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

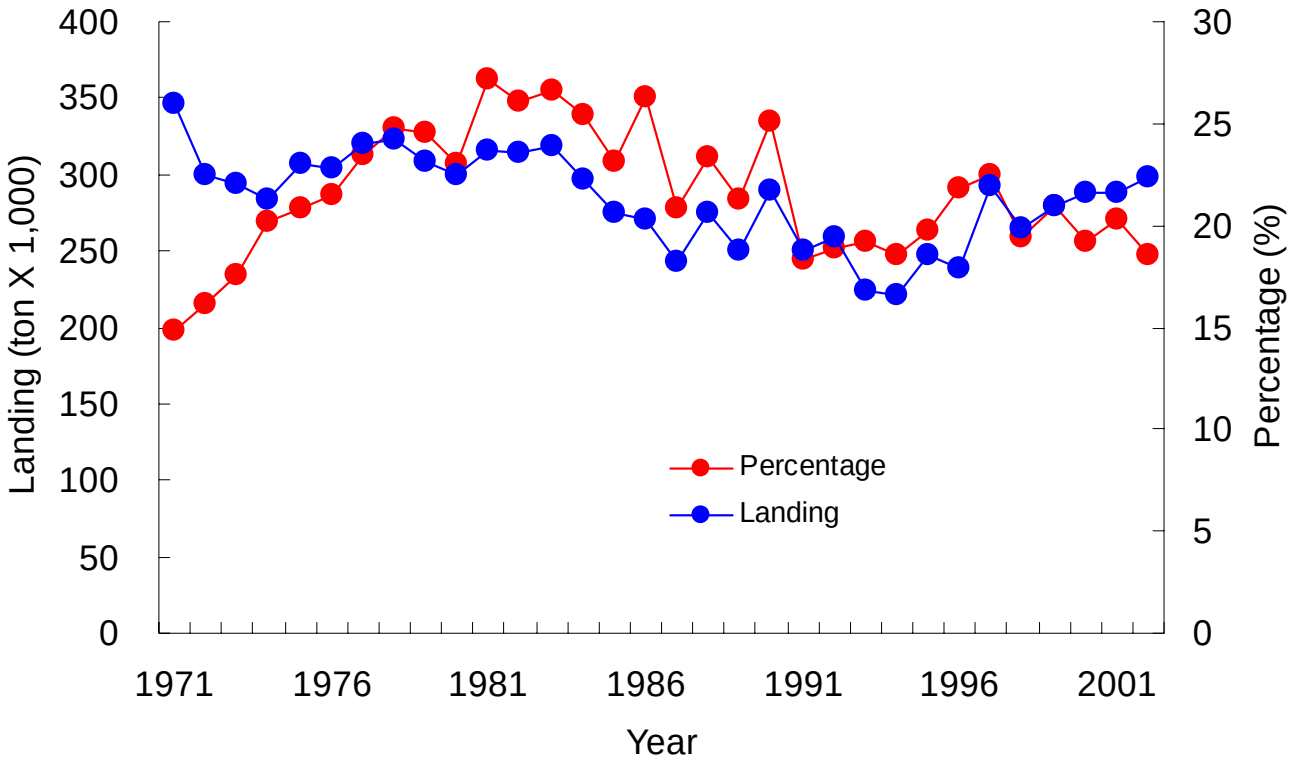
- Management rule by biological and geographical region

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

Demersal fish landing in Korean waters



- **Purpose**

  - Analysis of demersal fish community structure by SOM

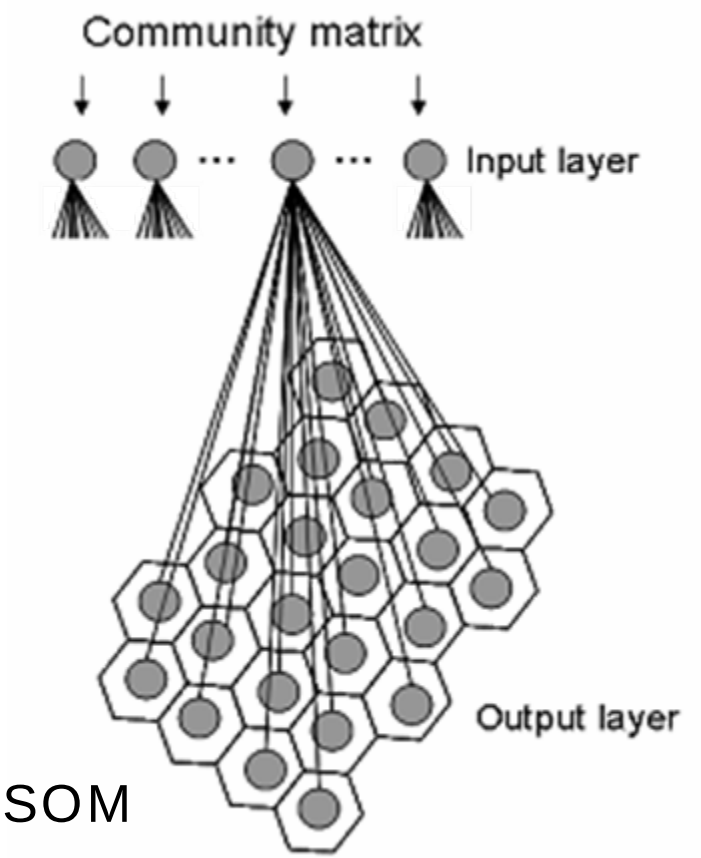
  - Examine the relationship between demersal fish biological aspect and environmental condition

  - 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)



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

patterning, classification, ordination, etc.

