Designing fish management boundaries in Korean waters using SOM (Self Organizing Maps)

Fisheries Resources Research Team, NFRDI

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Demersal fish

- Kind of fisheries resources in bottom area ex) flatfish, rockfish
- Larval mortality effected by settlement substrate and plankton biomass
- Distribution pattern is different defend on bottom substrate and environments
- Species diversity is important ecological factor
- Management rule by biological and geographical region
Representative demersal fish in Korean waters

- Decreasing demersal fish catch
- More than 200 species caught by target and bycatch (Dominant: Rockfish, Croaker, Yellow goose fish, Pacific cod, Flatfish, Hairtail)
- Regional management approaching
- Previous regional fisheries resources managed by traditional and geographical separated area

- Using an accurate and various data; developed simple accessing and analyzing method
- Requested reasonable management boundary separation considered environments and ecological aspect
• **Purpose**

- Analysis of demersal fish community structure by SOM
- Examine the relationship between demersal fish biological aspect and environmental condition
- Application of new management rule for each boundaries
• **Data**
  - Seasonal individual and biomass: 2004-2005
  - Sampling gear: Bottom trawl
  - Environments: Temp., Sal. and Depth

• **Data collection**
  - Over than 2 time caught
  - Data unit: catch per swept area
**Unsupervised learning algorithm: self-organising map (SOM)**

**Fig. Schematic diagram of the SOM analyzing step.**

**STEP 1.**
Initialize weight

**STEP 2.**
Compute distance to all nodes. Select output node with minimum distance

**STEP 3.**
With sufficient presentation of input vectors, weights will specify cluster.

**STEP 4.**
Determine the winner node for each input vector.

**STEP 5.**
Determine neighbors whose distance to the winner node on the feature map of the network is less than or equal. Update weights are decreased with time as convergence is reached.

**STEP 6. Go to the STEP 3**
### Sampling year, season and area

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#### Input data

- **Input layer**

#### Catch data
Data treatment and computation

- Optimal output layer dimension: $8 \times 10$
- Quantization error: 1.562
- Topographic error: 0.037
NFRDI

U-matrix
Dendrogram using the Ward linkage method based on Euclidean distance
MVSP and Primer result of community pattern by biomass data
Ecological Index of Each Cluster Group

- **No. of Species**
  - Cluster 1: b
  - Cluster 2: c
  - Cluster 3: a
  - Cluster 4: a

- **No. of Individuals**
  - Cluster 1: a
  - Cluster 2: a
  - Cluster 3: a
  - Cluster 4: a

- **Diversity**
  - Cluster 1: bc
  - Cluster 2: c
  - Cluster 3: ab
  - Cluster 4: a

- **Total Biomass**
  - Cluster 1: b
  - Cluster 2: ab
  - Cluster 3: ab
  - Cluster 4: a
Environmental index of Each Cluster Group

- Surface Temperature
- Bottom Temperature
- Surface Salinity
- Bottom Salinity
- Depth

Clusters:
a
b
bc

Legend:
a
b
bc

Different letters indicate significant differences.
Typical distribution patterns of species

Cluster 1
Sea raven, Rockfish, Fat cod

Cluster 3
Yellow croaker, Spotted velvetfish

Cluster 2
Flatfish, Sailfin sandfish

Cluster 4
Blackthroat seaperch, John dory, Jack marckerel

Clusters 1 and 2
Pacific cod

Clusters 1 and 3
Croaker

Clusters 3 and 4
Hairtail, Eel

Clusters 1, 3 and 4
Yellow goose fish
## Environmental characters of each cluster group

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Temp (Bottom)</th>
<th>Sal (Bottom)</th>
<th>Depth</th>
<th>Area</th>
<th>Reference</th>
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<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>Low</td>
<td>Shallow</td>
<td>Yellow Sea</td>
<td>Typical temperate sea</td>
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<tr>
<td>2</td>
<td>Low</td>
<td>High</td>
<td>Deep</td>
<td>East Sea</td>
<td>Developed upwelling, water mixing layer</td>
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<tr>
<td>3</td>
<td>-</td>
<td>High</td>
<td>-</td>
<td>East China Sea</td>
<td>Warm current</td>
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<tr>
<td>4</td>
<td>High</td>
<td>High</td>
<td>-</td>
<td>South Sea</td>
<td>Seasonal current change</td>
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</table>
Figure. Simple schematic diagram of food chain around Korean waters.
• Conclusions
  - Four community groups have to consider for new demersal fish management
  - Each groups distinguished by physical environment, depth and bottom temperature
  - New approaching management rule refer to the ecological distinguishing character
### Ecological characters of each cluster group

<table>
<thead>
<tr>
<th>Cluster</th>
<th>Biomass</th>
<th>No. Sp.</th>
<th>Diversity</th>
<th>Trophic level</th>
<th>Life history strategy of main sp.</th>
<th>Longevity of main sp.</th>
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<tbody>
<tr>
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<td>-</td>
<td>-</td>
<td>3.5</td>
<td>Equilibrium sp., Lecithotrophic larvae</td>
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<tr>
<td>2</td>
<td>High</td>
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<td>3</td>
<td>Equilibrium sp., Lecithotrophic larvae</td>
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<td>High</td>
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<td>Opportunistic sp., Small egg</td>
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<td>Opportunistic sp., Small egg</td>
<td>Short</td>
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</table>
Remarks and future plan
- Examination of prey-predator relationship in each management boundary by stomach contents
- Understanding the function of main target and dominant species in each area
- Prediction each area community structure changing by climate or physical environments changing
- Understand for the function of demersal fish community on ecosystem
Thank you for your attention!!

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