflora						
Seabirds						
Acipenser sinensis						
Thamnaconus						
Harpadon nehereus						
Pennahia argentata						
Pleuronectiform						
Champsodon capensis						
Priacanthus macracanthus						
Sparidae						
Coilia						
Large jellyfish						
Cephalopods						
Larimichthys polyactis						
Larimichthys crocea (1)						
Argentinidae						
Shrimps						
Small demersal fishes						
Stromateoidae						
Crabs						
Engraulis japonicus						
Scomber japonicus						
Trachurus japonicus						
Decapterus maruadsi						
Small pelagic fishes						
Setipinna taty						
Macrobenthic						
Sardina						
Trichiurus lepturus (1)						
Microbenthic						
Zooplankton						
Heterotrophic bacteria						
Phytoplankton						
Detritus						

#### 4 FPA and fishing closure scenarios



##### 1) Natural reserves and special marine protection areas.

17 national natural reserves and 5 special marine protection areas have been set by China in the west of the prohibited fishing line in ECS until 2003 (without Taiwan district). These protected areas are not large enough to be represented on the Ecospace base map, so it will not be possible to do an analysis in ECS Ecospace modelling.

##### 2) Fishery protected areas

Table 2 Fishery protected areas in ECS in China

No.	Name	Time	Area(km <sup>2</sup> )	Close time	Close fleets
1	Large yellow croaker juvenile reserve	1981		Aug., Sep. & Oct.	Trawl
2	Hairtail juvenile reserve	1981		Aug., Sep. & Oct.	Trawl
3	Spawning hairtail reserve	1988		May & June	Trawl

### 3) Prohibited fishing line

The alongshore current area on the continental shelf of ECS provides natural spawning grounds for many species with high economical value such as hairtail and large yellow croaker. So, the prohibited fishing line had been set around the -50m depth contour in order to protect the coastal fishery resources and spawning ground environment by China.

### 4) Summer closure area and duration

The enforcement of the summer closed fishing in the East China Sea was declared by Chinese government in 1995 and the location for the closed fishing was 27°00'N - 35°00'N and trawl and stow net were prohibited with the duration from July 1<sup>st</sup> to August 31<sup>st</sup> per year. In 1998 the location was enlarged to 26°00'N - 35°00'N, the prohibited fishing fleets was extended to shrimp trawl and the duration was prolonged which was from June 16<sup>th</sup> to September 15<sup>th</sup> per year and the summer closed fishing area was extended to the South China Sea , the Yellow Sea and the Bohai Sea.

Table 3 Summer fishing closure in the East China Sea in 2006

No.	Region	Close time	Closed fleets
1	117-120E; 22.5-23.5N	June 1 <sup>st</sup> to Aug. 1 <sup>st</sup>	Trawl, Stow net & Purse seine
2	23.5-26.5N	June 1 <sup>st</sup> to Aug. 1 <sup>st</sup>	Trawl & Stow net
3	26.5-35N	June 16 <sup>th</sup> to Aug. 16 <sup>th</sup>	Shrimp trawl
4	26.5-35N	June 16 <sup>th</sup> to Sep. 16 <sup>th</sup>	Trawl & Stow net

### 5) Main scenarios to be tested during this La Paz workshop

SC1 for Whole ECS area: area western to prohibit line from January to December + the rest area of survey from June to September, Trawl + Stow net + Shrimp trawl were closed;

SC2 for area western to prohibit line from January to December + FP1 from June to October + FP2 from June to October + FP3 from May to September +

the rest area of survey from June to September, Trawl + Stow net +Shrimp trawl were closed;

SC3 for area western to prohibit line from January to December + FP1 from May to August + FP2 from May to August + FP3 from May to August + the rest area of survey from June to August, Trawl + Stow net +Shrimp trawl were closed?

- 6) Other scenarios to be expected to be tested in future if there is enough time
  - a) Global climate change
  - b) Pollutant
  - c) Runoff discharge

### **5 Problems to be expected to be resolved during La Paz meeting**

- 1) Fishing landings for 6 fleets input to basemap of Ecospace;
- 2) Scenarios selection;
- 3) GIS digit data input to the basemap of Ecospace.

### **6. Suggestions to improve the Ecospace Model**

- 1) Multilayer of MPAs is necessary to be explored and spatial effect spreadout is also necessary to be provided some explanation in detail;
- 2) Spatial validation or spatial scale of Ecospace Model is to be expected to have a defined;
- 3) Difference of modelling results between the Ecosim model and Ecospace is necessary to be explained or to explore a new version.