Fig. Schematic diagram of the SOM analyzing step.

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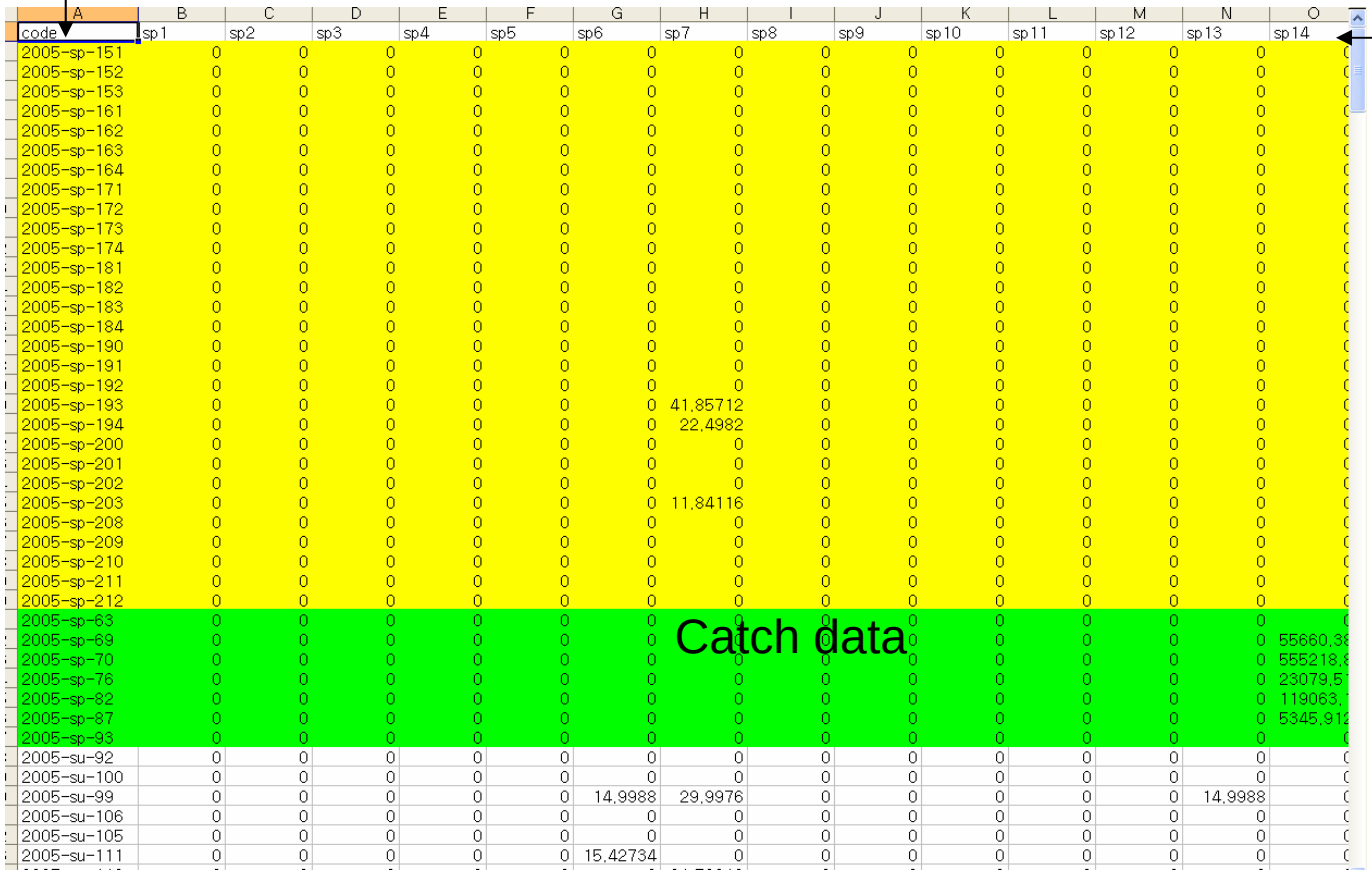
Sampling year, season and area



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2005-sp-152	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-sp-153	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-sp-161	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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2005-sp-163	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2005-sp-164	0	0	0	0	0	0	0	0	0	0	0	0	0	0
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Input layer

Input data

Catch data

Data treatment and computation

- Optimal output layer dimension: 8 × 10
- Quantization error: 1.562
- Topographic error: 0.037

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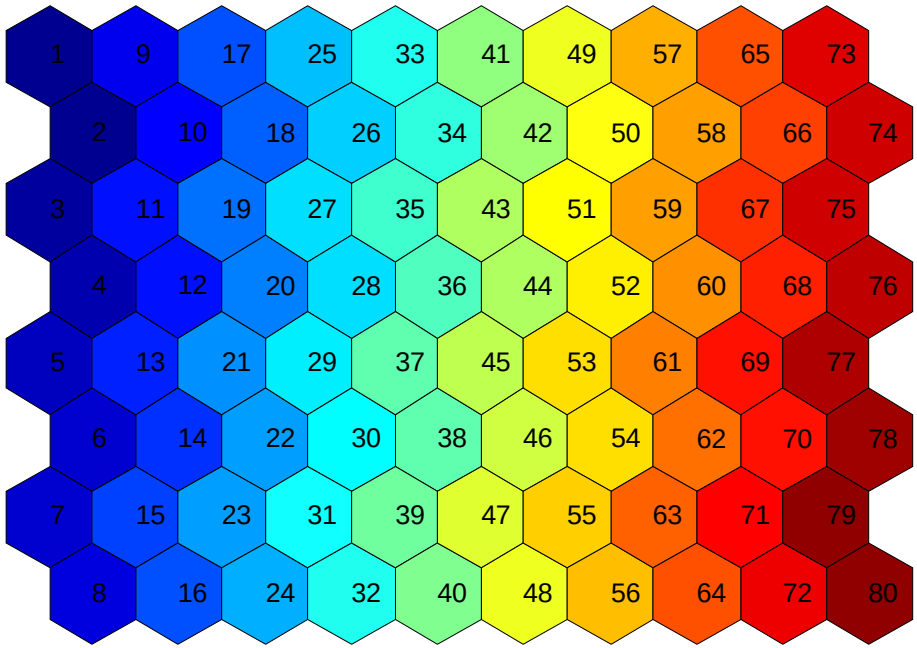
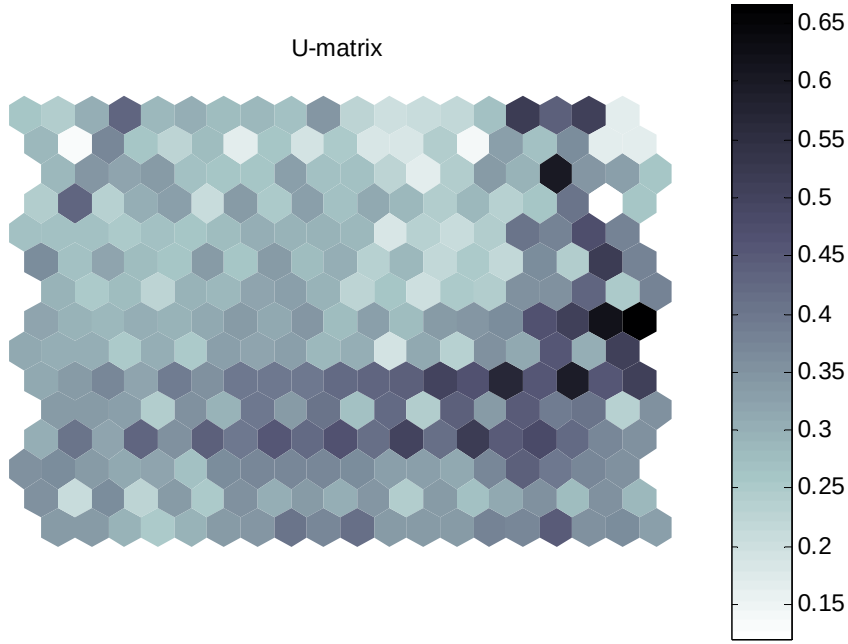

1 9 17 25 33 41 49 57 65 73
2 10 18 26 34 42 50 58 66 74
3 11 19 27 35 43 51 59 67 75
4 12 20 28 36 44 52 60 68 76
5 13 21 29 37 45 53 61 69 77
6 14 22 30 38 46 54 62 70 78
7 15 23 31 39 47 55 63 71 79
8 16 24 32 40 48 56 64 72 80


U-matrix
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15

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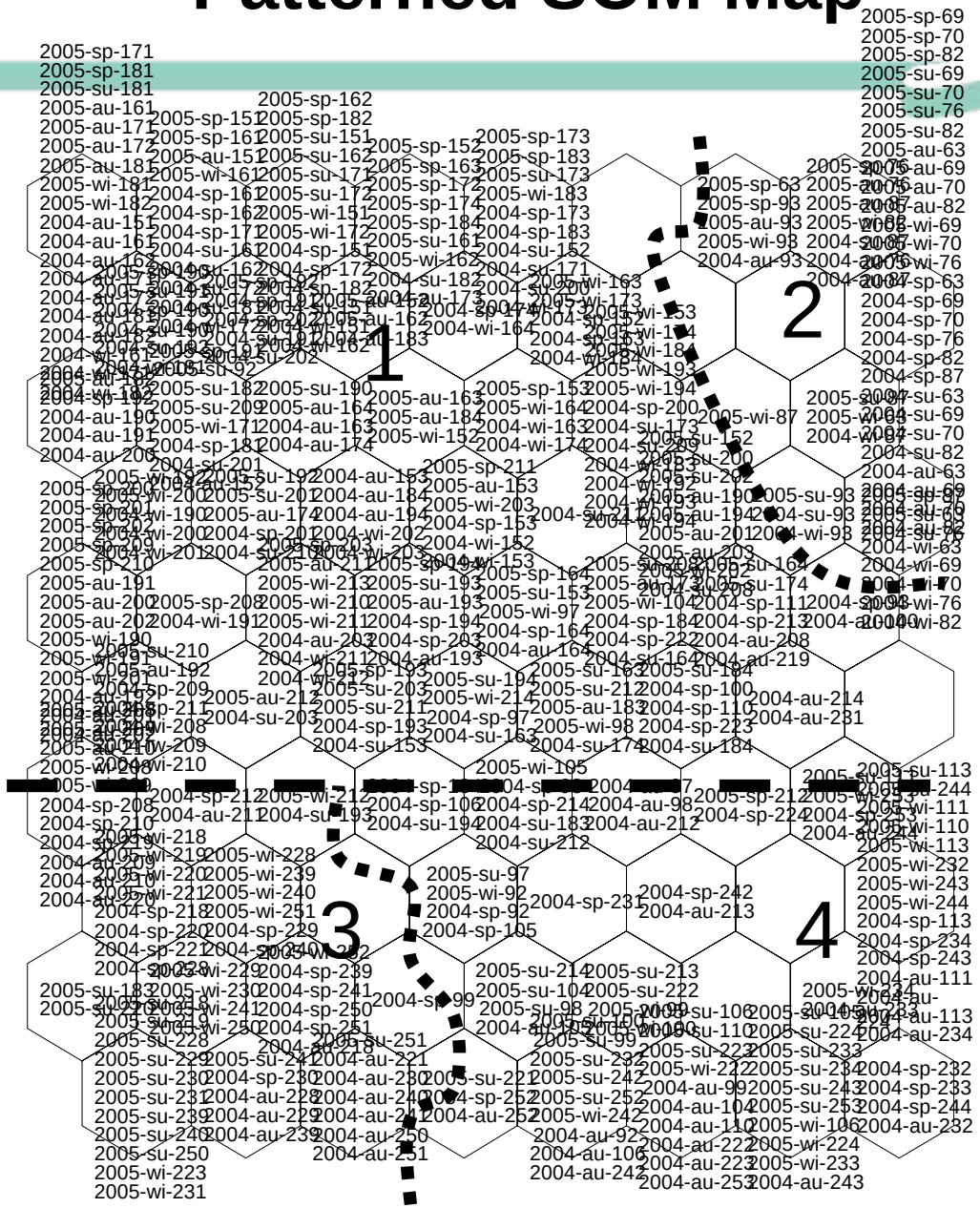
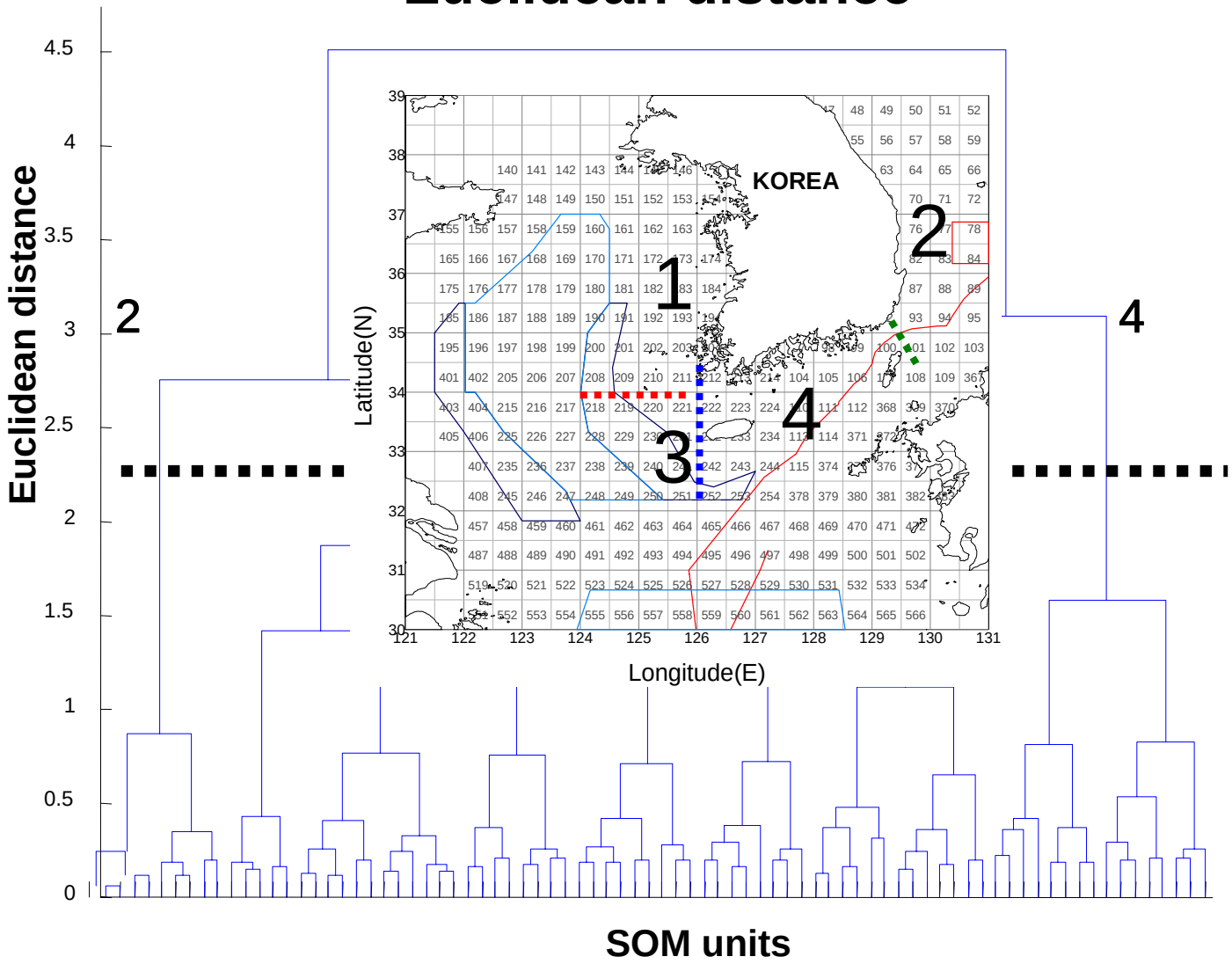
Patterned SOM Map



Dendrogram using the Ward linkage method based on Euclidean distance



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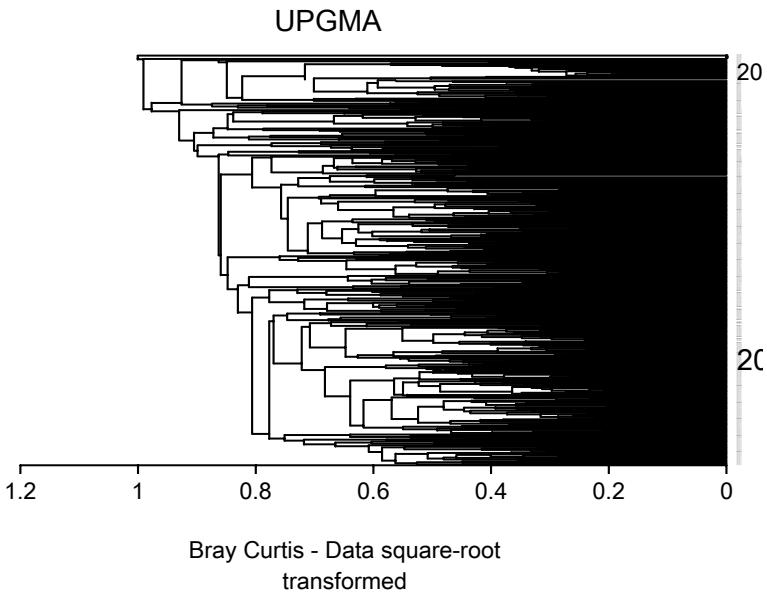
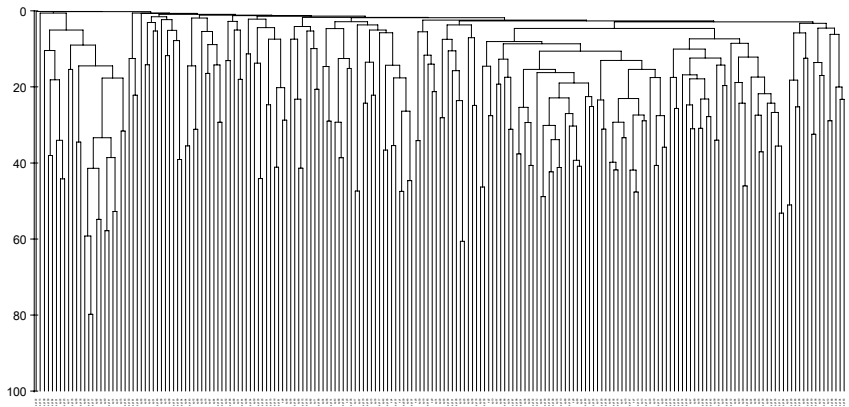
MVSP and Primer result of community pattern by biomass data





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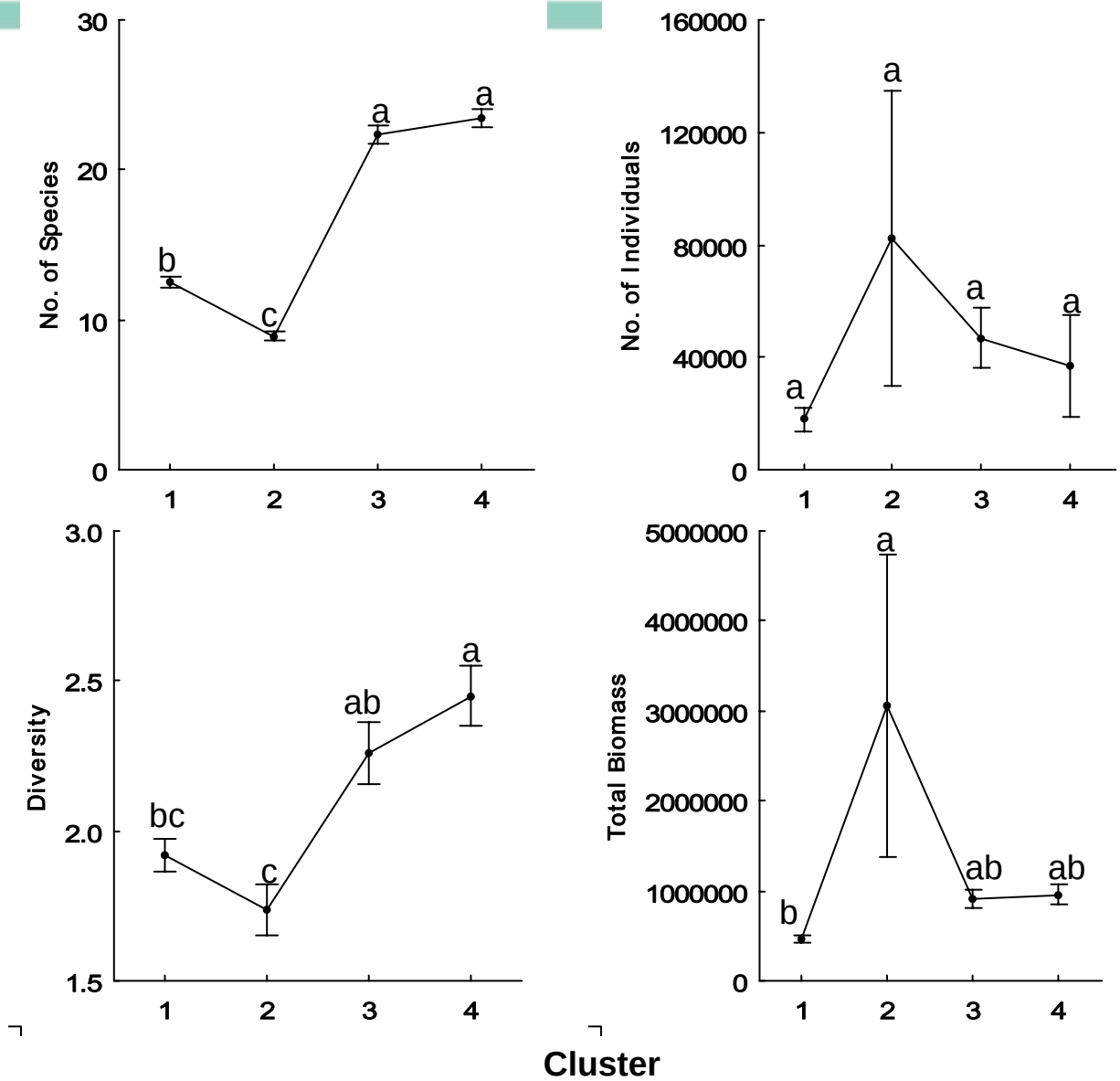
Ecological Index of Each Cluster Group



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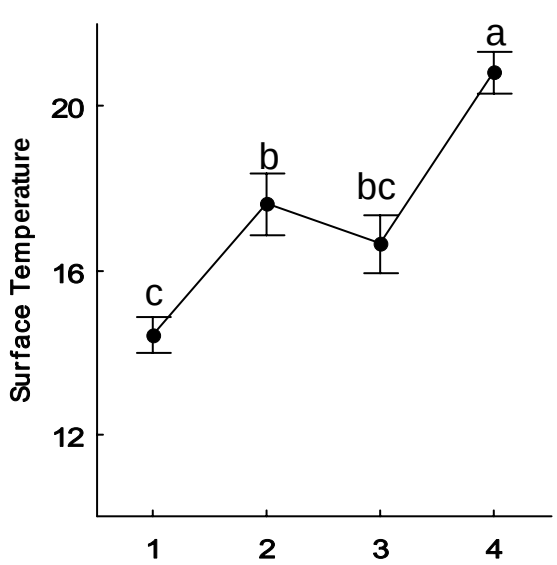
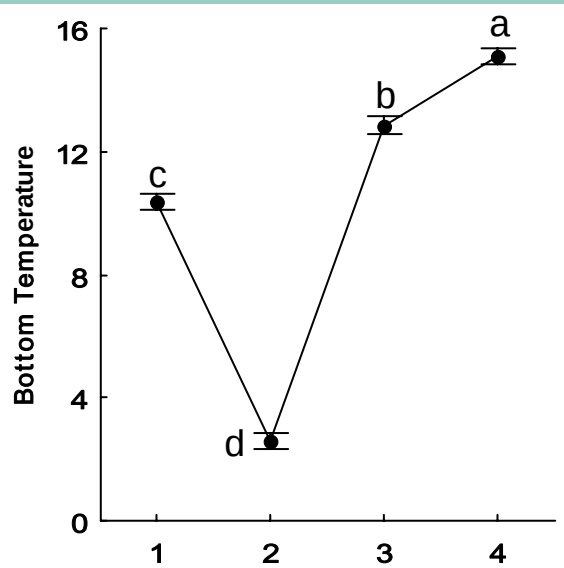
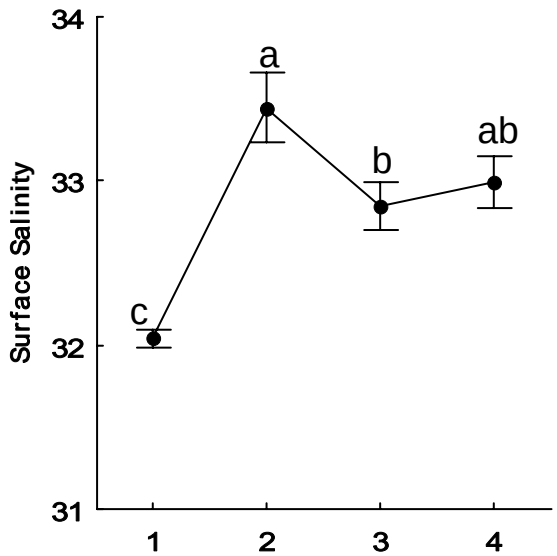
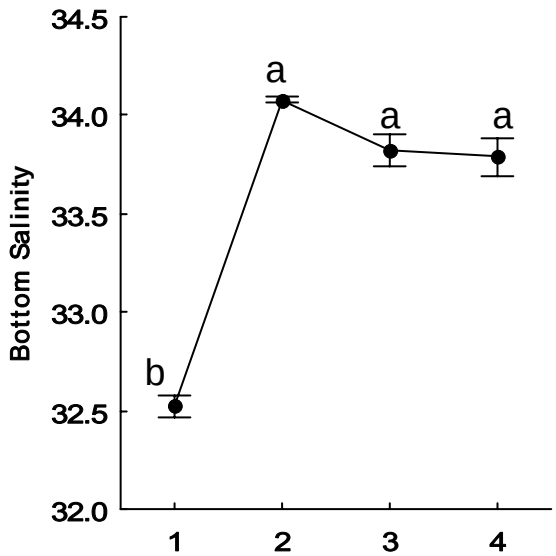
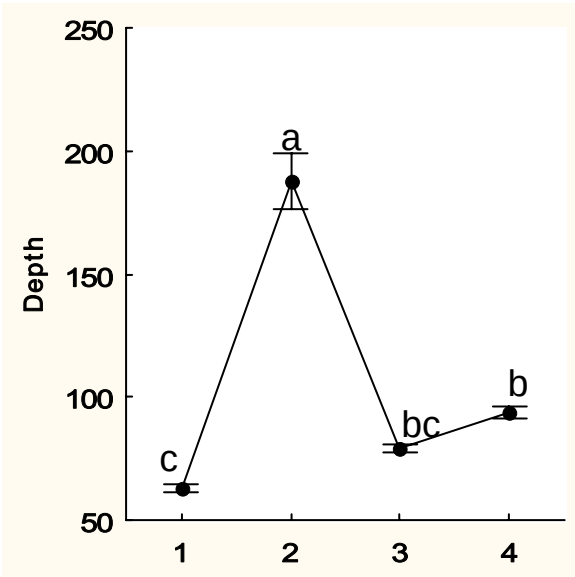
Environmental index of Each Cluster Group











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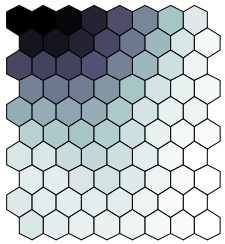
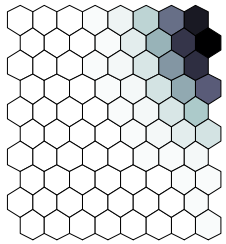
Typical distribution patterns of species



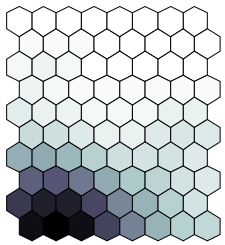
Cluster 1

Sea raven, Rockfish, Fat cod



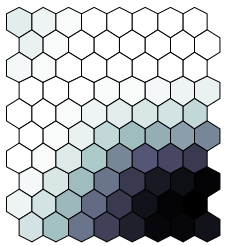
Cluster 2

Flatfish, Sailfin sandfish



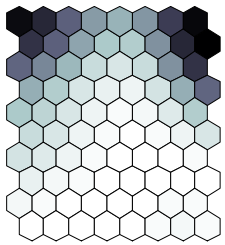
Cluster 3

Yellow croaker, Spotted velvetfish



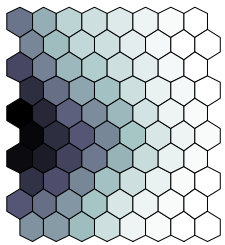
Cluster 4

Blackthroat seaperch, John dory, Jack marckerel



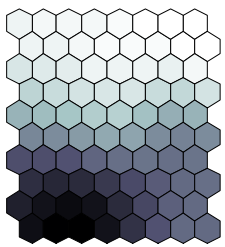
Clusters 1 and 2

Pacific cod



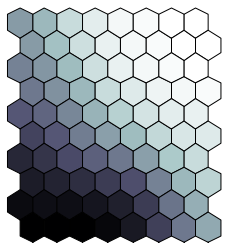
Clusters 1 and 3

Croaker



Clusters 3 and 4

Hairtail, Eel



Clusters 1, 3 and 4

Yellow goose fish

- **Environmental characters of each cluster group**

Cluster	Temp (Bottom)	Sal (Bottom)	Depth	Area	Reference
1	-	Low	Shallow	Yellow Sea	Typical temperate sea
2	Low	High	Deep	East Sea	Developed upwelling, water mixing layer
3	-	High	-	East China Sea	Warm current
4	High	High	-	South Sea	Seasonal current change

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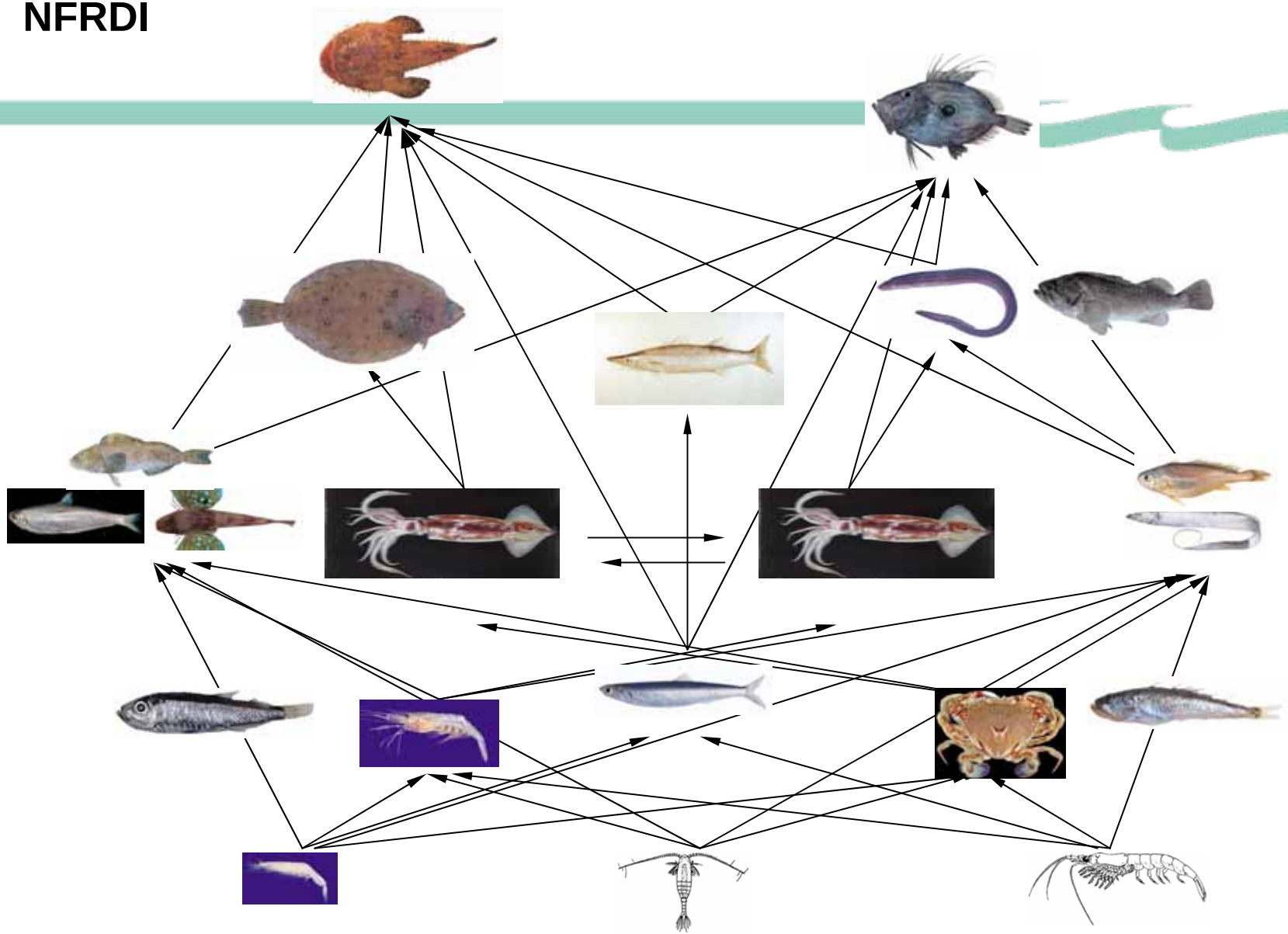

Figure. Simple schematic diagram of food chain around Korean waters.

- **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**

Cluster	Biomass	No. Sp.	Diver-sity	Trophic level	Life history strategy of main sp.	Longevity of main sp.
1	Low		-	3.5	Equilibrium sp., Lecithotrophic larvae	Short
2	High	Low	Low	3	Equilibrium sp., Lecithotrophic larvae	Long
3	-	High	-	3	Opportunistic sp., Small egg	Short
4	-	High	High	4	Opportunistic sp., Small egg	Short

- **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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